Fundamentals of Piano Practice, 2nd Edition

by Chuan C. Chang

November 21, 2004

Request To those who have found this material useful, please make an effort to let at least two people know about my web site (`http://members.aol.com/chang8828/contents.htm`), so that we can start a chain reaction of ever more people that will be informed of this site.

I am looking for volunteers to translate this book into any language. See "Notes for Translators" in the web page site. Please email me at `cc88m@aol.com` to discuss this matter.

This book is now available in German, Polish, Italian and French. I am very grateful to our German translator, Edgar Lins, for his many suggestions that have significantly improved the quality of this book.

If you feel that you have benefited from this book and wish to express your appreciation, please send a contribution to:

C. C. Chang, 35 Orchard Ln, Colts Neck, NJ 07722, USA,

to defray my expenses for writing this book and maintaining these web pages. Those who download the non-English versions should send their donations to the translator. If you send $15 or more, I will send you my 1st edition book (available in English only) until I run out of them (include your shipping address and email address). I will pay shipping and handling (1st class in US, airmail for overseas).

About this version This version has been typesetted, indexed and converted to PDF by Frédéric Loyer. Some other variants are available depending of the paper size or the font size; You may find them at the following address:

`http://www.sinerj.org/~loyer/PianoBook`.

Feel free to send typographic error reports or suggestions specific to this version at the following address : `frederic.loyer@club-internet.fr`. The original book, in HTML, can be found at

`http://members.aol.com/chang8828/contents.htm`.

Printing One way to print this book, is to save it in a file and send the file electronically to `http://docstore.kinkos.com` and follow directions (e.g., request double side, regular white paper, collate, coil binding, clear front and black vinyl back covers, locate nearest Kinko's Store, etc.); cost is about $30/copy (8 cents/page) if you pick it up at Kinko's, less if you order more copies.

For learning Piano For learning piano, use this book as a supplementary textbook if you have a teacher. If you don't have a teacher, pick any piece of music you want to learn (that is within your technical skill level) and start practicing it using the methods described here; the methods are arranged roughly in the order in which you will need them as you start learning a new piece. In either case (with or without a teacher), read the entire book quickly the first time, starting with the Preface which gives you a quick overview. Skip any section that you think is not relevant or is too detailed; do not try to understand every concept or to remember anything – read it like a science fiction novel, mainly for fun – you just want to get acquainted with the book and get some idea of where certain topics are discussed. Finally, read as much of the Testimonial section as you find interesting. Then re-start from where you think the book gives material that you need; most people will need to read all of 1.1 and 1.2. Then you can skip around to specific topics that apply to the composition you are learning. If you don't have a clear idea of what compositions to learn, this book cites many examples, from beginner material (1.3.18) to intermediate; therefore, in your first reading, look for where these examples/suggestions are

This book is dedicated to my wife Merry,
whose love, support, and boundless energy
is what enabled me to devote so much time to this project.

Testimonials

Updated: June 28, 2004

These testimonials illustrate the hopes, trials, tribulations, and triumphs, of pianists and piano teachers. The testimonials are not just a collection of flattering endorsements but are open, frank discussions of what it means to learn piano. I am heartened by the number of teachers who provided testimonials and by their indication that they are having more success with their students by using these types of methods. It seems inescapable that teachers who conduct research and improve their teaching methods are more successful. Numerous pianists mentioned that they were taught all wrong by previous teachers. Many, who liked their teachers, noted that these teachers used methods similar to those in this book. There is almost uniform agreement on what is right and what is wrong; therefore, when you follow the scientific approach, you don't get into the situation in which people cannot agree on what is right. I was impressed by how quickly some people picked up these methods.

The excerpts have been edited minimally, but irrelevant details have been excised so as not to waste the readers' time. Entries in [...] are my comments. I take this opportunity to thank everyone who wrote; they have helped me to improve the book. I can't get over the fact that readers of my book keep writing the book for me (i.e., I could insert their remarks in my book, and they would fit perfectly!). In the following, I have not selected just the flattering remarks; I chose material that seemed significant (educational), whether positive or critical.

1. [From a Christian Minister]

   This book is the Piano Bible. I have made such tremendous progress since purchasing it [1st edition book]. I continue to recommend it to others.

2. [In Jan., 2003, I received this email] (with permission)

   My name is Marc, and I am 17 years old. I just started playing the piano about a month ago and have been reading your book, The Fundamentals of Piano Practice... I do not have an instructor yet, but am in the process of looking for one ... [followed by a series of precocious questions for a young person with so little piano experience. I answered his questions as well as I could; then]

3. [in May, 2004, I received this astounding email]

   I don't quite expect you to remember me, but I sent you an email a little more than a year ago... I would like to let you know how piano has been coming along for me using your method. I began playing the piano about Christmas of 2002, using your method from the beginning. Mid-March of 2003, I entered my high school's concerto competition for fun and experience — not in the hopes of winning their $500 scholarship. I unexpectedly won first place, competing against more seasoned pianists of up to 10 yrs. It did shock the judges when I told them I had been playing for 3 months. A few days ago, I won this year's competition, as well. In other words, progress has come very quickly. Such progress is one of the greatest motivators (aside from the general love of music), so I can now see myself playing — and improving in — the piano for the rest of my life. And, though I must give my teachers credit as well, your method is my foundation upon which they build, and I believe it is the main reason for my progress. However, I still consider myself a beginner ... My website (`http://www.mtm-piano.tk`) as all of the recordings which I have made to date (18)... recently, I have been re-recording Chopin's "Raindrop" prelude, Scarlatti's K.466, and Bach's Invention in F major... My next recording will be Bach's Sinfonia in E minor, and I plan to have that done by the end of next week. Your book is far more than any lover of music and the piano could expect, and I cannot thank you enough for the help you have given to me and so many other aspiring pianists ... [Go to the website and listen to those amazing recordings!! You can even find him at the `http://music.download.com` web site (search Marc McCarthy).

4. [From a respected, experienced piano teacher.]

   I just skimmed your new section [on parallel set exercises] and thought I'd share my initial reaction. As the Queen Regent of Exercise-Haters, I've lobbied loud and strong for the criminalization of Hanon et al, and was at first aghast to think you may have joined the downtrodden masses of the pseudo-voodoo-esque practitioners, hopelessly, helplessly, repeating, repeating, ... Anyway, to get to the point, I do see a point of merit in your approach, IF IF IF the student follows your COMPLETE directions and uses the described key combinations as a diagnostic tool — NOT to repeat each and every combination as a daily routine. As a diagnostic tool and subsequent remedy, you've succeeded marvelously! There was something familiar about your exercises, so I dug around at the studio today and found the Technische Studien by Louis Plaidy, Edition Peters, first printing ca 1850. Although Plaidy's philosophy concerning the use of his exercises is much different from yours, the actual notes printed on the page follow nearly to the letter (tee, hee, I should say to the note) what you have described in your exercise chapter. Plaidy's exercises were highly respected in Europe throughout the late 1800's and were used during that time at the Conservatory in Leipzig. Plaidy himself was quite a sought-after instructor, with several of his protege accepted into Liszt's inner circle and/or having some sort of success on the concert stage. You're in the company of greatness!

5. I am curious to know if you know of the work of Guy Maier. Does his approach with "impulse" practice of 5 finger patterns go along with the "parallel sets" you mention? Maier does use the principle of repeating one note with each finger as the others are held quietly at the key surface as one of the 5 finger exercises. *Thinking Fingers* was one of the books of exercises Maier wrote with Herbert Bradshaw in the early 1940s. One of his first 5 finger exercises that seems to mirror what you have said about "quads" repetitions on one note using one finger is as follows:

   (a) Single fingers in repeated note impulses of 1, 2, 3, 4, 8, and 16.

   (b) Practice each finger separately, depress other keys lightly or hold fingers silently at key top position.

(c) Using CDEFG in right hand, place 5 fingers on these notes one octave above middle C, right hand thumb on C.

(d) Similarly with left hand, one octave below middle C, with fifth finger on C.

(e) Exercise hands separately; starting with right hand thumb play one impulse C, then release, then two impulses, etc., up to 16. Repeat with each finger, then do the left hand.

[See my Exercise section 1.3.7.2; it is amazing how we independently arrived at groups of "quads" (four repetitions), up to 4 quads (16 repetitions) for this exercise which is almost identical to my Exercise #1.]

(f) Beginners will have to do the impulses slowly, working up to full speed (and here I think your "quads" come into play — so many repetitions per second is the goal).

Maier mentions 16 as his limit. He gives a great many patterns for using this approach to 5 finger impulse exercises, in Book 1 and Book 2 of *Thinking Fingers* published by Belwin Mills Inc., NY, NY in 1948. I think Maier was striving to help students get the facility they needed without the endless repetitions of Hanon, Pischna, et al.

6. Please send me your book — I've been a piano teacher for over 50 years, still eager to learn.

7. [This testimonial is an eye opener: it teaches us about one of the most frequently misdiagnosed problems that stops us from playing fast.]

At a young age, I started, and then quit piano. Then as a teenager, I went to a [famous] conservatory and tried for years to acquire technique but failed miserably and ended up with an engineering career. Years later, I have returned to piano (Clavinova) and am trying to do what I failed to do years ago. One of the reasons I stopped practicing is that my wife and son would get irritated when they heard me repeat passages over and over; the Clavinova allows me to practice guiltlessly at any hour. I read your web page and was fascinated. Wish I had thought of some of your ideas years ago. I have a question and I can't seem to get an answer that makes any sense, yet it is such a basic question. I was taught that when you play piano, you support the weight of your arm on each finger that plays. Gravity. You never push down, you must be relaxed. So I asked my teachers how to play pianissimo. The answer was that you play closer to the keys. This does not work for me. [Long discussion of various methods of trying to play pianissimo with arm weight and why they don't work. Seems he can play pianissimo only by consciously lifting his hands off the keys. Also, since everything tends come out forte, speed is a problem.] Would you kindly answer this question for me? What does one do with ones arm weight when one plays pianissimo? I have read many books about playing the piano and have spoken with many accomplished pianists. It is one thing to know how to play anything and it is quite another to be able to teach someone how to play. [I could not have said this any better!] Your writings are brilliant and in many ways revolutionary, I knew instinctively that if anyone could help me you could.

[After such a compliment, I had to do something, so I read the account of his difficulties carefully and came to the conclusion that he must, after so many years of trying, be unwittingly pushing down on the piano, almost as if he were hypnotized. I told him to find a way to see if he was actually pushing down — not an easy task. Then came this reply.]

Thank you for your response. Truth is best examined through extremes. Your suggestion gave me the idea that maybe I should ALWAYS play like I play MY pianissimo — by lifting my hands off the keys. I rushed to my Hanon, and YES! I can play much faster! I quickly rushed to the Bach Prelude II that I could never play to speed (144) and I always had troubles getting the fingers to land together when playing fast, and at speeds above 120 the fingers were landing like one note together. No fumbles, no strain. Not only that, I can play piano or forte as fast as I want. It feels so incredibly EASY! Just discovered it now! I can't believe this. [Long discussion of how, through the years, he had come to equate arm weight with pushing down, mainly caused by a fear of not understanding the teacher who was a strict, arm weight disciplinarian. This is actually something I have been very suspicious of, about the arm weight method: that so much emphasis on arm weight and overly strict discipline might cause some type of neurosis or misunderstanding — perhaps even some type of hypnosis.] A huge wall just crumbled and now after so many years of thought and hours of practice (I practiced up to 10 hours a day at the conservatory and still only memorized music without ever improving my technique) and now I can see beyond. I discovered that I have the ability to play faster than I ever dreamed I could (just tried the C major scale and I was shocked that this was me playing) with full range of sound that I want WITHOUT TENSION. [A long description of all the new things he is now doing and comparing them to his previous years of struggles and criticisms from others.] I have you to thank for this. Yours was the only book I have ever read that offered enough variation from the mainline to get me to finally free my mind from a huge misconception. I was pushing down, not letting go. My arms simply don't weigh a ton, but they are free. Because I was afraid of my teacher and was obsessed with the weight of my arms, I was subconsciously bearing down. I never dared play *ppp* for her. I knew how, but I was certain it was the wrong technique. [I am afraid this happens frequently with youngsters; they don't understand the teacher but are afraid to ask, and end up assuming the wrong thing.] What she should have told me was DON'T EVER PUSH DOWN; instead, I fixated on the weight of my arms as being key to everything. [A youngster must push down to put any "weight" on his arms! How are you going to explain that this is wrong to a child who hasn't studied physics?] She also never allowed me to play quickly. [This is another comment I have heard from students of strict arm weight teachers — speed is a no-no until certain milestones are achieved; although we must exercise caution when practicing for speed, slowing down is not the quickest way to speed.] Because I was tense, and she said I would never play quickly if I'm tense. In your book you say that we have to play fast to discover technique. I was never allowed to! Your book and your email freed the chains in my mind that held me captive for all these years. Thank you so very much. I cannot describe how grateful I am to you and your insight.

[Although my comments seem to be directed against the arm weight school, that is not the case — similar difficulties apply to any teaching based on insufficient knowledge in the hands of strict disciplinarian teachers. Unfortunately, a large number of piano teachers has historically adopted inflexible teaching methods because of a lack of a theoretical understanding and rational explanations. For systematic treatments of speed, see sections 1.2.13 and especially 1.3.7.1]

8. I found your book on the internet and consider myself very lucky. Thank you very much for making such a great effort on describing the piano technique and practice habits that make sense. I am a piano teacher. I've only started to read the book and have already applied some practice techniques with my students. They liked it and I liked it too. The practice becomes so much more interesting. Do you know the book called "The Amateur Pianist's Companion" by James Ching, published by Keith Prowse Music Publishing Co., 1956, London. This book may be out of print, but I found it second hand at: `http://dogbert.abebooks.com/abe/BookSearch`

   You might be interested because "the detail of correct postures, movement and conditions as outlined in this book are the result of extensive researches into the physiological-mechanics of piano technique carried out by the author in conjunction with Professor H. Hartridge, Professor of Physiology, and H. T. Jessop, Lecturer in Mechanics and Applied Mathematics, at the University of London".

9. I am so grateful that I found your web site. I am an adult piano player, that was taught all wrong, when I was young. I am still trying to unlearn my bad techniques and habits. I now take lessons from a very good teacher.

10. A few weeks ago I downloaded your book from the Internet and have been trying it out. I'm about halfway through and a long way from fully applying everything, but I'm so pleased with the results up to now that I thought I'd give some spontaneous feedback.

    Firstly some background. I studied piano up to an advanced level and started a music degree, which I dropped after a year to study math. After graduation I was an enthusiastic amateur, but over the last 20 years my playing has become less frequent, mainly due to my frustration at a lack of progress, convinced that I would never be able to find the hours of exercise needed to be able to play better.

    I was looking for some hints for buying a piano and came across your site. After reading a couple of chapters I downloaded the whole thing and started trying it out. This is not the first time I have tried to improve with a book or advice from a teacher, but I'm a sucker for punishment. Here are my experiences after three weeks. [Note how quickly people can learn and immediately make use of these methods.]

    I've been concentrating on studying 4 pieces which are very dear to me:

    - Ravel's Prelude;
    - Chopin Prelude no. 26 in A♭ major;
    - Poulenc Novelette no. 1;
    - Ravel Alborada del Graziosa from Miroirs.

The Ravel Prelude is a small piece of no apparent technical difficulty. This is a piece that I had always played on sight, but never really well. There is a crossed hands section in the middle with some exquisite dissonance that poses some difficulties, but that's about it. I applied the practice methods in the book to this piece and it suddenly came alive with far more nuance than I had ever credited it. It's anything but the throwaway I thought it was, but without proper practice methods it will always seem that way.

The Poulenc Novelette is one of the pieces that I have played at least once a week for 20 years and am very fond of. I've never really played this fully to my satisfaction, but I'd always assumed that this was due to a lack of exercise time. Using your suggestions I started analyzing what was wrong. Aside from some obvious flubs that had never really been learnt correctly the most surprising result was that it was impossible for me to keep in time to the metronome!! Some more detailed analysis revealed the cause — a lot of Poulenc's writing requires rapid and awkward shifts of hand position with melodies that need to be sustained across these shifts. The bad habit that I had learnt was to "grab" at the keys during these shifts, hence destroying the melody line and gradually speeding up the piece. The revelation to me was that the problem could not be fixed by practicing with the metronome! It could only be fixed by analyzing this problem and working out a strategy for dealing with the shifts. Now I am very satisfied with the way I play and even have a lot of time left over to consider the music.

Alborada del Graziosa is a case apart. This is a fiendishly difficult piece which I had tried to learn in the past, but was unable to bring most of the passages up to the correct speed. My assumption had always been that more practice was necessary and that I could never find the time. Again — applied the methods in your book to learning this and, after three weeks, I'm not yet there but I can now play most of it up to speed and reasonably musically as well. I reckon I'll have it all in my fingers in a couple of weeks then I can concentrate on the music.

Last but not least, the Chopin prelude. I learnt this for an exam when I was 16 yrs. old, but have never really played it since. I started relearning it and made a couple of discoveries. Firstly I had never played it up to speed, even for the exam, so this was something I needed to fix. However this just didn't work — I discovered that for two reasons I couldn't speed up. Firstly I had learnt to fake the legato with the pedal — but once you speed up you just get a jumble of sound and if I try to pedal correctly I just couldn't get the legato. Secondly the middle section contains some highly stretched broken chords in the left hand that shift on each beat. Played slowly this is ok, but at speed it becomes fiendishly difficult and even painful to play. Basically I have had to relearn this piece — new fingerings, new hand positions, different pedaling etc. Now I can play this at any speed I like with no stress. I found this an interesting proof of what you say in the book — this is a very small piece that seems fairly easy, but at speed it completely changes character and will frustrate any student using the intuitive method, unless they are blessed with a span of over 1.5 octaves.

In closing I'd like to thank you for writing the book and even more for making it available on the Internet. I have in the past spent enormous amounts of money on highly recommended teachers and not one of them, although I have no doubt that they understood these techniques themselves, could teach me how to practice.

11. I think your book is worth my reading although many of the "rules" (such as hands separate practice, chord attack, ...) I have learned from our teachers. In my logic even if just one rule I learned from your book works, it is worth far more than the $15 I paid for the 1st edition. I also like the section on how to prepare for recitals. I agree that practicing full speed before the recital is a "no no". I discussed this with my teacher and we see several reasons why [extended discussions on why playing full speed on day of recital can lead to problems, not excerpted here because I can't understand them]. Thus practice fast before the recital is a no-win situation. Finally, I would like to see more about how to gain speed and how to put hands together more efficiently. Some music (Bach's Inventions come to mind) is easy to play hands separate but difficult hands together. Overall, I enjoy reading your book.

12. I encourage everyone to try hands separate practice as stated in your book. While studying with Robert Palmieri at Kent State University, he had me do this as part of my practice. It helped me get past the amateur stage and on to much better technique and musical playing.

13. Based on what I was able to glean from your web site, I applied one of the principles — hands separate playing at full tempo — on a couple of difficult passages in two completely different types of songs I was playing, one a church hymn, the other a jazz tune. Interestingly, I found that when I got to church yesterday and it came time to accompany the congregation, the difficult portions I had learned by the hands separate method were among the most solid and sure of the entire hymn. It seemed that each time I came to one of those difficult spots, a mental trigger went off that alerted my brain/nervous system to execute those parts with particular care and accuracy. Same goes for the difficult spot in the jazz tune, which is now no longer a problem at all.

14. About one and a half years ago I ordered the book Fundamentals of Piano Practice from you. I just wanted to personally thank you for your contribution. It has helped me a great deal! I never knew how to practice before your book because I was never taught. I took lessons, mind you, but my teachers never taught me now to practice. Isn't that amazing! I suspect that it is commonplace. The most beneficial piece of advice for me is your suggestion to play at a much slower speed on the last run-through of the piece you are practicing. I must admit developing this habit has been most difficult for me. But I am trying. I find that slow practice is a big help. Also, practicing just a measure or two at a time has been valuable! I wished that memorizing music came easier; if you have any new ideas on memorizing, please let me know. [I have added considerable material on memorizing since this correspondence.]

15. Thank you for answering my piano practice questions. I must tell you that there is one particularly tricky Prelude of Chopin's — the one in C sharp minor. When I received your book, I mastered this Prelude more than up to its rapid speed in one day. Granted it is a short one, but many pianists wrestle with it. This experience has been very encouraging.

16. I have been playing piano for 8 years now and bought your book about a year ago. After reading this book, my 1 hour a day practice sessions are much more productive. I also learn new pieces much faster. You show insight on the following:

    - Correct methods of practice;
    - How to start a new piece;
    - Slow practice (when to do it and why);
    - When to play faster than normal;
    - How to get ready for a performance.

    I don't agree with everything you write, but I read your book about every couple of months so I don't lose sight of the proper way to practice. [This is a common refrain: my book is such a dense compilation that you need to read it several times.]

17. After one week, I was very pleased with myself and the method since I thought that I had successfully MEMORIZED!!! a whole page HS. This was an absolutely unknown achievement as far as I was concerned. But problems arose when I tried to put the two hands together, which I then tried to do whilst learning the rest of the piece. I also found on trying to learn the rest of the piece that I had 'memorized' the first page wrongly, and I ended up writing notes to myself. [This probably happens more often than most of us would like to admit — when you have difficulty in getting up to speed HT, CHECK THE SCORE! the cause could be an error in reading the music. Errors in rhythm are particularly difficult to detect.] Your book HAS given me exactly what I was looking for — i.e. some basis for working out how to learn more quickly and efficiently. No teacher has ever been able to give me any clue as to how to go about learning a piece. The only suggestion I have ever had is, 'Have a look at this and see what you can make of it', and as for how to improve the accuracy and/or speed, 'Keep practicing, practicing, ...' WHAT????? I've now got answers to these vital questions. Thanks.

18. I have been reading your book on your site and have been getting a lot out of it. You have inspired me to practice the way I have always known was the best way but never had the patience to do it. What you outline about even chords before trying to play fast lines sure has helped me a lot. I think my inability to play beyond a certain speed is due to a basic unevenness in my fingers that I have never really addressed. I always would just say, "I just can't play fast well". I have worked up a small portion of an etude using the chord attack approach and can actually play it fairly smoothly and evenly! I am curious about your theories on perfect pitch development. The camps seem very divided on that subject: genetics vs. environment. [Since this correspondence, I added the parallel set exercises for chord practice, and have written an expanded section on acquiring perfect pitch.]

19. I just wanted to let you know how much my family of musicians has been enjoying your book on piano playing. Without doubt, you set forth some innovative, unorthodox ideas in your book that really do work in spite of the fact they sound extreme by most practicing piano teachers' standards. [I agree!]

The method of practicing hands separately seems to be working quite well as well as the method of not playing everything soooooo slowly! Also, putting less emphasis on the metronome has also been proving beneficial. Certainly, your methods have helped speed up the entire learning process on new pieces, and now I can't imagine how we ever managed before without knowing these "musical truths" of yours. Thank you again for writing such a marvelous JEWEL of a book!

20. I read the online sections and think every piano teacher should be required to have read this book. I'm one of the unfortunate who spent 7 years practicing scales/Hanon without any hints about relaxation or efficient practice methods. I started to pick good practice hints from internet discussion groups and various books, but your book is by far the most comprehensive and convincing source I have found yet.

21. I am a piano player at an intermediate level. A month ago I downloaded parts of your book and I must say in one word that it is fabulous! Being a scientist I appreciate the structural way the subject matter is presented and explained on a down to earth level. It changed my way of looking at piano practice. Especially the part on memorizing helped me already to reduce memorizing efforts considerably. My private teacher (a performing soloist) uses bits and pieces from your method. However this teacher is a Czerny addict and never heard of thumb over. You need to spend more attention to the thumb over, especially how to smoothly join parallel sets. I gave a copy of the book to my teacher and I recommend it to everybody.

    [A year later]

    I already wrote you once more than a year ago about your fantastic book on the internet. The methods really work. Using your methods I was able to learn and master some pieces much faster. Your methods really work for pieces that are notoriously difficult to memorize, like some Mozart sonatas, and pieces of which my piano teacher said are difficult to memorize like the Bach Inventions or some preludes of Chopin. Piece of cake using your method. I am now tackling the Fantaisie Impromptu and this seemingly impossible piece appears to be within my reach! I also like your contribution about the subconscious mind. I wonder whether you know the book of J. D. Sarno: The Mindbody Prescription. This book treats the subconscious exactly like you do. While working on my PhD thesis, I solved many seemingly unsolvable theoretical enigmas just like you did. I fed it to my brain and some days later the solution just popped out. So what you write is dead right!

22. Your suggestions on how to memorize music by creating associations (a story, for example) sounded silly to me. But when I was practicing, I couldn't help asking what I could associate with a certain musical phrase that had a problematic F chord. "Give yourself an F for failing" popped into my mind. I thought that was not very encouraging thinking! But now every time I come to that phrase I remember the F. I've got it. Sheesh! Thanks. Your book is very useful. It mirrors my teacher's suggestions, but with more detail. When I can't play the piano nothing is more fun than reading about playing the piano .... In the final weeks before my last recital, my teacher suggested playing through my mistakes during practice. Then going back and working on the

problem measures, much as you suggest, though that was the only time that it came up. She says most people will not even know the mistake was made unless it interrupts the music. Her point is to not interrupt the music and to correct the problem at the source by going back to the measure. I find that I do correct myself (stutter) a lot; I'm going to focus on not doing it. This advice is not intuitive, you know. One corrects mistakes naturally when they happen. But I can see that constantly doing that is actually building the mistakes in.

23. I stumbled on your online book on piano practice when I was searching for articles on absolute pitch. When I read it, I was impressed by the scientific approach used. Especially the concept of "speed wall" and how to overcome it helped me a lot. I found your book at just the right time. Many problems I encounter in playing the piano are discussed in your book. Many piano teachers don't seem to have a clear scientific concept on how to handle specific problems of intermediate piano players. So I am working through the book, section by section with good success. There are several things I am missing in your book. In some chapters, pictures would be very helpful, such as correct hand position, thumb over, parallel set exercises. Something like a chronological table for the practice routine might be useful. "Practicing cold" would be on position number one, for example. You always mention the importance of WHEN to do WHAT. Could you order the exercises you explain in a way that makes them most efficient? Anyway, I want to express my deep appreciation for your project!

24. All this winter, I continued my personal piano learning and I must say that every word in your book is true. I have been studying piano for several years and made only average progress. Because I love piano and romantic music, that makes me sometimes crazy and deeply frustrated. After application of your methods from about 1 year ago, I made tremendous progress. I am now working on several pieces at once, compositions I never thought before that I can play. It's wonderful. Today, I have a small repertoire that I can play with great satisfaction.

25. I have ordered and received your 1st ed. book and have read sections of your 2nd ed. I have found your information to be extremely valuable. I am sending you this email because I was hoping to get some advice on my upcoming recital. I am extremely nervous but after reading your sections on recitals I understand their importance. I wish I had your notes on memorizing when I started because it has taken me an extremely long time to finally memorize it (the improper way). I am not sure how to perform the piece for the recital. On the few occasions that I played for others I would stumble on certain sections because I would forget where I was in the piece because of nerves. This is my first recital so I don't know what to expect. Any tips or advice on practice routines would be much appreciated.

    [After a few exchanges about what he was playing, etc., I gave him a scenario of typical practice routines for recital preparation and what to expect during the recital. After the recital, I received the following email.]

    I just wanted to let you know that my recital went extremely well considering it was my first time. The advice you gave me was very helpful. I was nervous starting the piece but then I became extremely focused (just like you said would happen). I was even able to concentrate musically rather than just going through the motions. The audience was impressed at my ability to do it from memory (just like you said they would). You were right in saying that a positive experience like this would help me with my confidence. I feel great about the experience! My teacher is from [a famous Conservatory], and teaches Hanon exercises and other technique material. That is why your book was and is a gold mine for me. I want to be able to play the pieces that I enjoy without having to spend 20 years to learn them. But I also feel that I need a teacher.

26. Finally, hundreds of communications of the type:

    I must say that you book is excellent ....

    Since reading C. C. Chang's Fundamentals of Piano Practice, I've been trying out his suggestions; thanks to those who recommended it and to Mr. Chang for taking the time to write it and make it available.

    I have found your web pages very useful for me in my work on playing the piano.

    Your work is very wonderful!

    This is helpful and encouraging as I go back to the piano after years of not having one available; thanks!

    You have been of enormous help to me.

    From what I have read so far it makes a lot of sense and I'm excited to start trying it.

    Etc., etc.

Preface

Updated: August 11, 2004

This is the first book ever written on how to practice at the piano! The revelation of this book is that there are highly efficient practice methods that can accelerate your learning rate, by up to 1,000 times if you have not yet learned the most efficient practice methods. What is surprising is that, although these methods were known since the earliest days of piano, they were seldom taught because only a few teachers knew about them and these knowledgeable teachers never bothered to write them down (or let others in on their secret).

I realized in the 1960s that there was no good book on how to practice the piano. The best I could find, after a literature search, was Whiteside's book, which was an utter disappointment (see References section). As a graduate student at Cornell University, studying until 2 AM just to keep up with some of the brightest students from all over the world, I had little time to practice piano. I needed to know what the best practice methods were, especially because whatever I was using wasn't working although I had taken piano lessons diligently for 7 years in my youth. How concert pianists could play the way they did was an absolute mystery to me. Was it just a matter of sufficient effort, time, and talent, as most people seem to think? If the answer were "Yes", it would have been devastating for me because it meant that my talent level was so low that I was a hopeless case because I had put in sufficient effort and time, at least in my youth, practicing up to 8 hours a day on weekends.

The answers came to me gradually in the 1970's when I noticed that our two daughters' piano teacher was teaching some surprisingly efficient methods of practice that were quite different from methods taught by the majority of piano teachers. Over a period of more than 10 years, I kept track of these efficient methods and came to the realization that the most important factor for learning to play the piano was the *practice methods*. Effort, time, and talent were merely secondary factors! In fact, "talent" is difficult to define and impossible to measure; talent might play some role in determining the winner of a Van Cliburn competition; however, for the majority of aspiring musicians "talent" is a nebulous word we use frequently but it has no definable meaning. In fact, proper practice methods can make practically anybody into a "talented" musician! I saw this happen all the time at the hundreds of student recitals and piano competitions that I have witnessed. Every dedicated student who found the right teacher became a "talented" musician.

There is now mounting evidence, some discussed in this book, that genius or talent may be more created than born (see Olson) — Mozart is possibly the most prominent example of the "Mozart Effect" (`http://parenting-baby.com/Parenting-Baby-Music-Research/Music-Research.html`). Some have renamed this "The Beethoven Effect" which might be more appropriate because Mozart had some personality weaknesses, etc., that sometimes tainted his otherwise glorious music. Note that listening to music is only one component of the complex Mozart Effect. For pianists, *making music* comprises the larger component. Thus good practice methods will not only accelerate the learning rate but also help to develop the musical brain, especially for the young. The learning rate is accelerated, not merely speeded up (it's like the difference between an accelerating vehicle and one going at a constant speed). Therefore, in a matter of a few years, students without proper practice methods will fall hopelessly behind. This makes those students with good practice methods appear far more talented than they really are because they can learn in minutes or days what it takes the others months or years to learn. Thus the notion that "piano technique is finger strength and dexterity" may be mostly a figment of the imagination with no supporting evidence; technique is more brain/nerve development and improved music/memory ability.

Practice methods can make the difference between a lifetime of futility, and a concert pianist in less than 10 years for young, dedicated students. Using the right practice methods, it takes just a few years for a diligent student at any age to start playing meaningful pieces from famous composers. The saddest truth of the past two centuries has been that, although most of these great practice methods were discovered and rediscovered thousands of times, they were never documented and each student either had to rediscover them by her/imself, or, if lucky, learn them from teachers who had some of these methods in their heads. The best example of this lack of documentation is the "teachings" of Franz Liszt. There are a dozen Franz Liszt societies and they have produced hundreds of publications. **Numerous books have been written about Liszt (see Eigeldinger, in References), and thousands of teachers have claimed to teach the "Franz Liszt method", complete with documented teaching lineages. Yet there is not one publication that describes what that method is!** One reason for this lack of documentation may be that good teaching methods are the basis for the livelihood of most teachers and are therefore a form of "trade secret". There are endless accounts of Liszt's accomplishments and technical prowess, yet there is not one reference on the details of how he got that way. There is some evidence in the literature that Liszt himself could not remember exactly what he did in his youth; this is understandable because he was probably experimenting and trying something different every day. Since piano pedagogy has succeeded in losing track of how the greatest pianist of all time initially acquired his basic technique, it is little wonder that we have not had anything close to what we might call a textbook on learning piano. Can you imagine learning math, physics, history, computer programming, or anything else without a textbook, and (if you are lucky) only your teacher's memory as a guide? Yet, when you go to your piano lesson, the teacher never gives you a textbook on piano practice. Consequently, every teacher has her/is own methods of teaching/practice, and each thinks that her/is method is better than anyone else's. Without textbooks and documentation, our civilization would not have advanced much beyond that of jungle tribes whose knowledge base had been passed on by word of mouth. That's basically where piano pedagogy has been for the last 200 years!

There are many books on learning piano (see References), but none of them qualify as textbooks for practice methods, which is what students need. Many of these books tell you what skills you need (scales, arpeggios, trills, etc.) and the more advanced books describe the fingerings, hand positions, movements, etc., to play them, but none of them provide a systematic set of instructions on how to practice. Most beginner music books provide a few such instructions, but many of those instructions are wrong — a good example is the amateurish advertisement on how to "become a virtuoso in 60 exercises" in the introduction to the Hanon series, written by none other than Hanon himself (see section 1.3.7.8). If you were to take a survey of recommended piano practice methods from a large number of piano teachers who have not read this book, many of those methods would contradict each other, so that we know immediately that they can't all be correct. Not only that but, because there was no textbook, we had no idea about what comprises a reasonably complete set of instructions. In piano pedagogy, the most essential tool for the student — a basic set of instructions on how to practice, had been basically non-existent until this book was written.

I did not realize how revolutionary the methods of this book were until after I finished my first edition book. All I knew initially was that they were better than what I had been previously using. For years, I had been applying them with good, but not remarkable, results. I experienced my first awakening after I finished that book. That was when I really read my own book and followed the methods systematically, and experienced their incredible efficiency. So, what was the difference between just knowing the parts of the method and reading a book? In writing the book, I had to take the various parts and arrange them into an organized structure that served a specific purpose and that had no missing essential components. As a trained scientist, I knew that organizing the material into a logical structure was the only way to write a useful manual (see 3.2). It is well known in science that most discoveries are made while writing the research reports, not when conducting the research. It was as if I had all the parts of a terrific car, but without a mechanic to assemble the car and tune it up, those parts weren't much good for transportation. Whatever the exact reasons were for the effectiveness of the book, I became convinced of its potential to revolutionize piano teaching (see "Testimonials" section) and decided to write this 2nd edition. The 1st edition wasn't even a bona fide book; it didn't have an index or a reference section. I had hurriedly written it in four months when I had a little free time between jobs. Clearly, I had to conduct a broader research in order to fill any gaps and do a thorough review of the literature; i.e., I had to satisfy the requirements for a truly scientific approach to piano practice (see Chapter Three). I also decided to write this book on my web site, so that it could be updated as my research progressed and whatever was written would be immediately available to the public. As we all know by now, an internet book has many other advantages; one of them is that you don't need an index because you can do a word search. As it turned out, this book is becoming a pioneering effort in providing free education over the internet.

Why are these practice methods so revolutionary? For detailed answers, you will have to read this book and try them out. In the following paragraphs, I will attempt to present a few overviews of how these miraculous results are achieved and to briefly explain why they work. Let me start by pointing out that I did not originate any of the basic ideas in this book. They were invented and re-invented umpteen times in the last 200 years by every successful pianist. The basic framework for the methods of this book was constructed using the teachings of Mlle. Yvonne Combe, the teacher of our two daughters who became accomplished pianists (they have won many first prizes in piano competitions and averaged over 10 recitals a year each for many years; both have perfect pitch, and now enjoy composing music). Other parts of this book were assembled from the literature and my research using the internet. My contributions are in gathering these ideas, organizing them into a structure, and providing some understanding of why they work. This understanding is critical for the success of the method. Piano has often been taught like religion: Faith, Hope, and Charity. Faith that, if you followed procedures suggested by a "master" teacher, you will succeed; Hope that, "practice, practice, practice" will lead you to the rainbow, and Charity that your sacrifices and paying your dues will perform miracles. This book is different — an idea is not acceptable unless the student understands why it works and to adapt it to her/is specific needs. Finding the correct understanding is not easy because you can't just pluck an explanation out of thin air (it will be wrong, and incorrect explanations are worse than none at all) — you need enough expertise in that field of knowledge in order to arrive at the correct explanation. Providing a correct scientific explanation automatically filters out the wrong practice methods. This may explain why even experienced piano teachers, whose educations were narrowly concentrated in music, can have difficulty in providing the proper understanding and will frequently give wrong explanations for even correct practice methods. Giving an incorrect explanation for a correct method can do more harm than good because it not only confuses the student but also, an intelligent student would conclude that the method should not work. This is another quick way for the teacher to lose all credibility. In this regard, my career/educational background in industrial problem solving, materials science (metals, semiconductors, insulators), optics, acoustics, physics, electronics, chemistry, scientific reporting (I have published over 100 peer-reviewed articles in major scientific journals), etc., have been invaluable for producing this book. These diverse requirements might explain why nobody else was able to write this type of book.

So, what are some of these magical ideas that are supposed to revolutionize piano teaching? Let's start with the fact that, when you watch famous pianists perform, they may be playing incredibly difficult things, but they always make them look easy. How do they do that? Fact is, they *are* easy for them! Therefore, many of the learning tricks discussed here are methods for making difficult things easy: not only easy, but often trivially simple. This is accomplished by practicing the two hands separately and by picking short sections to practice, sometimes down to only one or two notes. You can't make things any simpler than that! Accomplished pianists can also play incredibly fast — how do *we* practice to be able to play fast? Simple! By using the "chord attack" — this is a way of moving all the fingers simultaneously so that, for certain combinations of notes, they can be played *infinitely* fast, even for novice players. We certainly don't need any speed faster than infinity! See section 1.2.11 on "parallel sets". Although I coined the phrase "parallel sets" for this application, it is just a fancy word for "chord" (here, I use "chord" loosely to mean more than one note played simultaneously). However, "chord" was not as good a choice as "parallel sets" because I needed a name more descriptive of how the fingers move (the connotation is that the fingers move in parallel) and among musicians, "chord" has a more narrowly defined meaning. Of course, it takes practice to be able to string fast parallel sets together to produce music but, at least, we now have a bio-physically sound procedure for developing the necessary muscle/nerve configurations for playing fast. In this book, I have elevated parallel set exercises to a very special level because they can be used both as a diagnostic tool to discover your technical weaknesses and as a way to solve those specific weaknesses. That is, parallel set exercises can provide almost instant solutions to a majority of technical deficiencies. Parallel set exercises are not finger exercises in the sense of Hanon or Czerny; instead, they are the single most powerful set of tools for rapid technique acquisition. In summary, the key to the success of the methods here is the use of ingenious "learning tricks" that are needed to solve specific problems.

Even with the methods described here, you may need to practice difficult passages hundreds of times and, once in a while, up to 10,000 times before you can play the most difficult passages with ease. Now if you were to practice a Beethoven Sonata at, say, half speed (you are just learning it), it would take about an hour to play through. Therefore, repeating it 10,000 times would take 30 years, or half a lifetime, if you had, say, one hour per day to practice and practiced only this sonata 7 days a week. Clearly, this is not the way to learn the sonata, although many students use practice methods not too different from it. This book describes methods for identifying just the few notes that you need to practice and then playing them in a fraction of a second (for example, by using parallel set exercises), so that you can repeat them 10,000 times in just a few weeks (or even days for easier material), practicing them for only about 10 minutes per day, 5 days per week. Of course, these arguments are greatly over-simplified but when all the complex factors are included, the final conclusions remain basically the same: good practice methods can make the difference between a lifetime of frustration and wonderful rewards within a few months (see Testimonials section).

This book discusses many more efficiency principles, such as practicing and memorizing at the same time. During practice, you have to repeat many times and repetition is the best way to memorize; therefore, it doesn't make sense not to memorize while practicing. In order to be able to memorize a large repertoire, you need to practice memorizing all the time, in exactly the same way that you need to practice every day in order to be technically proficient. Students who use the methods of this book memorize everything they learn, except for sight-reading material. This is why this book does not recommend exercises such as Hanon and Czerny, that are not meant to be memorized and performed; by the same token, the Chopin Etudes are recommended. Practicing something that wasn't meant to be performed is not only a waste of time but also degrades any sense of music you originally had. Once you memorize, you are empowered to do many other things that most people would expect only from "gifted musicians", such as playing the composition in your head, away from the piano, or even writing the entire composition down from memory. If you can play every note in the composition from memory, there is no reason why you can't write them all down! Such abilities are not for show or bragging rights, but are essential for performing without flubs or memory lapses and come almost as automatic byproducts of these methods, even for us ordinary folks with ordinary memory. Many students can play complete compositions but can't write them down — such students have only partially memorized the composition in a manner that is inadequate for performances. Many pianists are frustrated by their inability to memorize. What they don't know is that, when learning new pieces, you tend to forget previously memorized material. This means that trying to maintain a large repertoire while learning new pieces is not a fruitful endeavor. This knowledge, together with the arsenal of methods for progressively implanting permanent memory discussed in this book, goes a long way towards eliminating the frustration and restoring confidence so that you can build up your repertoire. Since students who use inefficient practice methods must spend all their time learning new pieces, they can never develop a memorized repertoire and therefore encounter horrendous difficulties when they try to perform. They wonder why performing is such an impossible task while Mozart could just sit down and play.

We will see that many "established fundamental techniques" are actually diabolical myths that can cause untold misery to the pianist. These include: the curled finger position, thumb under method of playing scales, finger exercises, sitting high on the chair, "no pain, no gain", slowly ramping up your speed, and liberal use of the metronome. We not only expose these myths by explaining why they are harmful but also provide the correct alternatives, which are, respectively: flat finger positions, thumb over method, parallel sets, sitting lower on the chair, methods for completely avoiding fatigue, quick acceleration by understanding “speed walls” and identification of specific beneficial uses of the metronome.

Another example of helpful knowledge is the use of gravity. The weight of the arm is important not only as a reference force for uniform and even playing (gravity is always constant), but also for testing your level of relaxation. On a more fundamental level, I provide the explanation of why the piano was *designed* with gravity as the reference force (section 1.2.10). Relaxation is another example. When we perform difficult physical tasks, such as playing a challenging piano passage, our natural tendency is to tense up so that the entire body becomes one contracted mass of muscle. Trying to move the fingers independently and rapidly under such conditions is like trying to run a sprint with rubber bands wrapped around both legs. If you can relax all unnecessary muscles, and use only the required muscles for just those instants at which they are needed, you can move extremely fast, effortlessly, for long periods of time without fatigue. Another example is speed walls. What are speed walls, how many are there, what causes them, and how do you avoid or eliminate them? Answers: they are the results of your attempts to do the impossible (you erect speed walls yourself!), there are basically an infinite number of them, and you avoid them by using the correct practice methods. One way of avoiding speed walls is not to build them in the first place, by knowing their causes (stress, incorrect fingering or rhythm, lack of technique, practicing too fast, practicing hands together before you are ready, etc.). Another way is to come down in speed from infinite speed by using the parallel sets, instead of increasing the speed gradually. If you can start at speeds above the speed wall, you will find that there is no speed wall when you come down in speed.

Most of this book deals with one important point — namely, that the best piano practice methods are surprisingly counter-intuitive to all except a few of the brightest minds. This point is paramount in piano pedagogy because it is the main explanation for why the wrong practice methods tend to be used by students and to be taught by teachers. If they weren’t so counter-intuitive, this book may not have been necessary. Consequently this book deals not only with what you should do but also with what you should not do. These negative sections are not for criticizing people who use the wrong methods but are an absolutely necessary part of the learning process. I have not yet found a satisfactory explanation for why intuitively logical methods of practice lead so frequently to disaster except that, perhaps, the tasks are so complex, and there are so many ways to accomplish them, that the probability of your hitting the right method is nearly zero if you randomly picked the simplest, obvious ones. Here are four examples:

1. Separating the hands for practice is counter-intuitive because you need to practice each hand, then both together, so that it looks like you have to practice three times instead of just once hands together. Why practice hands separately, which you will never use in the end? Approximately 80% of this book deals with why you *need* to practice hands separately. Hands separate practice is the only way to rapidly increase speed and control without getting into trouble. It allows you to work hard 100% of the time at any speed without fatigue, stress, or injury because the method is based on switching hands as soon as the working hand begins to tire. It is more important to time the resting hand than the working hand because the resting hand must not be allowed to cool

off; when timed perfectly, the rested hand is still "warmed up" but not tired and can often do incredible things. Hands separate practice is the only way in which you can experiment to find the correct hand motions for speed and expression and it is the fastest way to learn how to relax. Trying to acquire technique hands together is the main cause of speed walls, bad habits, injury, and stress. Thus, it can be beneficial to practice hands separately at speeds even faster than final speed (in fact, this is a necessity) but practicing hands together too fast is almost always detrimental. The irony of hands separate practice is that the ultimate objective of all those years of hard work, practicing hands separately, is to enable you to acquire all essential techniques rapidly so that, eventually, you can play hands together quickly with a minimum of hands separate work (or even none at all!).

2. Practicing slowly hands together and gradually ramping up the speed is what we tend to do intuitively, but it turns out that that approach is one of the worst ways to practice because it wastes so much time and you are training the hands to execute motions that are different from what you need at the final speed. Some students compound the problem by using the metronome as a constant guide to ramp up the speed or to keep the rhythm. This is one of the worst abuses you can make of the metronome. Metronomes should be used only briefly to check your timing (speed and rhythm); if you over use it, you can run into all kinds of problems (another counter-intuitive fact), such as loss of your internal rhythm, loss of musicality, and even total confusion, not to mention bio-physical difficulties from over-exposure to rigid repetition (your brain will actually start to counteract the metronome click). Therefore, it is important to know how to use the metronome correctly and why. Knowing the optimum practice speed for all possible circumstances is a key component of the methods of this book. Technique for speed is acquired by discovering new hand motions, not by speeding up a slow motion; i.e., the hand motions for playing slowly and fast are different. This is why trying to speed up a slow motion leads to speed walls — because you are trying to do the impossible. Speeding up a slow play is exactly like asking a horse to speed up a walk to the speed of a gallop — it can't. A horse must change from walk to trot to canter and then to gallop. If you force a horse to walk at the speed of a canter, it will hit a speed wall and will most likely injure itself by kicking its own hoofs to shreds. This book discusses the most important hand motions; it is not possible to discuss all of them because of the incredible versatility of the human hand and brain; most beginning students are totally unaware of the miracles that their hands can perform. For example, in playing scales, you will have to learn the "glissando motion" and how to use the thumb which is the most versatile finger — piano playing as we know it today would be absolutely impossible without the thumb. The numerous basic examples finger/hand motions described in this book will teach the students how to discover new hand motions by themselves.

3. In order to memorize well, and to be able to play fast, you must practice slowly, even after you can play the piece easily at speed. This is counter-intuitive because you always perform at speed, so why practice slowly and waste so much time? Since you perform at speed, you would think that practicing at speed will help you to memorize and perform it well. It turns out that playing fast can be detrimental to technique as well as to memory. Thus practicing the recital

pieces at full speed on recital day will result in a poor performance. How often have you heard the refrain, "I played awfully during my lesson although I played so well this morning (or yesterday)!"? Therefore, although much of this book is oriented towards learning to play at the correct speed, it is the proper use of slow play that is critical in achieving the goals of strong memorization and performing without mistakes. However, practicing slowly is tricky because you should not practice slowly until you can play fast! Otherwise, you would have no idea if your slow play motion is right or wrong. This problem is solved by practicing hands separately for acquiring technique and for getting up to speed. Therefore, it is absolutely critical for the student to know when to practice slowly.

4. Most people feel uncomfortable trying to memorize something they can't play, so they instinctively learn a piece first, and *then* try to memorize it. It turns out that you can save a lot of time by memorizing first and then practicing from memory (we are talking about technically challenging music that is too difficult to sight read). Moreover, for reasons explained in this book, those who memorize after learning the piece never succeed in memorizing well. They will be haunted forever by memory problems. Therefore, good memorizing methods must be an integral part of any practice procedure; memorizing is a necessity, not a luxury.

These four examples should give the reader some idea of what I mean by counter-intuitive practice methods. What is surprising is that *the majority* of good practice methods is counter-intuitive to most people. Fortunately, the geniuses who came before us could see beyond the intuitive barriers and have found better practice methods.

Why does the fact, that the correct methods are counter-intuitive, lead to disaster? Even students who learned the correct methods (but were never taught what not to do) can drift back into intuitive methods simply because their brains keep telling them that they should use the intuitive methods (that's the *definition* of intuitive methods). This of course happens to teachers as well. Parents fall for it every time! Thus mere parental involvement can sometimes be counterproductive; the parents must also be *informed*. This is why this book makes every effort to identify and to point out the follies of the intuitive methods. Thus many teachers discourage parental involvement unless the parents can also attend the lessons. Left to their own devices, the majority of students, teachers, and parents will gravitate towards the intuitive (wrong) methods. This is the main reason why so many wrong methods are taught today, and why students need good teachers and proper textbooks.

Piano teachers generally fall into three categories: (a) private teachers who can't teach, (b) private teachers that are very good, and (c) teachers at universities and conservatories. The last group is usually fairly good because they are in an environment in which they must communicate with one another. They are able to quickly identify the worst intuitive teaching methods and eliminate them. Unfortunately, most students at conservatories are already quite advanced and so the teachers do not need to teach basic practice methods; therefore a novice student may not get much help from such teachers. The (a) group teachers consists mainly of individuals that do not communicate well with other teachers and invariably use mostly intuitive methods; this explains why they can't teach. By choosing only teachers that have web sites, you can eliminate most of the poor teachers because these have at least learned to communicate. Groups (b) and (c) are fairly familiar with the correct practice methods, though very few know all of them because there has not been a standardized textbook; on the other hand, most of them know a lot of useful details that aren't in this book. There are precious few group (b) type teachers and the group (c) teachers generally accept only advanced students. The problem with this situation is that most students start with the group (a) teachers and never progress beyond novice or intermediate level and therefore never qualify for the group (c) teachers. Thus the majority of beginner students give up in frustration although practically all of them have the potential to become accomplished musicians. Moreover, this lack of progress feeds the general misconception that learning piano is a lifetime of fruitless efforts; consequently, students of poor teachers do not realize that they need a different teacher.

All piano teachers should use a textbook that explains practice methods; this will free the teachers from having to teach the mechanics of practicing and allow them to concentrate on music where the teachers are most needed. The parents should also read the textbook because parents are most susceptible to the pitfalls of intuitive methods.

There is an intimate relationship between music and mathematics. It is becoming clearer that music, in many aspects, is a form of mathematics, and the great composers explored and exploited this relationship. Most basic theories of music can be expressed using mathematical terms. Many basic rules of composition are simple exploitations of group theoretical concepts. Harmony follows the simplest of mathematical principles, and harmony gives rise to the chromatic scale, which is just a logarithmic equation. All the music scales are subsets of the chromatic scale, and chord progressions are the simplest relationships between these subsets. I discuss some concrete examples of the use of mathematics in some of the most famous compositions (section 1.4.4) and include all the topics for future music research (mathematical or otherwise) in section 1.4. Of course, music is not math! Music is art, which is explained in section 1.3.7.1. Math is simply a way of measuring something quantitatively; therefore, anything in music that can be quantified (such as time signature, thematic structure, etc.) can be treated mathematically. Thus, although math is not necessary to an artist, music and mathematics are inseparably intertwined and a knowledge of these relationships can often be useful (as demonstrated by every great composer), and will become more useful as mathematics progressively catches up to music and as artists learn to take advantage of mathematics.

Too many pianists are ignorant of how the piano works and what it means to tune in the temperaments, or what it means to voice the piano. This is especially surprising because piano maintenance directly affects (1) the ability to make music and (2) technical development. There are many concert pianists who do not know the difference between equal and Well temperaments while some of the compositions they are playing (e.g. Bach) formally require the use of one or the other. When to use electronic pianos, when to change to a higher quality (grand) piano, and how to recognize quality in a piano are critical decisions in the career of any pianist. Therefore, this book contains a chapter on how to tune your own piano.

As a scientist, I have agonized over how to define "science" and argued over this definition with other scientists and non-scientists. Because the scientific approach is so basic to this book, I have included a chapter on The Scientific Method in which I address common misconceptions regarding science. Science is not the theoretical world of the brightest geniuses; it is the most effective way to simplify our lives.

Therefore, I discuss the basic ways in which science achieves this goal, in Chapter Three. We need geniuses to develop science; however, once developed, it is the masses that benefit from these advances.

Music is an art. Art is a shortcut way of using the human brain to achieve concepts not achievable in any other way. The scientific approach to music only deals with the simpler levels of music that can be analytically treated: science supports art. You need both! It is wrong to assume that science will eventually replace art or, on the other extreme, that art is all you need for piano. Historical accounts suggest that Franz Liszt may have approached piano practice from a purely artist point of view. Because of his genius, he could use art as a shortcut way to achieve his technique. Having acquired it, however, he could not explain it to his students; he could only demonstrate (Fay, Jaynes). Today, we have a much better system!

Because we need both art and science, and art is obviously the more important component, the objective of this book is to devote 10% of the practice time to acquiring technique analytically and 90% to making music. This practice time ratio actually maximizes your technique acquisition rate because you can truly exercise your musical fingers (rhythm, control, color, expression, speed, etc.) only by playing finished pieces (counter-intuitive?). Thus practicing difficult material all the time is not the fastest way to acquire technique; i.e., technique and musicality cannot be separated. This practice time ratio is the strongest argument for not trying to learn compositions that are too far above your skill level.

In summary, this book represents an unique event in the history of piano pedagogy and is revolutionizing piano teaching. Surprisingly, there is little that is fundamentally new in this book. Every method presented below had been invented and re-invented by accomplished pianists. The amount of time and effort that has been wasted in re-inventing the wheel and futilely repeating finger exercises with every generation of pianist staggers the imagination. By making the knowledge in this book available to the student from day one of piano lessons, we are ushering in a new era in learning to play the piano.

This book is obviously my personal gift to society. The translators have also contributed their precious time. Together, we are pioneering a web based approach for providing free education of the highest caliber, something that will hopefully become the wave of the future. There is no reason why education can't be free. Such a revolution might seem to put some teachers' jobs in jeopardy, but with improved learning methods, piano playing will become much more popular, creating a greater demand for teachers who can teach. Thus improved learning methods benefit everybody. It is clear that piano teachers can't just keep on teaching the same old way anymore — they must now obtain a broader education in order to be able to teach today's better educated students. The economic impact of this improved learning method is enormous. This web site was started in the summer of 1999. Since then, I estimate that over 10,000 students have learned this method by year 2002. Let's assume that 10,000 serious piano students save 5 hours/week using these methods, that they practice 40 weeks/year, and that their time is worth about $5/hour; then the total yearly savings are:

(5hrs/wk, per student)(40wks/yr)($5/hr)(10,000 students)
= $10,000,000/yr, in 2002.

This number will increase every year. $10M/yr is only the savings of the students, and we are just starting. Whenever adoption of scientific approaches produced such quantum leaps in efficiency, the field has historically flourished, seemingly without limit, and benefited everyone: in this case, mostly the students, parents, teachers, technicians (tuners), and piano manufacturers. You can't stop progress. Just as electronic pianos are already always in tune, acoustic pianos must soon become permanently in tune, for example, by using the thermal expansion coefficient of the strings to electronically tune the piano (see `http://www.qrsmusic.com/Press/pr02032501.htm`). Today, practically all home pianos are out of tune almost all the time because it starts to go out of tune the moment the tuner leaves your house or if the room temperature or humidity changes. That's a totally unacceptable situation. In future pianos, you will flick a switch and the piano will tune itself in seconds. When mass produced, the cost will be small compared to the price of a quality piano. You might think that this would put piano tuners out of work but that will not be the case because the number of pianos will increase, the self-tuning mechanism requires maintenance and, for pianos in such perfect tune, frequent hammer voicing and regulation (that are too often neglected today) will make a significant improvement in musical output. This higher level of maintenance will be demanded by the increasing number of advanced pianists. The music from such pianos will sound like what you hear in concert halls. You might suddenly realize that it was the piano, not you, that limited your technical development and musical output (worn hammers will do it every time!). Why do you think concert pianists are so fussy about their pianos?

This book is not the end of the road — it is just a beginning. Future research into practice methods will undoubtedly uncover improvements; that's the nature of the scientific approach. It guarantees that we will never again lose useful information, that we will always make forward progress, and that even the worst teacher will have access to the same information as the best one. We still do not understand the biological changes that accompany the acquisition of technique and how the human (especially the infant) brain develops musically. Understanding these will allow us to directly address them instead of having to repeat something 10,000 times. Since the time of Bach, piano pedagogy had been in a state of arrested development; we can now hope to transform piano from a dream that was mostly out of reach to an art that more people can enjoy.

Contents

Chapter 1

Technique

1.1 Introduction

Updated: August 11, 2004

1.1.1 Objective

The objective of this book is to present the best known methods for practicing piano. For students, knowing these methods means a reduction in learning time that is a significant fraction of a lifetime and an increase in the time available for making music instead of struggling with technique. Many students spend 100% of their time learning new compositions and, because this process takes so long, there is no time left to practice the art of making music. This sorry state is the greatest hindrance to acquiring technique because making music is necessary for fast technical development. **The goal here is to make the learning process so fast that we aim to allocate 10% of practice time to learning and 90% to making music, thus maximizing technical development.** Now, in the larger picture, 10% is basically a negligible amount of time — therefore, what we are saying is that we must start making music as soon as we possibly can.

Here, we define "learning a piece" as memorizing the notes and being able to play the composition basically at speed. One might logically think that learning a piece, and acquiring the required technique to play it, are synonymous. For pedagogical purposes, it helps to define technique more narrowly as the ability to make music; therefore, "technique" will be discussed in some detail below. The reason for this definition has to do with how to practice so that you can perform for an audience, such as your teacher during lessons. Most students have no trouble practicing to play a piece to their satisfaction, yet run into terrible problems when performing. They tend to blame such difficulties on nervousness, but it is much more fundamental — it is caused by inappropriate practice methods. If we claim here that these practice methods work, then it should follow that nervousness should be greatly reduced and performances should follow naturally. And everything hinges on just one thing — acquiring technique!

At this point, you can justifiably ask, "How can it be that simple?" Then consider this. Even students who have terrible difficulties during recitals have much less problems performing for the teacher during lessons. The reason for this is that you practice performing for the teacher about once very week. Obviously, if you practice it, you will become good at it. The rest of this book is dedicated to showing you how to practice so that you are basically performing every time you practice. In order to succeed in acquiring technique, you must quickly learn how to make music.

1.1.2 What is Piano Technique?

We must understand what technique means because not understanding technique leads to incorrect practice methods. More importantly, the correct understanding can help us to develop superior practice methods. The most common misunderstanding is that technique is some inherited finger dexterity. It is not. **The innate dexterity of accomplished pianists and ordinary folk are not that different.** This means that practically anyone can learn to play the piano well. There are numerous examples of mentally handicapped people with limited coordination that exhibit incredible musical talent. Unfortunately, many of us are much more dexterous but can't manage the musical passages because of a lack of some simple but critical information. **Acquiring technique is mostly a process of brain/nerve development, not development of finger-moving muscles or strength.**

Technique is the ability to execute a zillion different piano passages; therefore it is not dexterity, but an aggregate of many skills. The task of acquiring technique thus boils down to solving the problem of how to acquire so many different skills in a short time. The wondrous thing about piano technique, and **the most important message of this book, is that piano skills can be learned in a short time, if the correct learning procedures are applied**. These skills are acquired in two stages: (1) discovering how the fingers, hands, arms, etc., are to be moved, and (2) conditioning the muscles and nerves to execute these with ease and control. This second stage is concerned with control, not the development of strength or athletic endurance. Many students think of piano practice as hours of intense finger calisthenics because they were never taught the proper definition of technique. **The reality is that you are actually improving your brain when learning piano!** Acquiring technique is a process of developing faster nerve connections, creating more brain cells for the proper movements and memory functions, and for "speaking the language of music". You are actually making yourself smarter and improving your memory; this is why learning piano correctly has so many beneficial consequences, such as the ability to better cope with everyday problems or the ability to retain memory longer as you age. This is why, in this book, memorizing is an inseparable part of technique acquisition.

The above definition of technique tells us that, once you have learned something, like playing a scale, practicing it over and over does not materially improve technique and can waste a lot of time. We must understand our own anatomy and learn how to discover and acquire the correct technique. This turns out to be a nearly impossible task for the average human brain unless you dedicate your entire life to it from childhood. Even then, most will not succeed. The reason why it takes an entire dedicated lifetime is that, without proper instruction, the pianist must discover the correct motions, etc., by trial and error. You must depend on the small probability that, as you try to play that difficult passage faster, your hand accidentally stumbles onto a motion that works. If you are unlucky, your hand never discovers the motion and you are stuck forever, a phenomenon called "speed wall". Most beginning piano students haven't the foggiest idea about the complex motions that the fingers, hands, and arms can perform. Fortunately, the many geniuses who came before us have made most of the useful discoveries (otherwise, they wouldn't have been such great performers) leading to efficient practice methods.

Another misconception about technique is that once the fingers become sufficiently skillful, you can play anything. Almost every different passage is a new adventure; it must be learned anew. Experienced pianists *seem* to be able to play just about anything because (1) they have practiced all the things that you encounter frequently, and (2) they know how to learn new things very quickly. Therefore, acquiring technique might at first appear to be a daunting task because there is almost an infinite number of different piano passages — how are we to learn them all? This problem has been mostly solved. There are large classes of passages, such as scales, that appear frequently; knowledge of how to play these will cover significant portions of most compositions. But more importantly, there are specific solutions for specific problems — these solutions are the main subject matter of this book.

Some of the most important solutions we will discuss are powerful *learning tricks* that allow you to acquire difficult technique using general procedures that apply to almost any passage. **These learning tricks provide the fastest way for you to discover the optimum finger/hand/arm motions for playing that passage**. There are two reasons why you need to make your own discoveries. First, there are so many different passages that the methods for playing them can't all be listed here. Second, the needs of each individual are different, so that the set of rules in this book should only serve as a starting point for each person who must adapt them to the individual needs. **Readers who truly understand the contents of this book will not only be able to immediately speed up their learning rate, but also to accelerate it with each added skill.** The degree of this acceleration will largely determine how fast and how far you will advance as a pianist.

Unfortunately, many private piano teachers not associated with music institutions do not know these methods and they teach most of the beginners. At the other extreme, the great masters and professional pianists have written books on piano playing that discuss topics at a higher level on how to make music but do not deal with how to acquire basic technique. That is why I wrote this book.

1.1.3 Technique and Music

Although it is not easy to define music precisely, we can discuss how to play musically, as done at various points in this book. The relationship between technique and music determines the way we practice for technique. Technique is needed, and is used, to make music; therefore, we must always practice musically. If we concentrate only on developing "finger technique" and neglect music during practice, we can pick up non-musical playing habits. This is an insidious problem because practicing to acquire technique implies a lack of technique so, initially, there is no way to make music. Then, how is the student supposed to practice musically? Of course, you start non-musically. The error occurs when the students forget to add the music as soon as they are able to do so. One common symptom of this error is the inability to play the lesson pieces when the teacher (or anyone else!) is listening. When an audience is present, these students make strange errors that they didn't make during "practice". This happens because the students practiced without regard for music but suddenly realized that music must now be added because the teacher is listening. Unfortunately, until lesson time, they had never really practiced it!

There is an even more fundamental connection between technique and music. **Piano teachers know that students need to practice musically in order to acquire technique. What is right for the ears and the brain turns out to be right for the human playing mechanism.** Both musicality and technique require accuracy and control. Practically any technical flaw can be detected in the music. At the very least, the music is the supreme test of whether the technique is right or wrong. As we shall see throughout this book, there are more reasons why music should never be separated from technique. Nonetheless, many students tend to practice neglecting the music and preferring to "work" when no one is around to listen. Such practice methods are detrimental to technique acquisition and produce "closet pianists" who love to play but can't perform. Once you become a closet pianist, it is extremely difficult to reverse that psychology. If students are taught to practice musically all the time, this type of problem will not even exist; performing and practice are one and the same. We provide many suggestions in this book for practicing to perform, such as video taping your practices from the very beginning. However, the single most important concept is that of practicing musically.

Why is slow, musical play more effective than fast practice for increasing playing speed? There are three main reasons. The first is that both require the same amount of accuracy and control. The second is that you can avoid picking up bad habits and stress when playing slowly. The third is that you can concentrate on new or efficient motions, relaxation, etc., and practice them more effectively when playing slowly. All these factors conspire to produce a phenomenon called "fast play degradation" in which, one day, you suddenly find that you can't play a piece to your satisfaction although you played it very well (and fast) the previous day. Of course, methods for quickly developing speed are equally important, and are discussed in great detail here. A judicious choice of practice speed, alternating between slow and fast practice, is what enables you to optimize your practice efficiency.

1.1.4 Basic Approach, Interpretation, Musical Training, Perfect Pitch

Teachers play a critical role in showing students how to play and practice musically. There are some general and useful principles of musicality. For example, most pieces of music begin and end with the same chord, a somewhat mysterious rule which is actually a result of basic chord progression rules. An understanding of chord progressions is very useful for memorizing. A musical phrase generally starts and ends with softer notes, with the louder ones in between; when in doubt, this is a good default principle. There are many books that discuss musical interpretation (Gieseking, Sandor), and we will encounter numerous pointers throughout this book. Clearly, education in music theory, relative and perfect pitch, etc., will be very beneficial to the pianist.

Musical training of the very young can be extremely rewarding. Most babies exposed frequently to perfectly tuned pianos will automatically develop perfect pitch — this is nothing extra-ordinary. Nobody is born with perfect pitch, because it is a 100% learned skill (the exact frequencies of the musical scales are arbitrary human concoctions — there is no natural law that says that middle A should be 440 Hz). If this perfect pitch is not maintained, it will be lost later in life. **Piano training of young children can begin as early as age three to four. Early exposure of youngsters (from birth) to classical music is beneficial because classical music has the highest musical content (deep, complex, logic) among all the different types of music.** Some forms of contemporary music, by over-emphasizing certain narrow aspects, such as loudness or simplistic music structures that do not stimulate the brain, can detract from musical development by distancing the brain from music.

A person does not have to be especially gifted to be able to play the piano well. Although you need to be musically gifted to compose music, the ability to move the fingers is not that dependent on the musical brain. In fact, most of us are more musical than we give ourselves credit for and it is the lack of technique that limits our musical expression at the piano. We have all had the experience of listening to famous pianists and noticing that one is different from the other — that is more musical sensitivity than we will ever need to start playing the piano. There is no need to practice eight hours a day; some famous pianists have recommended practice times of less than an hour. You can make progress practicing three or four times a week, one hour each. If you practice more, you will of course make faster progress.

One of the most important lessons of this book is to play relaxed. What should you feel when you have learned to play completely relaxed? Firstly, speed ceases to be an issue, not only because it isn't that difficult, but also because you have an automatic speed limit called music, which will limit your speed long before you encounter any difficulties. You will feel that the fingers actually *want* to go faster, and you will often have to hold them back. You develop "quiet hands" in which the hands move minimally while the fingers fly. You can play even moderately difficult material and actually rest the hands on the piano and feel the fatigue decreasing as you play. Note that relaxation applies only to the physical playing mechanism; the brain must never be shut off — it must always be intensely focused on the music, even (or especially) when practicing. Thus mindless repetitions of exercises such as the Hanon series is the worst thing you can do to develop stamina in your musical brain. If you don't develop brain stamina during practice, the brain will tire out part way through any performance and you will end up playing like a robotic zombie with no active control over the performance. This type of situation is what naturally gives rise to nervousness because, without proper preparation, your brain knows that the chances of success are slim.

Finally, total music education (scales, time signatures, dictation, ear training [including perfect pitch], dictation, theory, etc.) should be an integral part of learning to play the piano because each different thing you learn helps all the others. In the final analysis, a total music education is the only way to learn piano. Unfortunately, the majority of aspiring pianists do not have the resources or the time to follow such a path. This book was designed to give the student a head start by learning how to acquire technique quickly so that they can consider studying all the other helpful subjects. **Statistically, students who excel in playing the piano almost always end up composing music of their own.** Learning theory later in life is often not a viable option; for example, learning perfect pitch becomes more difficult with age, see details in section 1.3.12. On the other hand, studying music composition is not a prerequisite for composing. Some musicians frown on learning to much composition theory before starting to compose your own music because that can prevent you from developing your own musical style.

What are some unique features of the methods of this book?

1. They are not overly demanding, like older methods that require students to commit to a dedicated lifestyle to fit the piano instruction. In the methods of this book, students are given the tools to pick a specific procedure that will achieve a defined objective. If the methods *really* work, they shouldn't require a lifetime of blind faith in order to achieve proficiency!

2. Every procedure of these methods has a physical basis (if it works, it always has one; the past problems have been in identifying the correct explanations); it must further contain the following required elements: (a) **Objective:** what techniques to acquire, i.e., if you can't play fast enough, or you can't trill well,

you want to memorize, etc., (b) **Then do:** i.e., practice hands separately, use chord attack, memorize as you practice, etc.,(c) **Because:** the physiological, psychological, mechanical, etc., explanations for why these methods work. For example, hands separate practice allows quick acquisition of technique by making difficult passages simpler (one hand is easier than two) and the chord attack enables instant acceleration to the final speed, etc., and (d) **If not:** problems that arise if uninformed methods are used, i.e., acquiring bad habits from too many repetitions, developing stress from practicing with fatigued hands, etc. Without this “If not”, students can pick any other method — why this one? We need to know what not to do because bad habits and wrong methods, not insufficient practice, are the main causes of a lack of progress.

1.2 Basic Procedures for Piano Practice

This section contains the minimum set of instructions that you need before starting practice.

1.2.1 The Practice Routine

Many students use the following practice routine:

1. First, practice scales or technical exercises until the fingers are limbered up. Continue this for 30 minutes or longer, if you have time, to improve technique, especially by using exercises such as the Hanon series.

2. Then take a new piece of music and slowly read it for a page or two, carefully playing both hands together, starting from the beginning. This slow play is repeated until it can be performed reasonably well and then it is gradually speeded up until the final speed is attained. A metronome might be used for this gradual speed-up.

3. At the end of a two hour practice, the fingers are flying, so the students can play as fast as they want and enjoy the experience before quitting. After all, they are tired of practicing so that they can relax, play their hearts out at full speed; this is the time to enjoy the music!

4. On the day of the recital or lesson, they practice the piece at correct speed (or faster!) as many times as possible in order to make sure that they know it inside out and to keep it in top condition. This is the last chance; obviously, the more practice, the better.

EVERY STEP OF THIS PROCEDURE IS WRONG! The above will almost guarantee that the students will not progress beyond intermediate level even if they practice several hours daily. You will understand this as soon as you read about the more efficient methods described below. For example, this method tells the students nothing about what to do when they hit an impossible passage except to keep repeating, sometimes for a lifetime, with no clear idea of when or how the needed technique will be acquired. This method leaves the task of learning the piano completely to the student. Moreover, the music will come out flat during the recital and unexpected flubs will be almost unavoidable, as explained below. The lessons of this section will demonstrate why the above procedures are wrong. You will know why the recital will come out flat, and why the wrong method leads to flubs. But more importantly, you will know the *correct* methods!

Lack of progress is the main reason why so many students quit piano. Students, especially youngsters, are smart; why work like a slave and learn nothing? Reward the students and you will get more dedication than any teacher could want. You can be a doctor, scientist, lawyer, athlete, or anything you want, and still become a good pianist. This is because there are methods that let you acquire technique in a relatively short period of time, as we shall soon see.

Note that the above practice routine is an "intuitive" method. If a person of average intelligence were marooned on an island with just a piano and decided to practice, that person would most likely devise a practice method like the one above. That is, a teacher using this type of practice routine isn't teaching anything — the method is intuitive. **When I first started to compile the "correct learning procedures" of this book, I was struck most by how counter-intuitive many of them were.** I will explain later why they are so counter-intuitive but this offers the best explanation for why so many teachers use the intuitive approach. These teachers never really understood the correct methods and therefore defaulted naturally to the intuitive method. The trouble with counter-intuitive methods is that they are harder to adopt than intuitive ones; your brain is constantly telling you that they are not right and to get back to the intuitive ones. This message from the brain can become irresistible just before a lesson or recital — try telling (uninformed) students not to enjoy playing their finished pieces before quitting practice, or not to practice full speed on recital day! It is not just the students or teachers. It is also any parents or friends with good intentions that influence the practice routines of young students. **Parents who are not informed will always force their children to use the intuitive methods.** This is one reason why good teachers always ask parents to accompany their children to the lessons. If the parents are not informed, there is a virtual guarantee that they will force the students to use methods that are in direct contradiction to the teacher's instructions.

Students who started with the correct methods from the beginning are the *apparently* lucky ones. However, they must be careful later in life because they don't know what the wrong methods are. Once they leave the teacher, they can stumble into the intuitive methods and have no idea why everything is falling apart. It's like a bear that had never seen a bear trap — it gets caught every time. These lucky ones often can't teach either, because the correct methods are second nature and they can't understand why anyone would use any other method. They may not realize that the correct methods need to be taught and that many intuitive methods can lead to disaster. Something that is second nature is often difficult to describe because you never gave it much thought. You never realize how difficult English is until you try to teach it to a Japanese. On the other hand, the *apparently unlucky* students who first learned the intuitive methods and then changed over to the better ones have some unexpected advantages. They know both the right and wrong methods and often make much better teachers. **Therefore, although this chapter teaches the correct methods, it is just as important to know what NOT to do, and why.** This is why the most frequently used wrong methods are extensively discussed in this book; they help us to better understand the correct methods.

We describe the components of a proper practice routine in the following sections. They are presented in approximately the order in which a student might use them from start to finish of a new piece of music. Sections 1.2.1 to 1.2.4 are preliminaries; the really new material of this book starts in section 1.2.5.

1.2.2 Finger Positions

Everyone seems to have her/is own ideas about finger positions, so it is clear that there are no rigid rules. The only guidance is that the fingers should be in the most relaxed and powerful positions. First, make a tight fist. Then open your fingers and stretch them as far out as they will go. Now relax the fingers completely. In this relaxed state, place the hand on a flat surface with all the fingertips resting on the surface and the wrist at the same height as the knuckles. **The hand and fingers should form a dome. All the fingers should be curved. The thumb should point slightly down and bend very slightly towards the fingers so that the last digit of the thumb is parallel to the other fingers.** It is important to maintain this slight inward bend of the thumb when playing chords with wide spans. This positions the tip of the thumb parallel to the keys making it less likely to hit adjacent keys. It also orients the thumb so that the correct muscles are used to raise and lower the thumb. **The fingers are slightly curled, curving down and meeting the keys at angles near 45 degrees.** This curved configuration allows the fingers to play between the black keys. The tip of the thumb and the other fingertips should form an approximate semicircle on the flat surface. This is a good starting hand position for playing the piano. You can then modify it to suit your playing style. If you do this with both hands side by side, the two thumbnails should be facing each other. Use the part of the thumb directly below the thumbnails to play, not the joint. For the other fingers, the bone comes very close to the outer skin at the fingertips. Just inside the fingertip (away from the fingernail), the flesh is slightly thicker. This fleshy part should contact the keys, not the fingertip.

This is just a suggested starting position. Once you begin play, these rules immediately go out the window. You may need to stretch the fingers almost straight, or curl them more, depending on what you are playing.

1.2.3 Bench Height and Distance from Piano

The right height of the bench and its distance from the piano is also very much a matter of personal taste. A good starting point can be determined in the following way. Sit at the bench with your elbows at your sides and forearms parallel to the keys. **With your hands on the keys in playing position, the elbows should be at the height of the keys.** Now place your hands on the white keys — the distance of the bench from the piano (and your sitting position) should be such that the elbows just miss your body as you move them in towards each other. Do not sit at the center of the bench, but sit closer to the front edge. The bench height and location are most critical when playing loud chords. Therefore, you can test this position by playing two black key chords simultaneously, as loudly as you can. The chords are C2♯ G2♯ C3♯ (5, 2, 1) for the left hand and C5♯ G5♯ C6♯ (1, 2, 5) for the right hand. Press down hard, leaning forwards a little, with the whole weight of your arms and shoulders, to make a thundering, authoritative sound. Make sure that the shoulders are totally involved. Loud, impressive sounds cannot be made using only the hands and forearms; the force must come from the shoulders and the body. If this is comfortable, the bench and sitting positions should be correct.

1.2.4 Starting a Piece: Listening and Analysis (Für Elise)

Look over the new piece and start sight-reading with it, so that you become familiar with how it sounds. **The best way to become familiar with a new piece is to listen to a performance (recording).** The criticism that listening first is some sort of "cheating" has no defensible basis. The purported disadvantage is that students might end up imitating instead of using their creativity. **It is impossible to imitate someone else's playing because playing styles are so individualistic.** A mathematical "proof" of this impossibility is presented in section 1.4.3. This fact can be reassuring and relieves some students from blaming themselves for the inability to imitate some famous pianist. If possible, listen to several different recordings. They can open up all sorts of new vistas and possibilities. Not listening is like saying that you shouldn't go to school because that will destroy your creativity. Some students think that listening is a waste of time because they will never play that well. In that case, think again. If the methods described here will not make people play "that well", I wouldn't be writing this book! What happens most frequently when students listen to many recordings is that they discover that the performances are not uniformly good; that they actually prefer *their own* playing to some of those in the recordings.

The next step is to analyze the structure of the composition. This structure will be used to determine the practice program. Let's use Beethoven's Für Elise as an example. The first 4 bars are repeated 15 times, so by just learning 4 bars you can play 50% of the piece (it has 125 bars). Another 6 bars are repeated 4 times, so learning only 10 bars enables you to play 70% of it. Using the methods of this book, therefore, 70% of this piece can be memorized in less than 30 minutes, because these bars are quite easy. Application of this method automatically commits those sections you practice to memory. Among these repeated bars, there are two interruptions that are not easy. When you can play these interruptions satisfactorily, using the methods described below, join them with the repetitions, and Voila! — you can play, and have memorized, the whole piece. Of course, mastering the two difficult interruptions is the key to learning this piece, and we shall address that issue in the following sections. A student with 2 years of lessons should be able to learn the required 50 different bars of this piece in 2 to 5 days and be able to play the whole piece at speed and from memory. At this point, the teacher is ready to work with the student on the musical content of the composition; how long that will take depends on the musical level of the student. Musically speaking, you never really finish any piece.

This is the end of the preliminaries. We are ready to begin the real exciting lessons. **The secret for acquiring technique quickly lies in knowing certain tricks for reducing impossibly difficult passages to not only playable but also to trivially simple ones.** We shall now embark upon that magical journey into the brains of geniuses who figured out incredibly efficient ways to practice the piano!

1.2.5 Practice the Most Difficult Sections First

Returning to our Für Elise, look for the difficult sections; there are two interruptions with 16 and 23 bars inserted among the repeated material. These are the difficult sections. **Start learning the piece by practicing the most difficult sections first.** The reason is obvious; it will take the longest time to learn these, so they should be given the most practice time. If you practice the difficult sections last and then try to perform the piece, you will find that the difficult part is the weakest and it will always give you trouble. Since the ending of most pieces is generally the most exciting, interesting, and difficult, you will probably learn most pieces starting from the end. For compositions with several movements, you will most frequently start with the end of the final movement.

1.2.6 Shortening Difficult Passages: Segmental (Bar-by-Bar) Practice

A most important learning trick is to choose a short practice segment. This trick has perhaps the largest effect on reducing the practice time because of many reasons.

1. **Within any difficult passage of say, 10 bars, there is typically only a few note combinations that stymie you. There is no need to practice anything other than those notes.** If there are 10 bars with 8 notes each but there are only 4 difficult notes, then by just practicing those four, you can get to play all 10 bars, greatly cutting down on practice time. Let's revisit the two difficult interruptions in Für Elise. Examine them and find the most troublesome bars. This may be the first bar or the last five bars of the first interruption, or the final arpeggio in the second interruption. In all difficult segments, it is critically important to observe the finger markings and to make doubly sure that you are comfortable with them. For the last five bars of the first interruption, the difficulty is in the RH where most of the action is in fingers 1 and 5. Finger 2 plays a key role on certain notes, but there is an option of using mostly finger 1. Use of finger 2 is the most conventionally correct way and provides better control and smoother play. However, use of mostly finger 1 is easier to remember, which can be a lifesaver if you haven't played this piece for a while. It is very important that you choose one fingering and stick to it. For the arpeggio in the second interruption, use the fingering 1231354321... Either thumb under or thumb over (see section 1.3.5) will work because this passage is not overly fast, but I prefer thumb over because the thumb under will require some elbow motion and this extra movement can lead to flubs.

2. **Practicing only short segments allows you to practice the same segment dozens, even hundreds of times, in a matter of minutes.** Use of these quick, successive repetitions is the fastest way to teach your hand new motions. If the difficult notes are played as part of a longer segment, the longer interval between successive practice and the playing of other notes in between can confuse the hand and cause it to learn much more slowly. This effect is quantitatively calculated in section 1.4.5, and that calculation provides the basis for the claim in this book that these methods can be 1000 times faster than the intuitive methods.

3. We all know that playing a passage faster than your technique allows is detrimental. However, **the shorter a segment you choose, the faster you can practice it without ill effects. Initially, the most common short segment you will choose is one bar or less, often just two notes. By choosing such short segments, you can bring practically any difficult note combination up to speed in just minutes.** Therefore, you can practice most of the time *at or beyond final speed*, which is the ideal situation because it saves so much time. In the intuitive method, you are practicing most of the time at slow speed.

1.2.7 Hands Separate Practice: Acquiring Technique

Essentially 100% of technique development is accomplished by practicing hands separately (HS). Do not try to develop finger/hand technique hands together (HT) as that is much more difficult, time consuming, and *dangerous*, as explained in detail later.

Start practicing any difficult passage HS. Choose two short passages, one each for the right hand (RH) and the left hand (LH). **Practice the RH until it begins to tire, then switch to the LH. Switch every 5 to 15 seconds, before either the resting hand cools and becomes sluggish, or the working hand becomes tired.** If you choose the rest interval just right, you will find that the rested hand is eager to perform. Don't practice when the hand is tired, because that will lead to stress and bad habits. Those unfamiliar with HS practice will generally have a weaker LH. In that case, give the LH more work. In this scheme, you can practice hard 100% of the time, but you never practice with fatigued hands!

For the two difficult sections of Für Elise, practice them HS until each hand becomes very comfortable, up to speeds much faster than final speed, before putting the hands together. This may take from a few days to several weeks depending on your level of play. As soon as you can play HS reasonably well, try HT to check that the fingering works. It is best to try to use similar fingerings (or closely related fingerings) in the two hands; this will make the task of playing HT simpler. Don't worry at this point if you can't play it satisfactorily, you just need to make sure that there are no conflicts or better fingerings.

It should be emphasized that the HS practice is only for difficult passages that you cannot play. If you can play the passage adequately HT, by all means, skip the HS part! The ultimate objective of this book is for you to be able to quickly play HT with practically no HS practice after you become proficient. The objective is not to cultivate a dependence on HS practice. Use HS only when necessary and try to reduce its use gradually as your technique advances. However, you will be able to play HT with little HS practice only after you have become pretty advanced — most students will be dependent on HS practice for 5 to 10 years, and will never completely abandon its use. The reason for this is that all technique is most quickly acquired HS. There is one exception to this rule on avoiding HS practice whenever possible. That is memorizing; you should memorize everything HS for several important reasons (see "Memorizing" in section 1.3.6).

Beginning students should practice HS all the time for all pieces so as to master this critically important method as quickly as possible. However, once the HS method is mastered, the student should start to explore the possibility of playing HT without using HS. Beginner students should be able to master the HS methods in two to three years. The HS method is not just separating the hands. What we will learn below are the myriad of learning tricks you can use once the hands are separated.

HS practice is valuable long after you have learned a piece. You can push your technique much further HS than HT. And it is a lot of fun! You can really exercise the fingers/hands/arms. It is superior to anything Hanon or other exercises can provide. This is when you can figure out "incredible ways" to play that piece. This is when you can *really* improve your technique. The initial learning of the composition only serves to familiarize your fingers with the music. The amount of time spent playing pieces you have completely learned is what separates the accomplished pianist from the amateur. This is why accomplished pianists can perform but most amateurs can only play for themselves.

Finally, it should be understood that all finger technique is acquired HS because there is no method that is more efficient. If you can play HT immediately, there is no need for HS practice. However, if you can't quite play HT, how do you tell if you can skip HS practice? There is a clear test for that — you can skip HS practice only if you can play HS comfortably, relaxed, and accurately at faster than final speed. **It is usually best to bring the HS speed up to at least 1.5 times final speed.** That is usually not difficult, and can be a lot of fun, because you can see the rapid improvement in your skill level. For this reason, you might find yourself practicing HS a lot more than is absolutely necessary, and will certainly use it all your life. Each hand must eventually learn its own set of skills independently of the other (you certainly don't want one hand to depend on the other). The quickest way to acquire these skills is to learn them separately. Each alone is difficult enough; trying to learn them together will be much more difficult and time consuming. In HS practice, you acquire finger/hand technique; then in HT practice you only need to learn how to coordinate the two hands.

1.2.8 The Continuity Rule

Suppose that you want to play the (LH) "do-so-mi-so" quadruplet ("Alberti accompaniment") many times in succession, very fast (as in the 3rd movement of Beethoven's Moonlight Sonata). The sequence you practice is CGEGC. The inclusion of the last C is an application of **the continuity rule: while practicing one segment, always include the beginning of the following segment.** This ensures that when you have learned two adjacent segments, you can also play them together. The continuity rule applies to any segment you isolate for practice, such as a bar, an entire movement, or even to segments smaller than a bar.

A generalization of the continuity rule is that any passage may be broken up into short segments for practice, but these segments must overlap. The overlapping note or group of notes is called the conjunction. If you are practicing the end of the first movement, then include a few bars of the beginning of the second movement; don't immediately jump back. During a recital, you will be glad that you had practiced in this way; otherwise, you might suddenly find yourself stumped on how to start the 2nd movement!

We can now apply the continuity rule to those difficult interruptions in Für Elise. For the first interruption, the 8th bar (of this interruption) can be practiced by itself. Play the last note with finger 1. The conjunction is the first note of bar 9 (finger 2), which is the same as the first note of bar 8, so by using this C as the conjunction, you can cycle bar 8 continually for a good workout without any wasted time. This bar is said to be self-cycling — see "Cycling", section 1.3.2, for more details on cycling. Bars 9 and 10 as a unit are also self-cycling. Since all the difficult sections are for the RH, find some LH material to practice, even from a different piece of music, in order to give the RH periodic rests by switching hands.

1.2.9 The Chord Attack

Let's return to the (LH) CGEG quadruplet. If you practice it slowly and then gradually speed it up (HS), you will hit a "speed wall", a speed beyond which everything breaks down and stress builds up. The way to break this speed wall is to play the quadruplet as a single chord (CEG). **You have gone from slow speed to infinite speed!** This is called a chord attack. Now you only have to learn to slow down, which is easier than speeding up because there is no speed wall when you are slowing down. But — how do you slow down?

First play the chord and bounce the hand up and down at the frequency at which the quadruplet should be played (say, between one and two times a second); it should be easier when played as a chord, but this may not be simple if it is your first time. Note that the fingers are now positioned exactly correctly for fast playing. Try varying the bounce frequency up and down (even beyond the required speed!), noting how to alter the wrist, arm, fingers, etc., positions and motions as you go through the different speeds. If you feel fatigue after a while, then you are either doing something wrong, or else you have not yet acquired the technique of bouncing the chords. You will need to practice it until you can do that without tiring because if you can't do it for a chord, you will never do it for quadruplets. In other words, you have just identified a weakness in the technique that needs to be remedied before you can progress to the next stage.

Play the chord with the most economical motions you can think of. Keep the fingers close to or on the keys as you increase speed. Get your whole body involved; shoulders, upper and lower arms, wrist. The sensation is to play from your shoulders and arms, not your fingertips. When you can play this softly, relaxed, fast, and without any feeling of fatigue, you know that you have made progress. Make sure that you are playing perfect chords (all notes landing at the same time) because, without this kind of sensitivity, you will not have the accuracy required to play fast. **It is important to practice the slow bounce because that is when you can work on the accuracy. Accuracy improves faster at the slower speeds.** However, it is absolutely essential that you get up to fast speeds (if only briefly) before slowing down. When you slow down, try to maintain the same motions that were required at high speed, because *that* is what you need to ultimately practice. If you think that this is the end of this simple chord business, you are in for a surprise — this is only the beginning; read on!

1.2.10 Gravity Drop, Chord Practice, and Relaxation

Practicing to play accurate chords is the first step in applying the chord attack. Let's practice the above CEG chord. The arm weight method is the best way to achieve accuracy and relaxation; this approach has been adequately treated in the referenced books (Fink, Sandor) and therefore will be discussed only briefly here. Place your fingers on the keys and position them correctly. Relax your arm (the whole body, actually), keep your wrist flexible, lift the hand from 5 to 20 cm above the keys (the shorter distance in the beginning), and just let gravity drop your hand. Let the hand and fingers drop as a unit, do not move the fingers. Relax the hands completely during the drop, then "set" your fingers and wrist at the time of impact with the keys and let the wrist flex slightly to take the shock of landing and to depress the keys. **By letting gravity lower your hand, you are referencing your strength or sensitivity to a very constant force.**

It may seem unbelievable at first, but an under-weight 6-year-old and a gargantuan sumo wrestler dropping their hands from the same height will produce sound of the same loudness. This happens because the speed of gravitational fall is independent of mass and the hammer goes into free flight as soon as the knuckle leaves the jack (the last few millimeters before hitting the strings). Physics students will recognize that in the elastic limit (billiard ball collision), kinetic energy is conserved and the above statements do not hold. In such an elastic collision, the piano key would fly off the fingertip at high velocity, somewhat like when playing staccato. But here, because the fingers are relaxed and the fingertips are soft (inelastic collision), kinetic energy is not conserved and the small mass (piano key) can stay with the large mass (finger-hand-arm), resulting in a controlled keydrop. Therefore, the above statements hold as long as the piano is properly regulated and the effective mass for the key drop is much smaller than the mass of the 6-year-old's finger-hand-arm. Stiffening the hand at impact ensures that the entire arm weight transfers to the key drop. Obviously, it is not possible to produce the full sound of the gravity drop if you do not stiffen the hand at impact. You must take care not to add force during this stiffening; therefore, it takes practice to be able to produce a pure gravity drop and this becomes more difficult with increasing height of the drop. Not adding this extra force is a more difficult task for the sumo wrestler because he needs such a large force to stop the momentum of his arm. The best criteria for the proper stiffening force are the loudness and tone of the sound.

Strictly speaking, the sumo wrestler will make a slightly louder sound because of momentum conservation, but the difference will be quite small, in spite of the fact that his arm may be 20 times heavier. Another surprise is that, once properly taught, the gravity drop may produce the loudest sound that this youngster has ever played (for a high drop), and is an excellent way to teach youngsters how to play firmly. Start with short drops for small youngsters because in the beginning, a truly free drop can be painful if the height is too high. For a successful gravity drop, especially for youngsters, it is important to teach them to make-believe that there is no piano and the hand should feel like it is falling through the keyboard (but is stopped by it). Otherwise, many youngsters will subconsciously lift the hand as it lands on the piano. In other words, the gravity drop is a constant acceleration and the hand is accelerating, even during the key drop. At the end, the hand is resting on the keys with its own weight — this action is what produces pleasant, deep, "tone". Note that it is important for the key drop to accelerate all the way down — see section 1.3.1 on producing good tone.

The well-known Steinway "accelerated action" works because it adds acceleration to the hammer motion by use of a rounded support under the center key bushing. This causes the pivot point to move forward with keydrop thus shortening the front side of the key and lengthening the back side and thereby causing the capstan to accelerate for a constant keydrop. This illustrates the importance piano designers place on accelerating the keydrop, and the arm weight method ensures that we take full advantage of gravitational acceleration to control the tone. The effectiveness of the "accelerated action" is controversial because there are excellent pianos without this feature. Obviously, it is more important for the pianist to control this acceleration.

The finger must be "set" at the moment of impact so as to depress the key and decelerate the fall. This requires a brief application of force to the finger. As soon as the key reaches the bottom of the keydrop, remove this force and relax completely so that you can feel gravity pulling the arm down. Rest the hand on the key with only this gravitational force keeping the key down. What you have just accomplished is to depress the key with the least possible effort; this is the essence of relaxation.

Beginning students will play chords with too many unnecessary forces that can not be accurately controlled. **The use of gravity to lower the hand allows you to eliminate all forces or tenseness in the hand that are the causes of certain fingers landing before the others.** It might seem like a curious coincidence that the force of gravity is just the right force for playing the piano. *This is no coincidence.* Humans evolved under the influence of gravity. Our strengths for walking, lifting, etc., evolved to match gravity *exactly*. The piano, of course, was built to match those strengths. Remember: the amount of force you need to play the chord is roughly equal to that supplied by gravity — don't bang those chords or tense the hands — a lot of things will start to go out of control! For beginners or those who have developed a habit of tensing the hands to play chords, it is a good idea to practice the gravity drop for several weeks, or even months, a little bit every time you practice. And of course, it must be incorporated into the everyday practicing and playing. What this means is that when you are truly relaxed, you can actually feel the effect of gravity on your hands as you are playing. Some teachers will emphasize relaxation to the point of neglecting everything else until "total" relaxation is achieved; that may be going too far overboard — being able to feel gravity is a necessary and sufficient criterion for relaxation.

The gravity drop also eliminates the need for momentum balance (see section 1.4.6). When the hand plays the piano, the downward momentum of the key is supplied by the momentum of the hand. This downward momentum must be compensated by the rest of the human playing mechanism which must provide an upward momentum if the gravity drop is not utilized. Although we all accomplish this without even thinking, it is in fact quite a complex feat. In the gravity drop method, this momentum is supplied by gravity, so that the piano is played with the absolute minimum action by the human playing mechanism. In this way, the gravity drop enables us to relax all the unnecessary muscles and to concentrate only on those that are needed to control the chord.

Gravity drop is therefore much more than just a method to practice chords. More importantly, **the gravity drop is a method to practice relaxation. Once this relaxed state is achieved, it must become a permanent, integral part of your piano playing.** The guiding principle in the arm weight method is relaxation. In addition to the gravity drop, it is important to learn to feel the effect of gravity as we play. We will treat relaxation in more detail below.

Finally, chord playing is an important component of piano technique. As such, it must be developed gradually in concert with your general skill level. There is no faster way of doing that than the use of the parallel sets described below. Also, see section 1.3.7 for more details; section 1.3.7.5 gives additional instructions on how to practice playing even chords when the gravity drop does not solve the problem.

1.2.11 Parallel Sets

Now that the LH CEG chord is satisfactory, (try to) switch suddenly from the chord to the quadruplet at several different bounce frequencies. You will now have to move the fingers but keep the finger motions to a minimum. Here again, you will need to incorporate the proper hand/arm motions (see Fink, Sandor), but that's advanced stuff, so let's back-track a little. You will be able to switch quickly after you have become proficient with this method but let's assume that you cannot, so that we can demonstrate a powerful method for solving this very common type of problem.

The most basic way to learn how to play a difficult passage is to build it up two notes at a time, using the chord attack. In our (LH) CGEG example, we start with the first two notes. A two-note chord attack! Play these two notes as a perfect chord, bouncing your hand and fingers (5 and 1) together up and down as you did previously with the CEG chord. In order to play these two notes rapidly one after the other, lower both fingers together, but keep the 1 finger slightly above the 5 so that the 5 lands first. It is just a rapid two-note rolling chord. Since you are bringing both fingers down at once and only delaying one slightly, you can play them as closely as you wish by decreasing the delay. This is how you slow down from infinite speed!

Is it possible to play any combination of notes infinitely fast in this way? Of course not. How do we know which ones can be played infinitely fast and which ones can't? In order to answer this question, we need to introduce the concept of parallel play. The above method of lowering fingers together is called parallel play because the fingers are lowered simultaneously, i.e., in parallel. **A parallel set is a group of notes that can be played as a chord. All parallel sets can be played infinitely fast. The delay between successive fingers is called the phase angle.** In a chord, the phase angle is zero for all the fingers. These and related concepts are explained more systematically in section 1.4.2. The highest speed is attained by reducing the phase to the smallest controllable value. This smallest value is approximately equal to the error in your chord playing. In other words, the more accurate your chords, the faster will be your maximum attainable speed. This is why so much space was devoted above to describing how to practice perfect chords.

Once you have conquered the CG, you can proceed with the next GE (1, 3), then EG and finally the GC to complete the quadruplet and conjunction. Then connect them in pairs, etc., to complete the quadruplet. Notice that CGE is also a parallel set. Therefore the quadruplet plus conjunction can be constructed from two parallel sets, (5, 1, 3) and (3, 1, 5). This is a faster way. The general rule for the use of parallel sets is: **construct the practice segment by using the largest parallel sets possible that are consistent with the fingering.** Break it up into smaller parallel sets only if the large parallel set is too difficult. If you have difficulty with a particular parallel set, read section 1.3.7 on parallel set exercises. Although, in theory, parallel sets can be played infinitely fast, that doesn't guarantee that *you* can play that *particular* parallel set with sufficient speed and control. You can play it only if you have the technique. Therefore, parallel sets can be used to pinpoint your weaknesses. Section 1.3.7 discusses details of how to practice playing parallel sets and how to quickly acquire technique by their use.

After you can play one quadruplet well, practice playing two in succession until you can do that comfortably, then three, etc. Soon, you will be able to play as many as you want in succession! When you initially bounced the chord, the hand moved up and down. But in the end, when playing the quadruplets in rapid succession, the hand is fairly stationary, but not rigid. You will also have to add hand motions — more on this later.

The second difficult section in Für Elise ends with an arpeggio that is composed of three parallel sets, 123, 135, and 432. First practice each parallel set individually, then add the conjunction, then connect them in pairs, etc., to build up the arpeggio.

Now we have the necessary terminology and can summarize the procedure for using the chord attack to scale speed walls (see sections 1.4.1 and 1.4.2 for discussions of speed walls). **Decompose the segment into parallel sets, apply the chord attack to these sets, and connect the parallel sets to complete the segment.** If you cannot play any of the needed parallel sets at nearly infinite speed, you will need the parallel set exercises of section 1.3.7. Whew! We are done with speed walls!

In order for the segment to sound smooth and musical, **we need to accomplish two things: (1) control the phase angles accurately and (2) connect the parallel sets smoothly.** Most of the finger/hand/arm motions described in the references are aimed at accomplishing these two tasks in the most ingenious ways. This is the most direct connection between the concept of parallel sets and the references. Since those subjects are adequately covered in the references, they are only briefly treated here in section 1.3.4. Therefore those references are necessary companions to this book. The material given here will get you started; the material in the references is necessary to bring you to the next level of proficiency and musicianship. In order to help you decide which reference you should use, I have provided (extremely brief) reviews for several of them in the Reference section. As you speed up the parallel sets, experiment with hand rotation, wrist motion up and down (in general, lower the wrist when playing the thumb and raise it as you approach the pinky), pronation, supination, cycling motion, thrust, pull, etc. These are detailed in the references and briefly surveyed in section 1.3.4.

You will need to read section 1.3.7 in order to know how to use parallel sets to acquire technique quickly. The above introduction to parallel play is just an abbreviated description and is in fact a little misleading. The parallel play described above is what is called a "phase locked" parallel play and is the easiest way to start, but that is not your ultimate goal. In order to acquire technique, you need complete finger independence, not phase locked fingers. Completely independent finger-by-finger play is called serial play. Our objective therefore, is fast serial play. In the intuitive method, you take a slow serial play and try to speed it up. Parallel play is not an objective in itself, but is the quickest way to fast serial play. These issues are explained in the section on Parallel Set Exercises. The idea of these exercises is to first test whether you can play "infinitely fast" — you will be surprised to find out that you cannot always do so, even with just two notes. The exercises then provide you with a way to practice only those sets that you need for that technique. You acquire the technique when you can play the parallel set with control over each note at any speed.

Of course, proficient parallel play by itself does not guarantee correct play. It just gets you there faster by at least getting you up to speed, so that you have fewer steps to take in order to arrive at the correct motions. That is, even with successful parallel play, you will still need to perform quite a bit of further experimentation in order to be able to manage the whole passage. Because the method described here allows you to try hundreds of trials in minutes, this experimentation can be conducted relatively quickly. If you apply the bar-by-bar method, each bar will take less than a second at speed, so in 5 minutes, you can practice it 300 times!

This is why you can't beat having a good teacher, since s/he can steer you quickly to the correct motions and bypass most of this experimentation. But having a teacher does not mean that you will stop experimenting — just that the experimentation will be more effective. Experimentation should be a constant part of any practice routine. This is another reason why HS practice is so valuable — experimenting is difficult enough HS, it is practically impossible HT!

Parallel play does not solve all problems; it solves mainly material containing runs, arpeggios and broken chords. Another major class of problems is jumps. For this go to section 1.3.7.6.

1.2.12 Learning and Memorizing

Updated: November 21, 2004

There is no faster way of memorizing than to memorize when you are first learning a piece and, for a difficult piece, there is no faster way of learning than memorizing it. Therefore memorize these sections that you are practicing for technique while you are repeating them so many times, in small segments, HS. Memorization is discussed in more detail in section 1.3.6. **The procedures for memorizing are almost exactly parallel to those for technique acquisition.** For example, memorization should be done HS first. This is why learning and memorizing should be done simultaneously; otherwise you will need to repeat the same procedure twice. It might appear that going through the same procedure a second time would be simpler. It is not. Memorizing is a complex task, even after you can play the piece well. For this reason, students who try memorize after learning a piece will either give up or never memorize it well. This is understandable; the effort required to memorize can quickly reach the point of diminishing returns if you can already play the piece at speed.

Once students develop memorizing-learning routines that are comfortable for them, most of them will find that learning and memorizing together takes less time than learning alone, for difficult passages. This happens because you eliminate the process of looking at the music, interpreting it, and passing the instructions from the eyes to the brain and then to the hands. With these slow steps bypassed, the learning can proceed unencumbered. Some might worry that memorizing too many compositions will create an unsustainable maintenance problem (see section 1.3.6.3 for a discussion of maintenance). The best attitude to have towards this problem is not to worry if you forget some pieces that are seldom played. This is because **recalling a forgotten piece is very fast as long as it was memorized well the first time. Material memorized when young (before about 20 years of age) is almost never forgotten.** This is why it is so critical to learn fast methods of technique acquisition and to memorize as many pieces as possible before reaching the later teen years.

As you go through each step described in this section to acquire technique, memorize the music at that same step. It is that simple. Section 1.3.6 also discusses the numerous benefits of memorization; these benefits are so valuable that it does not make any sense not to memorize. It is much easier to memorize something if you can play it fast; therefore, if you have difficulty memorizing it initially at slow speed, don't worry; it will become easier as you speed it up.

The major difference between practicing for technique and memorization is that for technique, you need to start with the most difficult sections first, whereas for memory, it is usually best to start with sections that are easy and repeated many times so that you can quickly memorize a large portion of the composition. Then, by memorizing the remaining small sections, you can connect the long easy sections and thereby memorize the whole piece quickly. In general, it is better to memorize first, and then practice for technique. That way, you can start to practice for technique while memorizing. Obviously, all these many requirements are often contradictory, so you must use your judgment on what to do first for each specific case.

1.2.13 Velocity, Choice of Practice Speed

Get up to speed as quickly as possible. Remember, we are still practicing HS. Playing so fast that you start to feel stress and make mistakes will not improve technique because playing with stress is not the way it will be played when you become proficient. Forcing the fingers to play the same way faster is not the way to increase speed. As demonstrated with parallel play, you need new ways that automatically increase speed. In fact, with parallel play, it is often easier to play fast than slowly. Devise hand positions and motions that will control the phase angle accurately and that will also position everything in such a way that the coming transition to the next parallel set is smooth. If you do not make significant progress in a few minutes, you are probably doing something wrong — think of something new. Repeating the same thing for more than a few minutes without any visible improvement will often do more harm than good. Students who use the intuitive method are resigned to repeating the same thing for hours with little visible improvement. That mentality must be avoided when using the methods of this book. There are two types of situations you will encounter when increasing speed. One involves technical skills you already have; you should be able to bring these parts up to speed in minutes. The other involves new skills; these will take longer and will be discussed below.

Technique improves most rapidly when playing at a speed at which you can play accurately. This is especially true when playing HT (please be patient — I promise we will eventually get to HT practice). Since you have more control HS, you can get away with much faster play HS than HT without increasing stress or forming bad habits. Thus it is erroneous to think that you can improve faster by playing as fast as possible (after all, if you play twice as fast, you can practice the same passage twice as often!). Since the main objective of HS practice is to gain speed, the need to quickly attain speed and to practice at a speed optimized for technical improvement become contradictory. The solution to this dilemma is to constantly change the speed of practice; do not stay at any one speed for too long. Although it is best to bring the passage up to speed immediately, for very difficult passages that require skills you don't already have, there is no alternative but to bring it up in stages. For this, use speeds that are too fast as exploratory excursions to determine what needs to be changed in order to play at such speeds. Then slow down and practice those new motions. Of course, if you lack the technique, you must go back to shortening the passage and applying the parallel set exercises.

To vary the speed, first get up to some manageable "maximum speed" at which you can play accurately. Then go faster (using chord attacks, etc., if necessary), and take note of how the playing needs to be changed (don't worry if you are not playing accurately). Then use that motion and play at the previous "maximum speed". It should now be noticeably easier. Practice at this speed for a while, then try even slower speeds to make sure that you are completely relaxed. Then repeat the whole procedure. In this way, you ratchet up the speed in manageable jumps and work on each needed skill separately. In most cases, you should be able to play a new piece, at least in small segments, HS, at the final speed during the first sitting. In the beginning, such feats may seem unattainable, but every student can reach this objective surprisingly quickly.

1.2.14 How to Relax

The most important thing to do as you get up to speed is to relax. Relaxing means that you use only those muscles that are needed to play. Thus you can be working as hard as you want, and be relaxed. The relaxed state is especially easy to attain when practicing HS. There are two schools of thought on relaxation. One school maintains that, in the long run, it is better not to practice at all than to practice with even the slightest amount of tension. This school teaches by showing you how to relax and play a single note, and then advancing carefully, giving you only those easy material that you can play relaxed. The other school argues that relaxation is just another necessary aspect of technique, but that subjugating the entire practice philosophy to relaxation is not the optimum approach. Which system is better is not clear at this time. Whichever system you choose, it is obvious that playing with stress must be avoided.

If you adopt the methods described in this book and get up to final speed rapidly, some initial stress may be unavoidable. Note that the whole idea of getting up to speed quickly is to enable you to practice at a slower speed, completely relaxed. As pointed out throughout this book, high speed is nearly impossible to attain without complete relaxation and de-coupling of all the muscles (especially the large muscles) so that the fingers can gain their independence.

Students who play with a lot of stress will know that the stress is gone when, all of a sudden, the playing becomes easy at speed. Those who had not been taught to eliminate stress think that this is the point at which they suddenly acquired a new technique. In reality, their technique had slowly improved to the point when they could start to relax. The relaxation allowed the technique to improve more and the improvement allowed further relaxation, and this feedback cycle is what caused such a magical transformation. It is obviously better to start with zero stress. Although starting with zero stress might appear to hold you back in the beginning, you tend to acquire technique faster starting with zero stress than rushing into a stressed state and then trying to eliminate the stress. So, then, how do you relax?

There are numerous instances in many books, with instructions to "involve the whole body", when playing the piano with no further suggestions on how to achieve it. Part, or sometimes most, of this involvement has to be relaxation. In many ways, the human brain is wasteful. For even the simplest tasks, the brain generally uses most of the muscles in the body. And if the task is difficult, the brain tends to lock the body in a mass of tensed muscles. In order to relax, you must make a conscious effort (involve the whole body) to shut down all unnecessary muscles. This is not easy because it goes against the natural tendency of the brain. You need to practice relaxation just as much as moving the fingers to depress the keys. Relaxing does not mean to "let go of all muscles"; it means that the unnecessary ones are relaxed even when the necessary ones are working full tilt, which is coordination a skill that requires a lot of practice to achieve.

Don't forget to relax all the various functions of the body, such as breathing and periodic swallowing. Some students will stop breathing when playing demanding passages because the playing muscles are anchored at the chest, and keeping that part of the body still makes it easier to play. When relaxed, you should be able to conduct all of the normal body functions and still be able to simultaneously concentrate on playing. Section 1.2.21 below explains how to use the diaphragm to breathe properly. If your throat is dry after a hard practice, it means that you had also stopped swallowing. These are all indications of stress.

The gravity drop method discussed above is an excellent way to practice relaxation. Practice this gravity drop with one finger. Choose a different finger each time. Although there is never a need to actively lift the 4th finger, don't get into the habit of completely relaxing it, as that will cause it to hit some unwanted keys. This is because evolution has connected the last three fingers with tendons to facilitate grasping tools. Acquire the habit of maintaining a slight upward tension on the 4th finger, especially when playing fingers 3 and 5. Again, the test for relaxation is gravity: feeling the effect of gravity as you play is a necessary and sufficient condition for relaxation.

Relaxing is finding the proper energy and momentum balance as well as arm/hand/finger positions and motions that allow you to execute with the appropriate expenditure of energy. Therefore relaxing requires a lot of experimentation to find those optimum conditions. However, if you had been concentrating on relaxation from day one of your piano lessons, this should be a routine procedure that you can quickly execute because you have done it many times before. For those who are new to relaxation, you can start with easier pieces you have learned, and practice adding relaxation. The parallel set exercises of 1.3.7 can also help you to practice relaxation. However, nothing can replace the daily experimentation you should conduct whenever you learn a new piece of music. You will then gradually build up an arsenal of relaxed motions — this is part of what is meant by technique. One easy way to feel relaxation is to practice one parallel set and accelerate it until you build up stress, and then try to relax; you will need to find motions and positions of arms, wrists, etc., that allow this; when you find them, you will feel the stress gradually draining from your hand.

Many people do not realize that relaxation is itself diagnostic tool in the experimentation. Assuming that you have a certain arsenal of hand motions (see section 1.3.4), the criterion for "good technique" is one that allows relaxation. Many students think that long repetitive practices somehow transform the hand so it can play. In reality, what happens is that the hand accidentally stumbles onto the right motion for relaxation. This is why some skills are acquired quickly while others take forever and why some students acquire certain skills quickly while other students struggle with the same skills. The correct (and faster) way to learn is to actively search for the right motions and to build up an arsenal of them. In this search, it helps to understand what causes fatigue and what biological functions influence the energy balance (see section 1.2.21 on Endurance below). Relaxation is a state of unstable equilibrium: as you learn to relax, it becomes easier to further relax, and vice versa. This explains why relaxation is a major problem for some while it is completely natural for others. But that is a most wonderful piece of information. It means that anyone can relax, if they are properly taught and constantly strive for relaxation!

The most important element in relaxation, obviously, is energy conservation. There are at least 2 ways to conserve: (1) don't use unnecessary muscles and (2) turn off the necessary muscles as soon as their jobs are done. Practice the art of turning off muscles quickly. Let's demonstrate these with the one-finger gravity drop. (1) is the easiest; simply allow gravity to completely control the drop, while the entire body is resting comfortably on the bench. For (2) you will need to learn a new habit if you don't already have it (few do, initially). That is the habit of relaxing all muscles as soon as you reach the bottom of the key drop. During a gravity drop, you let gravity pull the arm down, but at the end of the key drop, you need to tense the finger for an instant in order to stop the hand. Then you must quickly relax all muscles. Don't lift the hand, just rest the hand comfortably on the piano with just enough force to support the weight of the arm. Make sure that you are not pressing down. This is more difficult than you would think at first because the elbow is floating in mid air and the same muscles used to tense the finger in order to support the arm weight are also used to press down. One way to test if you are pressing down is to take the arm off the keys and rest your forearm on your legs in front of you, totally relaxed. Then carry over that same feeling to the end of the gravity drop.

Few people bother to turn off muscles explicitly. You just tend to forget about them when their work is done. This presents no problems when playing slowly, but becomes problematic with speed. You will need a new exercise because the gravity drop has little to do with speed. You need to start with the key down and to play a quick, moderately loud note. Now you have to apply extra downward force *and* turn it off. When you turn it off, you must return to the feeling you had at the end of gravity drop. You will find that, the harder you play the note, the longer it takes for you to relax. Practice shortening the relaxation time.

What is so wonderful about these relaxation methods is that after practicing them for a short time (perhaps a few weeks), they tend to be automatically incorporated into your playing, even into pieces that you have already learned, as long as you pay attention to relaxation.

The worst consequence of stress is that it gets you into a fight you can't win because you are fighting an opponent who is exactly as strong as you are — namely, yourself. It is one of your own muscles working against another. As you practice and get stronger, so does the opponent, by an exactly equal amount. And the stronger you get, the worse the problem. If it gets bad enough, it can lead to injury because the muscles become stronger than the material strength of your hand. That is why it is so important to get rid of stress.

Relaxation, arm weight (gravity drop), involving the whole body, and avoidance of mindless repetitive exercises were key elements in Chopin's teachings, but Liszt advocated exercises "to exhaustion" (Eigeldinger). My interpretation of the last apparent disagreement is that exercises can be beneficial, but are not necessary. Also, Liszt did not have the benefit of this book — he probably had to practice a lot before his hands accidentally stumbled onto the right motion. Of course, the piano makes a big difference. Chopin preferred the Pleyel, a piano with very light action and small keydrop, and required less effort to play. Relaxation is useless unless it is accompanied by musical playing; in fact, Chopin insisted on musical playing before acquiring technique because he knew that music and technique were inseparable. We now know that without relaxation, neither music nor technique is possible. **Technique originates in the brain. Non-musical playing apparently violates so many tenets of nature that it actually interferes with the brain's natural processes for controlling the playing mechanisms.** That is not to claim that you can't train yourself to become a machine, performing difficult acrobatics with blinding speed. The claim here is that mindless repetitions is a long, roundabout way to learn piano.

1.2.15 Post Practice Improvement (PPI)

There is only a certain amount of improvement you can expect during practice at one sitting, because there are two ways in which you improve. The first one is the obvious improvement that comes from learning the notes and motions, resulting in immediate improvement. This occurs for passages for which you already have the technique to play. The second one is called post practice improvement (PPI) that results from physiological changes as you acquire new technique. This is a very slow process of change that occurs mostly after you have stopped practicing because it requires the growth of nerve and muscle cells.

Therefore, as you practice, try to gauge your progress so that you can quit and go to something else as soon as a point of diminishing returns is reached, usually in less than 10 minutes. **Like magic, your technique will keep improving by itself for at least several days after a good practice.** Therefore, *if you had done everything right*, then, when you sit at the piano the next day, you should discover that you can now play better. If this happens for just one day, the effect is not that big. However, the cumulative effect of this occurring over weeks, months, or years can be huge.

It is usually more profitable to practice several things at one sitting and let them all improve simultaneously (while you are not practicing!), than working too hard on one thing. Over-practicing can actually hurt your technique if it leads to stress and bad habits. You do have to practice a certain minimum amount, perhaps a hundred repetitions, for this automatic improvement to take effect. But because we are talking about a few bars played at speed, practicing dozens or hundreds of times should take only about 10 minutes or less.

Therefore, don't fret if you practice hard but don't see much immediate improvement. This might be normal for that particular passage. If, after extensive analysis and you can't find anything wrong with that you are doing, it is time to stop and let the PPI take over.

There are many types of PPI depending on what is holding you back. One of the ways in which these different types manifest themselves is in the length of time over which they are effective, which varies from one day to many months. The shortest times may be associated with conditioning, such as the use of motions or muscles you had not used before, or memory issues. Intermediate times of several weeks may be associated with new nerve connections, such as HT play. Longer times may be associated with actual growth of brain/nerve/muscle cells, and conversion of slow to fast muscle cell types.

If you had developed certain bad habits, you may have to stop playing that piece for months until you lose whatever bad habit you had developed, which is another form of PPI. In most cases of bad habits, it is not possible to identify the culprit, so that the best thing to do is to not play the piece and to learn new pieces instead because learning new pieces is one way to erase old habits.

You must do everything right to maximize PPI. Many students do not know the rules and can actually *negate* the PPI with the result is that, when they play it the next day, it comes out *worse*. Most of these mistakes originate from incorrect use of fast and slow practice; therefore, we will discuss the rules for choosing the right practice speeds in more detail in the following sections. Any stress or unnecessary motion during practice will also undergo post-practice enhancement. The most common mistake students make to negate PPI is to play fast just before quitting practice. The last thing you do before quitting should be the most correct and best example of what you want to achieve. **Your last run-through seems to have an inordinately strong PPI effect.** The methods of this book are ideal for PPI, mainly because they emphasize practicing on only those segments that you cannot play. If you play HT slowly and ramp up the speed for a large section of any piece of music, PPI is not only insufficiently conditioned, but also becomes totally confused because you mix a large proportion of easy material with the small amount of difficult ones. In addition, the speed, and probably the motions are also incorrect.

PPI is nothing new; let's look at three examples: the body builder, the marathoner, and golfer. While lifting weights, the body builder's muscles don't grow; he will in fact lose weight. But during the following weeks, the body will react to the stimulus and add muscle. Almost all of the muscle growth occurs *after* the exercise. Thus the body builder does not measure how much muscle he gained or how much more weight he can lift at the end of the exercise, but instead concentrates on whether the exercise produces the appropriate conditioning. The difference here is that for piano, we are developing coordination and speed instead of strength and endurance. Thus, whereas the bodybuilder wants to grow the slow muscles, the pianist wants to convert the slow muscles into fast ones. Another example is the marathon runner. If you had never run a mile in your life, and tried it for the first time, you might be able to jog for a quarter mile before you need to slow down for a rest. After some rest, if you tried to run, you will again tire out in a quarter mile or less. Thus the first run resulted in no discernible improvement. However, the next day, you may be able to run a third of a mile before tiring — you have just experienced PPI. If you run incorrectly, you can create problems; for example, you might develop a bad habit of stubbing your toe if you push yourself too far and keep on running when you are too tired. This is the analogy to acquiring bad habits if you practice the piano with stress. Golf presents another excellent example. Golfers are familiar with the phenomenon in which they can hit the ball well one day, but terribly the next because they picked up a bad habit that they often cannot diagnose. Hitting the driver every day tends to ruin your swing, whereas practicing with the #9 can restore it. The analogy in piano is that playing fast, full tilt, tends to ruin the PPI whereas practicing short sections HS tends to improve it. Clearly, the conditioning procedure must be well understood in order to assure the desired PPI.

Most PPI occurs during sleep. The sleep must be the normal, over-night type with all of its major components, especially REM sleep. This is because most cell growth and repair occur during sleep. It is why babies and young children need so much sleep — because they are growing rapidly. You will not get good PPI if you did not sleep well that night. The best routine for using PPI is to practice in the evening for conditioning and then reviewing it the next morning.

1.2.16 Dangers of Slow Play — pitfalls of the intuitive method

Repetitive slow play can be harmful when starting a new piece. We stated in section 1.2.1 that playing slowly, and gradually ramping up the speed, is not an efficient way to practice piano. Let us examine this procedure to see why. We are assuming that the student is just starting the piece and does not yet know how to play it. In that case, the slow play will be very different from the way it should be played at speed. **When you start, there is no way of knowing whether the slow play motion you are using is right or wrong; in section 1.4.3, we show that the probability of playing incorrectly is nearly 100%,** because there is almost an infinity of ways to play it incorrectly but only one best way. What is the probability of accidentally hitting that one correct way out of an infinity of possibilities? Practicing this wrong play does not help the student to play correctly or faster. When this wrong motion is speeded up s/he will hit a speed wall, resulting in stress. Assuming that this student succeeded in changing the playing so as to avoid the speed wall and succeeded in increasing the speed in increments as the speed is ramped up, s/he will then need to unlearn the old way and then relearn this new play, etc., and keep repeating these cycles for each incremental increase in speed until s/he reaches the final speed. Finding all these intermediate methods of play by trial and error can take a lot of time.

Let's look at a concrete example of how different speeds require different motions. Consider the horse's gait. As the speed is increased, the gait goes through walk, trot, canter, and gallop. Each of these four gaits usually has at least a slow and fast mode. Also, a left turn is different from a right turn (the leading hoof is different). That's a minimum of 16 motions. These are the so-called natural gaits; most horses automatically have them; they can also be taught 3 more gaits: pace, foxtrot, and rack, which likewise have slow, fast, left, and right. All this, with only four legs of relatively simple structure and a comparatively limited brain. We have 10 very complex fingers, much more versatile shoulders, arms, and hands, and an infinitely more capable brain! Our hands are therefore capable of performing many more "gaits" than a horse. Ramping up a slow play in piano is like making a horse run as fast as a gallop by simply speeding up the walk — it just can't be done because as the speed increases, the momenta of the legs, body, etc., change, requiring the different gaits. Therefore, if the music requires a gallop, the student ends up having to learn all the intervening "gaits" if you ramp up the speed. You can easily understand why inducing a horse to walk as fast as a gallop would encounter speed walls and induce tremendous stress. But that is exactly what many piano students are trying to do with the intuitive method. What happens in practice is that the student does not end up acquiring the skill to walk as fast as a "gallop", but accidentally stumbles on a trot as the walk is accelerated.

Now a riding horse does not think, "hey at this speed, I have to canter"; it responds automatically to a rider's signals. Thus you can get a horse to make a left turn canter using right turn footing, and injure the horse. Therefore, it requires the superior intelligence of a human brain to figure out the horse's gait although it is the horse that is executing it. It works the same way with the piano, and the student can easily get her/imself into trouble. Although the human student is more intelligent than a horse, the number of possibilities that s/he faces is staggering. It takes a superior brain to figure out which are the best motions among the almost infinite variety that the human hand can perform. Most students with normal intelligence have little idea of how many motions are possible unless the teacher points this out to them. Two students, left to their own devices and asked to play the same piece, will be guaranteed to end up with different hand motions. This is another reason why it is so important to take lessons from a good teacher when starting piano; such a teacher can quickly weed out the bad motions. The point being made here is that, in the intuitive method, the student is guaranteed to pick up any number of bad habits before getting up to speed. The entire practice procedure ends up as a disastrous experience that actually hinders the student from progressing. This is especially true if the two hands have been locked together by extended HT practice. **Trying to un-learn a bad habit is one of the most frustrating, stressful, and time consuming tasks in piano practice.**

A common mistake is the habit of supporting or lifting the hand. In slow play, the hand can be lifted between notes when the hand weight is not necessary. When speeded up, this "lift" coincides with the next keydrop; these actions cancel, resulting in a missed note. Another common error is the waving of the free fingers — while playing fingers 1 and 2, the student might be waving fingers 4 and 5 in the air several times. This presents no difficulties until the motion is speeded up so fast that there is no time to wave the fingers. In this situation, the free fingers do not generally stop waving automatically at faster speeds because the motion has been ingrained by hundreds or even thousands of repetitions. Instead, the fingers are asked to do the impossible — wave several times at speeds they cannot attain — this creates the speed wall. The trouble here is that most students who use slow practice are generally unaware of these bad habits. **If you know how to play fast, it is safe to play slowly, but if you don't know how to play fast, you must be careful not to learn the wrong slow playing habits or to end up wasting tremendous amounts of time.** Slow play can waste huge chunks of time because each run-through takes so long. The methods of this book avoid all these pitfalls.

1.2.17 Importance of Slow Play

Having pointed out the dangers of slow play, we now discuss why slow play is *indispensable.* **Always end a practice session by playing slowly at least once.** This is the most important rule for good PPI. You should also cultivate a habit of doing this when switching hands during HS practice; before switching, play slowly at least once. **This may be one of the most important rules of this chapter because it has such an inordinately large effect on technique improvement, but why it works is not totally understood.** It is beneficial to both the immediate improvement and to PPI. One reason why it works may be that you can completely relax (see section 1.2.14). Another reason may be that you tend to pick up more bad habits than you realize while playing fast, and you can "erase" these with slow play. Contrary to intuition, playing slowly without mistakes is difficult (until you have completely mastered the passage). Thus slow play is a good way to test whether you have really learned this piece of music.

The effect of a final slow play to PPI is so dramatic dramatic that you can easily demonstrate it for yourself. Try one practice session in which you only play fast and see what happens the next day. Then try one in which you play slowly before quitting, and see what happens on the next day. Or you can practice a passage fast only and another passage (of the same difficulty) slowly at the end and compare them the next day. This effect is cumulative, so that if you were to repeat this experiment with the same two passages for a long time, you will eventually find a huge difference in the way you can handle these passages.

How slow is slow? That is a judgement call, and depends a lot on your skill level. If you play slower and slower, it will lose its effect below a certain speed. It is important, when playing slowly, to maintain the same motion as when playing fast. If you play too slowly, this may become impossible. Also, playing too slowly will take up too much time, resulting in waste. The best speed to try first is one at which you can play as accurately as you want, around 1/2 to 3/4 speed. Slow play is also needed for memorizing. The optimum slow speed for memorizing is slower than that needed to condition the PPI, about 1/2 speed. As technique improves, this slow speed can become faster. However, it is interesting that some famous pianists have often been observed to practice *very slowly!* Some accounts document practice at one note per second, which sounds almost irrational.

An important skill to practice when playing slowly is to think ahead of the music. When practicing a new piece fast, there is a tendency to mentally fall behind the music and this can become a habit. This is bad because that is how you lose control. Think ahead when playing slowly and then try to maintain that distance when you get back up to speed. When you can think ahead of what you are playing, you can sometimes foresee flubs or difficulties coming and have the time to take appropriate action.

1.2.18 Fingering

You usually won't go wrong by using the fingering marked on the music. Or, rather, if you don't follow the indicated fingering, you will probably get into a lot of trouble. Except in beginners' books, the basic fingerings are usually obvious and are not indicated in music scores. Some indicated fingerings may feel awkward at first, but it is there for a reason. This reason often does not become obvious until you get up to speed and/or you play HT. For beginners, following the indicated fingering is an educational experience for learning the most common fingerings. **Another advantage of using the indicated fingering is that you will always use the same one.** Not having a fixed fingering will greatly slow down the learning process and give you trouble later, even after you have learned the piece well. If you do change the fingering, make sure that you always stick to the new one. It is a good idea to mark the change on the music; it can be very annoying to come back to this music months later and not remember that nice fingering you had previously worked out.

However, not all suggested fingerings on the music score are appropriate for everyone. You may have large or small hands. You may have gotten used to a different fingering because of the way you learned. You might have a different skill set; e.g., you might be a better triller using 1, 3 than 2, 3. Music from different publishers may have different fingerings. For advanced players, the fingering can have a profound influence on the musical effect you want to project. Fortunately, the methods of this book are well suited to quickly changing fingerings. Part of the "explorations" alluded to above involve making sure that the fingering is optimized. Once you have become familiar with these methods, you will be able to change fingering very quickly. Make all the changes before you start HT practice because once fingerings are incorporated into HT play, they become very difficult to change. On the other hand, some fingerings are easy HS but become difficult HT, so it pays to check them HT before permanently accepting any changes. Everybody should memorize the fingerings for all the scales and arpeggios (section 1.3.5), as well as the chromatic scale, and to practice them until they become ingrained habits.

1.2.19 Accurate Tempo and the Metronome

Start all pieces by counting carefully, especially for beginners and youngsters. Children should be taught to count out loud because that is the only way to find out what *their* idea of counting is. It can be totally different from the intended one. You should understand the meter signature at the beginning of each composition. It looks like a fraction, consisting of a numerator and a denominator. The numerator indicates the number of beats per measure and the denominator indicates the note per beat. For example, 3/4 means that there are three beats per measure and that each beat is a quarter note. Typically, each bar contains one measure. Knowing the signature is essential when accompanying, because the moment that the accompanist starts is determined by the starting beat which the conductor indicates with the baton.

An advantage of HS practice is that you tend to count more accurately than HT. Students who start HT often end up with undetected mistakes in counting. Interestingly, these mistakes usually make it impossible to bring the music up to speed. There is something about wrong counting that creates its own speed wall. It probably messes up the rhythm. Therefore, if you run into problems with bringing it up to speed, check the counting. A metronome is very useful for this.

Use the metronome to check your speed and beat accuracy. I have been repeatedly surprised by the errors I discover when checked in this way. For example, I tend to slow down at difficult sections and speed up at easy ones, although I think it is actually the opposite when playing without the metronome. Most teachers will check their students' tempo with it. But it should be used only for a short time. Once the student gets the timing, it should be shut off. The metronome is one of your most reliable teachers — once you start using it, you will be glad you did. Develop a habit of using the metronome and your playing will undoubtedly improve. All serious students must have a metronome.

Metronomes should not be over used. **Long practice sessions with the metronome accompanying you are harmful to technique acquisition.** This leads to mechanical playing. When used for more than about 10 minutes continually, your mind will start to play mental tricks on you so that you may lose the timing accuracy. For example, if the metronome emits clicks, after some time, your brain will create anti-clicks in your head that can cancel the metronome click so that you will either not hear the metronome anymore, or will hear it at the wrong time. This is why most modern electronic metronomes have a light pulse mode. The visual cue is less prone to mental tricks and also does not interfere acoustically with the music. The most frequent abuse of the metronome is to use it to ramp up speed; this abuses the metronome, the student, the music, and the technique. If you must ramp up the speed gradually, use it to set the tempo, then turn it off and then keep on practicing; then use it again briefly when you increase the speed. **The metronome is for setting the tempo and for checking your accuracy. It is not a substitute for your own internal timing.**

The process of speeding up is a process of finding the appropriate new motions. When you find the correct new motion, you can make a quantum jump to a higher speed at which the hand plays comfortably; in fact, at intermediate speeds, neither the slow nor the fast motion applies and is often more difficult to play than the faster speed. If you happen to set the metronome at this intermediate speed, you might struggle at it for long periods of time and build up a speed wall. One of the reasons why the new motion works is that the human hand is a mechanical device and has resonances at which certain combinations of motions naturally work well. There is little doubt that some music was composed to be played at certain speeds because the composer found this resonance speed. On the other hand, each individual has a different hand with different resonance speeds, and this partly explains why different pianists choose different speeds. Without the metronome, you can jump from resonance to the next resonance because the hand feels comfortable at those speeds, whereas the chances of your setting the metronome at exactly those speeds is very low. Therefore, with the metronome, you are almost always practicing at the wrong speed. This is a great way to build any number of speed walls.

Electronic metronomes are superior to the mechanical ones in every respect although some people prefer the appearance of the old models. Electronics are more accurate, can make different sounds or flash lights, have variable volume, are less expensive, are less bulky, have memory functions, etc., while the mechanicals always seem to need rewinding at the worst possible times.

1.2.20 Weak Left Hand; Using One Hand to Teach the Other

Students who do not practice HS will always have a stronger RH than LH. This happens because the RH passages are generally more difficult, technically. The LH tends to get passages that require more strength, but it often lags behind in speed and technique. Thus "weaker" here means technically weaker, not strength-wise. **The HS method will balance the hands because you will automatically give the weaker hand more work.** For passages that one hand can play better than the other, the better hand is often your best teacher. To let one hand teach the other, select a very short segment and play it rapidly with the better hand, then repeat immediately with the weaker hand, one octave apart to prevent collisions. You will discover that the weaker hand can often "catch on" or "get the idea" of how the better hand is doing it. The fingering should be similar but does not need to be identical. Once the weaker hand "gets the idea", gradually wean it off by playing the weaker hand twice and the stronger hand once, then three against one, etc.

This ability of one hand to teach the other is more important than most people realize. The above example of solving one specific technical difficulty is just one example — more importantly, this concept applies to practically every practice session. The basic reason for this broad applicability is that one hand *always* plays something better than the other, such as relaxation, speed, quiet hands, and the innumerable finger/hand motions (Thumb Over, Flat Finger, etc., see following sections) — anything new that you are trying to learn. Therefore, once you learn this principle of using one hand to teach the other, you will be using it all the time. It can save you a tremendous amount of time.

1.2.21 Building Endurance, Breathing

"Endurance" is a controversial term in piano practice. This controversy originates from the fact that **piano playing requires control, not muscle power**, and many students have the wrong impression that they will not acquire technique until they grow enough muscles. On the other hand, a certain amount of endurance is necessary. This apparent contradiction can be resolved by understanding exactly what is needed and how to get it. Obviously, you can't play loud, grandiose passages without expending energy. Big, strong, pianists can certainly produce more sound than small, weak, pianists if they are equally skillful. And the stronger pianists can more easily play "demanding" pieces. Every pianist has enough physical stamina to play pieces at her/is level, simply because of the amount of practice that was required to get there. Yet we know that endurance *is* a problem. The answer lies in relaxation. When stamina becomes an issue, it is almost always caused by excess tension.

The most famous example of this is the LH octave tremolo in the first movement of Beethoven's "Pathétique". The *only* thing over 90% of the students need to do is to eliminate stress; yet many students practice it for months with little progress. The first mistake they make is to play it too loud. This adds extra stress and fatigue just when you can least afford it. Practice it softly, just concentrating on eliminating stress, as explained in section 1.3.3.2. As you practice, keep reminding yourself to look for hand positions that eliminate stress. In a week or two, you will be playing as many tremolos as fast as you want. Now start adding loudness and expression. Done! At this point, your physical strength and endurance is not any different from what it was when you started just a few weeks ago — the main thing you did was to find the best way to eliminate stress.

Playing demanding pieces requires about as much energy as a slow jog, at about 4 miles per hour, with the brain requiring more energy than the hands/body. Many youngsters cannot jog continuously for over one mile. Therefore, asking youngsters to practice difficult passages continually for 20 minutes would really strain their stamina because it would be about equivalent to jogging a mile. Teachers and parents must be careful when youngsters start their piano lessons, to limit practice times to under 15 minutes in the beginning until the students gain some stamina. Marathon runners have stamina, but they are not muscular. You need to condition the body for stamina for piano, but you don't need extra muscles.

Now there *is* a difference between piano playing and running a marathon because of the need to condition the brain for stamina in addition to the muscular conditioning. Therefore mindless practicing of scales and other exercises for stamina does not work. The most efficient ways to gain stamina are to either play finished pieces and make music, or to practice difficult sections HS continuously. Again using the jogging analogy, it would be very difficult for most students to practice difficult material continuously for more than a few hours because 2 hours of practice would be equivalent to jogging 6 miles, which is a terrific workout. Therefore, you will have to play some easy pieces between the hard practice sessions. Concentrated practice sessions longer than a few hours may not be that helpful until you are at an advanced level, when you have developed sufficient "piano stamina". It is probably better to take a break and restart practice after some rest. **Clearly, hard piano practice is strenuous work and serious practicing can put the student in good physical shape.** HS practice is most valuable in this regard because it allows one hand to rest while the other works hard, allowing the pianist to work as hard as s/he wants, 100% of the time, without injury or fatigue. Of course, in terms of stamina, it is not difficult (if you have the time) to put in 6 or 8 hours of practice a day by including a lot of mindless finger exercises. This is a process of self-delusion in which the student thinks that just putting in the time will get you there — it will not. If anything, conditioning the brain is more important than conditioning the muscles because it is the brain that needs the conditioning for music. In addition, strenuous conditioning of the muscles will cause the body to convert fast muscles to slow muscles that have more endurance — this is exactly what you do not want.

What is stamina? It is something that enables us to keep on playing without getting tired. For long practice sessions of over several hours, pianists do get their second wind just as athletes do. Can we identify any biological factors that control stamina? Knowing the biological basis is the best way to understand stamina. In the absence of specific bio-physical studies, we can only speculate. **Clearly, we need sufficient oxygen intake and adequate blood flow to the muscles and the brain.** The biggest factor influencing oxygen intake is lung efficiency, and important components of that are breathing and posture. This may be one reason why meditation, with the emphasis on proper breathing using the diaphragm, is so helpful. **Use of only the rib muscles to breathe over-utilizes one breathing apparatus and under-utilizes the diaphragm.** The resulting rapid pumping of the chest or exaggerated chest expansion can interfere with piano playing because all of the piano playing muscles eventually anchor near the center of the chest. Use of the diaphragm interferes less with the playing motions. In addition, those who do not use the diaphragm consciously can tense it when stress builds up during play, and they will not even notice that the diaphragm is tense. By using both the ribs and the diaphragm, and maintaining good posture, the lungs can be expanded to their maximum volume with least effort and thereby take in the maximum amount of oxygen.

The following breathing exercise can be extremely helpful, not only for piano, but also for general well-being. Expand your chest, push your diaphragm down (this will make your lower abdomen bulge out), raise the shoulders up and towards your back, and take a deep breath; then exhale completely by reversing the process. When taking a deep breath, breathe through your throat (you can open or close your mouth), not through your nose because any effort to breathe through the nose will constrict the air passage way. If you have not done this for a long time, it should cause hyper-ventilation — you will feel dizzy — after one or two such exercises. Stop if you hyper-ventilate. Then repeat this exercise at a later time; you should find that you can take more breaths without hyper-ventilating. Repeat this exercise until you can take at least 5 breaths in succession without hyper-ventilating. Now, if you go to the doctor's office and he checks you out with his stethoscope and asks you to take a deep breath, you can do it without feeling dizzy! This exercise teaches you the basics of breathing. Keep these breathing elements in mind as you practice piano, and make sure that you are using them appropriately, especially when practicing something difficult. Breathing normally while playing something difficult is an important element of relaxation. Perform this exercise at least once every several months.

The above types of methods for increasing the stamina can be learned mostly during practice, at the piano. Other methods of increasing stamina are to increase the blood flow and to increase the amount of blood in the body. These processes occur during PPI. In piano playing, extra blood flow is needed in the brain as well as the playing mechanism; **therefore, blood flow can be increased by making sure that both the brain and the body are fully and simultaneously exercised during practice. This will cause the body to manufacture more blood, simply because more blood is needed.** Mindless repetitions of scales, etc., are harmful in this respect because you can shut off the brain part, thus reducing the need for more blood. Practicing after a large meal also increase the blood supply and conversely, resting after every meal will reduce stamina. Since most people do not have enough blood to engage in strenuous activity with a full stomach, your body will rebel by making you feel terrible, but this is just an expected reaction. Once the body manufactures the necessary extra blood, this terrible feeling will not return. Therefore, you should stay as active as you can after a meal. Practicing immediately after a meal will require blood for digestion, for the playing muscles, and for the brain, thus placing the greatest demand on blood supply. Clearly, participation in sports activities, proper health, and exercise are also helpful for gaining stamina in piano playing.

In summary, beginners who have never touched a piano previously will need to work up their stamina gradually, because piano practice *is* strenuous work. Parents must be careful about the practice time of very young beginners; allow them to quit or take a rest when they get tired. Never allow a sick child to practice piano, even easy pieces, because of the risk of aggravating the illness and of brain damage. At any skill level, we all have more muscle than we need to play the piano pieces at our level. Even professional pianists who practice 6 hours every day don't end up looking like Popeye. Franz Liszt was thin, not muscular at all. Thus acquiring technique and stamina is not a matter of building muscle, but of learning how to relax and to use our energy properly.

1.2.22 Bad Habits: A Pianist's Worst Enemy

Updated: November 21, 2004

Bad habits are the worst time wasters in piano practice. Most bad habits are caused by stress from practicing pieces that are too difficult. Therefore be careful not to over practice a passage that is too difficult, especially HT. This can even lead to injuries. HT practice is the greatest single cause of bad habits and speed walls. This is why, in this section, the HT methods are described at the end. Many of the bad habits from HT practice are difficult to diagnose, which makes them that much more perverse.

Another bad habit is the over-use of the damper or soft pedal, as discussed below. This is the surest sign of an amateur student taking lessons with an unqualified teacher. Overuse of these pedals can only help a severely technically deficient student.

Stuttering is caused by stop-and-go practice in which a student stops and replays a section every time there is a mistake. **If you make a mistake, always play through it; don't stop to correct it.** Simply make a mental note of where the mistake was and play that section again later to see if the mistake repeats. If it does, just fish out a small segment containing that mistake and work on it. Once you cultivate the habit of playing through mistakes you can graduate to the next level in which you anticipate mistakes (feel their approach before they occur) and take evasive action, such as slowing down, simplifying the section, or just maintaining the rhythm. Most audiences don't mind, and often don't even hear, mistakes unless the rhythm is broken.

The worst thing about bad habits is that they take so long to eliminate, especially if they are HT habits. Therefore nothing accelerates your learning rate like knowing all the bad habits and preventing them before they become ingrained. For example, **the time to prevent stuttering is when a student first begins piano lessons.** If playing through mistakes is taught at this stage, it becomes second nature and is very easy. To teach a stutterer to play through mistakes is a very difficult task.

Another bad habit is to bang away at the piano without regard to musicality. This often results because the student is so engrossed with the practice that s/he forgets to listen to the sounds coming out of the piano. This can be prevented by cultivating the habit of always listening to yourself play. Listening to yourself is much harder than many people realize because many students expend all their effort playing, with nothing left for listening. Also, you tend to hear what you think you want to play; therefore, what you hear may not be what you are actually playing. One way to reduce this problem is to record your playing so that you can listen to it later in a mentally detached way. **Then there are those with weak fingers.** This is most common among beginners and is more easily corrected than those who bang too loud.

Still another bad habit is always playing at the wrong speed, either too fast or too slow. The right speed is determined by many factors, including the difficulty of the piece in respect to your technical ability, what the audience might be expecting, the condition of the piano, what piece preceded or will follow this piece, etc. Some students might tend to perform pieces too fast for their skill level, while others are timid and play too slowly. Thoses who perform too fast can become very discouraged because they make too many mistakes and become convinced that they are poor performers. Timid players can also be psychologically affected by their own music, which will make them feel even more timid. These effects apply not only to performances but also to practices.

Poor tone quality is another common problem. Most of the time, during practice, no one is listening, so tone doesn't seem to matter. As a result, if the tone degrades slightly, it does not bother the student, with the result that the tone is totally ignored after some time. Students must always strive for tone, no matter how good they think it is. Listening to good recordings is the best way to wake up the student to the existence of good tone. If they only listen to their play, they may have no idea what good tone means. On the other hand, once you pay attention to tone and start getting results, it will feed on itself and you can readily learn the art of producing sounds that can attract an audience.

The number of possible bad habits is so large that they cannot all be discussed here. Suffice it so say that a rigorous anti-virus attitude towards bad habits is a requisite to rapid improvement.

1.2.23 Damper Pedal

Beginners often over-use the damper pedal. The obvious rule is, **if the music doesn't indicate a pedal, don't use it.** Some pieces might seem easier to play with the pedal, especially if you start slowly HT, but this is one of the worst traps a rank beginner can fall into that will truly hold back development. The action feels lighter with the damper pedal down because the foot is holding the dampers up instead of the fingers. Thus the action feels heavier when the pedal is released, especially for fast sections. This forms a trap that gradually sucks the beginner into using more damper pedal for fast parts. What these students do not realize is that where pedals are not indicated, it is impossible to play the music correctly at speed if you use the pedal.

Those who use HS practice will rarely fall into this trap because the method gets you up to speed so quickly that you can immediately see that the pedal doesn't belong there. This is another trap that frequently catches students who use the intuitive method. Because they start playing slowly at first, use of the pedal doesn't sound so bad and they get into the habit of practicing with the pedal. Only when they get up to speed, do they realize that the notes are all running into each other and they now have to get rid of a bad, established habit. For Für Elise, use the pedal only for the large LH broken chords and the one RH arpeggio. Practically all of the two difficult interruptions (except for this arpeggio) should be played without the pedal. Even the parts requiring the pedal should initially be practiced without the pedal until you have basically finished the piece. This will encourage the good habit of keeping the fingers close to the keys and discourage the bad habit of playing with too much jumping and lifting of the hands, and not pressing firmly into the keys.

Coordinating the pedal and hands accurately is not an easy task. Therefore, students who start learning a piece HT with the pedal will invariably end up with terrible pedal habits. The correct procedure is to practice HS first without pedal, then HS with pedal, then HT without pedal, and finally HT with pedal. In this way, you can concentrate on each new element as you introduce it into your playing.

Another point about the pedal is that it must be "played" just as carefully as you play the keys with the fingers. See the references for all the different ways to pedal, when to use them, and how to practice those moves. Make sure that you master all these moves before using the pedal with an actual piece of music. There are some very helpful exercises in the references for practicing proper pedaling. When you do use the pedal, know exactly which move you are using and why. For example, if you want as many sympathetic strings to vibrate as possible, depress the pedal before playing the note. If, on the other hand, you want just one clear note to sustain, press the pedal after playing the note; the longer you delay the pedal, the fewer sympathetic vibrations you will get (clearer note — see the following section for more detailed explanations). In general, you should get into the habit of depressing the pedal a split second after playing the note. You can get a legato effect without too much blurring by rapidly lifting and depressing the pedal every time the chord changes. It is just as important to know when to lift the pedal as when to press it down.

Inattention to the pedal can slow down technical development much more than many students realize; conversely, attention to the pedal can help technical development by increasing the over-all accuracy of what you are doing. When you do one thing wrong, it becomes difficult to do all the other things right. When the pedal is wrong, you can't even practice the correct finger technique because the music comes out wrong even when the fingers are technically correct.

Most of the HS practice should be done without the pedal, even when the pedal is indicated. While practicing HS, you are only trying to figure out how to move the fingers and manage the passage; you are not trying to make music yet, so the pedal is just an unnecessary interference. The most important reason for not using the pedal at this stage is that technique improves fastest without the pedal because you can hear exactly what you play without interference from previously played notes. Also, the keys feel a little heavier without the pedal, as explained above. This extra workout (without the pedal) makes the playing easier when the pedal is added later.

1.2.24 Soft Pedal, Timbre, and Normal Modes of Vibrating Strings

The soft pedal is used to change the mood of the sound from more percussive (without the soft pedal) to more serene and gentle for grand pianos (soft pedal depressed). For uprights, it mostly makes the sound softer. For grands, it should not be used solely to reduce the intensity of the sound because it will also change the timbre. In order to play pianissimo, you will just have to learn how to play softly. Another property of the grand is that very loud sounds can be made with the soft pedal depressed. The soft pedal on most uprights has only a negligibly small effect on timbre. The upright cannot produce loud sounds with the soft pedal depressed. These changes in timbre will be explained in more detail below. One difficulty with the use of the soft pedal is that it (una corda, or more correctly due corda for the modern grand) is often not indicated, so the decision to use it is often left to the pianist.

A frequently overlooked point concerning the soft pedal is hammer voicing. If you tend to need the soft pedal to play softly, or if it is distinctly easier to play pianissimo with the grand lid closed, the hammer almost certainly needs voicing. See the subsection on "Voicing" in section 2.7.1. With properly voiced hammers, you should be able to control soft playing to any desired degree without the soft pedal. With worn, compacted, hammers, playing softly is impossible and the soft pedal has much less effect in changing the tone. In that case, the soft pedal mostly helps you to play softly and the sound will have a percussive component even with the soft pedal. Therefore, with worn hammers, you lose both the ability to play softly and the truly wonderful timbre change of the soft pedal. In most cases, the original properties of the hammer can be easily restored with simple voicing (re-shaping and needling).

The uncertainties concerning the condition of the hammer are partly responsible for why the use of the soft pedal is so controversial, since many performing pianists do use it just to play softly. As shown in the section on "Voicing", energy transfer from the hammer to the string is most efficient when the string motion is still small. A compacted hammer transfers most of its energy in this range. That is why you can find so many old large grands that feel feather light. Soft hammers on the same piano (with nothing else changed), would make the action feel much heavier. This is because, with the softer impact point of the hammer, the string is lifted far from its original position before the hammer energy starts to transfer to the string. In this position, the energy transfer is more inefficient and the pianist has to push harder to produce any sound. Clearly, the *effective* key weight is only partly controlled by the force required to depress the key, since it also depends on the force required to produce a given amount of sound. In other words, the piano technician must strike a compromise between voicing a hammer sufficiently soft so as to produce a pleasant tone and sufficiently hard so as to produce adequate sound. For all except the highest quality pianos, the hammer needs to be on the hard side in order to produce sufficient sound and to make the action feel nimble, which makes it difficult to play softly. This in turn can "justify" use of the soft pedal where it otherwise shouldn't be used.

In most uprights, the soft pedal causes all the hammers to move closer to the strings, thus restricting hammer motion and decreasing volume. Unlike the grands, loud sounds cannot be produced in an upright when the soft pedal is depressed. One advantage of uprights is that a partial soft pedal works. There are a few uprights in which the soft pedal works similarly to that of the grands.

In modern grands, the soft pedal causes the entire action to shift to the right by one-half string distance (the distance between strings of the same note in the 3-string section). This causes the hammer to hit only two of the three strings, causing a serendipitous transformation in the character of the sound. The horizontal motion must not move one string distance because then the strings will fall into the grooves made by adjacent strings. Since string distances cannot be controlled sufficiently accurately, this would cause some strings to fall exactly into the grooves while others will miss, creating uneven sound. Also, by hitting the less used portions of the hammer between string grooves, you get an even gentler sound. In order to understand the change in timbre with the soft pedal, we must study the acoustical mechanics of coupled vibrating strings (see Scientific American reference).

Almost all of the piano sound we hear is produced by what is called normal modes in mechanics. This is the reason why the piano sound consists mostly of the fundamental and its harmonics. Normal modes can always be decomposed into components in two orthogonal planes; say, vertical and horizontal. Furthermore, these oscillations have wavelengths that are integer fractions of the string length. Why does the string oscillate in normal modes instead of producing a whole jumble of every conceivable wavelength? At the instant that the hammer hits, it *does* produce a lot of these. If you place your hand on the piano, you can feel the piano “shudder” for an instant. But this is like “white noise”, energy spread over a wide frequency spectrum, and the component of that energy that is within the auditory range is not sufficient to produce a significant amount of what our ears interpret as sound. What happens is that most of this energy quickly escapes out of the strings through the ends, after only a few vibrations. This happens in milliseconds, too short a time for the ear to hear anything.

The only energies trapped in the strings are those in the normal modes. Why? Because **in normal modes, the ends of the strings are nodes: regions of the string that do not move.** Since no transverse energy can be transmitted across a string that is motionless, only the normal modes are trapped within the string. But not quite — the ends of the piano string are not ideal (absolutely motionless) nodes. The bridge and hitch pins are designed with just enough flexibility so that a controlled amount of energy is delivered to the soundboard. This is how the piano produces the fundamental frequency and its harmonics. Only exact harmonics are trapped because these are the only vibrations whose nodes coincide with those of the fundamental at the ends of the string. Since the hammer strikes the string in the vertical plane, all the normal modes are, initially, also in the vertical plane. An inexpensive piano is not constructed as rigidly or with as heavy material as an expensive piano and therefore has looser nodes, allowing more energy to escape. Since energy escapes quickly, a cheap piano also has less sustain. A larger piano can produce more sound because the longer strings, with more tension, can store more energy and, at the same time, the more rigid nodes of the heavier, better built pianos allow less energy to escape, producing a longer sustain.

What are the normal modes of three parallel strings whose ends are coupled by placing them close together at the bridge? These strings can all move in the same direction, thus pulling the piano in that direction, or move opposite to each other, in which case the piano does not move. The opposing motions are called symmetric modes because the strings move symmetrically in opposite directions about the center of gravity of the three strings. The center of gravity is stationary during these motions. Since it requires a lot of energy to move the piano, the non-symmetric modes quickly dissipate, leaving only the symmetric modes as possible normal modes of a 3-wire system. There is only one vertical normal mode for a three string system: the center string moves in one direction while the two side strings move in the opposite direction with half the amplitude. There are two horizontal normal modes: the one in which the center string is stationary and the side strings move in opposite directions, and the one in which the center string moves in one direction while the other two move in the opposite direction at half the amplitude. For a two-string system, there is no vertical normal mode! The one in which one string moves up and the other moves down is not symmetric; it twists the piano. The only possible horizontal mode for two strings is the one in which they move in opposite directions. The lack of symmetric normal modes is one reason why the fundamentals are so weak in the two and one string sections in the bass; however, they can sustain strong harmonics. The actual motion of the strings can be any combination of these normal modes. The different admixtures of the normal modes determine the polarization of the oscillations. The polarizations change with time and this change controls the nature of the piano sound, especially things like undesirable beats.

Now we can explain what happens when the hammer hits a three string system. It initially produces mostly the vertical normal modes. Since these vertical modes couple efficiently with the soundboard (which is most flexible in that direction; i.e., it is thinnest in this direction), a loud "prompt" sound is produced. Because of the high coupling efficiency, the soundboard vibrates actively like a drum, producing a drum-like percussive sound. Now, because the piano is not symmetrical on both sides of the strings, some sideways motions are created by the vertical oscillations, which transfer energy from the vertical modes into the horizontal modes. These new modes transfer energy poorly to the soundboard, which is "thickest" in the horizontal direction and cannot vibrate horizontally. This also excites a different set of vibrational modes of the soundboard, thus changing the timbre of the sound. Therefore the horizontal modes survive much longer than the vertical modes and produce the "after sound" which has a longer sustain and a different character (Scientific American article, p. 120). Therefore, when the three strings are struck, there will be a percussive prompt sound followed by a gentler after sound.

Note that the prompt sound has two components, the initial "noise bang" associated with the white noise of the hammer strike that produces large numbers of travelling waves and anharmonic vibrations, and the following prompt sound made principally by the normal modes. Because the instantaneous volume of this impact sound can be so high, it is probably this initial sound spike that is most damaging to the ear, especially from worn hammers that release most of their energies during the initial impact. See "Voicing" in section 2.7.1 for details of the interaction of worn hammers with the string. For pianos with such worn hammers, it may in fact be wise to close the lid (as the majority of their owners probably do because of the painful effect on their ears). Of course, nothing beats getting the hammers properly voiced.

The above explanations are obviously greatly oversimplified. Even the Scientific American article referenced is totally inadequate in explaining the real workings of a 3-string system. That article deals mostly with the motions of one string and discusses two string interactions for ideal, simplified cases. There is no treatment of a real 3-string system. Most discussions on string vibrations are concerned with transverse motions of the strings because those motions are the most visible and they explain the existence of the fundamental and harmonics. Although nodes do not transfer transverse motions, they do transfer tensile forces. The discussions in the "Voicing" section make it clear that tensile forces cannot be ignored since they are much larger than the transverse forces and might well dominate the acoustics of the piano. Also, the conclusions of the normal mode discussions presented above depend greatly on the coupling constant. For small coupling constants, the system becomes a superposition of coupled and uncoupled motions which allows many more modes. Thus the above discussions give only a qualitative flavor of what might be happening and give neither a quantitative, nor even a correct mechanistic, description of a real piano.

This type of understanding of piano acoustics helps us find the proper ways to use the damper pedal. If the pedal is depressed *before* a note is played, the initial "white noise" will excite all strings, creating a soft background roar. If you place your finger on any string, you can feel it vibrate. However, octave and harmonic strings will vibrate with higher amplitudes than the dissonant strings. This indicates that the initial "white noise" is not white but favors the normal modes. This is expected because the ends of the string are held still while the hammer strikes, thus discouraging the excitation of non-normal mode vibrations. Thus the piano not only selectively traps normal modes, but also selectively generates them. Now if the pedal is depressed *after* the note is struck, there will be sympathetic vibration in octave and harmonic strings, but the unrelated strings will be almost totally quiet. This produces a clear sustained note. The lesson here is that, in general, the pedal should be depressed immediately after striking the note, not before. This is a good habit to cultivate.

Many of the above explanations can be proven experimentally. The motions of the strings can be measured directly by a number of readily available instruments. A second method is to make use of the fact **that the string vibrations are linear processes; i.e. they decay exponentially with time.** Thus when the sound decay is plotted on a logarithmic scale, you get a straight line (see Scientific American reference). However, when so plotted, one gets two straight lines, an initial line with a steep slope (faster decay), followed by another one with a less steep slope. These two lines coincide with our perception of prompt and after sounds. **The fact that these lines are so straight tells us that our linear model is very accurate.** In linear systems, the existence of two straight lines also proves that they originate from two distinct mechanisms (in this case, different types of vibration). Because the string vibrations are not sufficiently violent to materially distort the piano, the transfer rate of vertical vibrational energy to the horizontal vibrations is a constant. This explains why the ratio of prompt sound to after sound is independent of loudness; i.e., you cannot change the timbre by just playing softly. However, there is one caveat. Timbre is controlled by at least two factors: the prompt/after-sound ratio just discussed, and the harmonic content. The harmonic content does depend on loudness. When the hammer strikes a string with higher force, the string becomes more distorted, which creates more high frequency components in the sound. This higher harmonic content makes the sound brighter or harsher. In practice, the condition of the hammer controls the harmonic content much more than the loudness. Therefore, proper voicing is necessary in order to produce the pleasant piano tone, especially for loud sounds.

The unstruck string plays an important role in producing the una corda sound. This string acts as a reservoir into which the other two strings can dump their energy. Since the vibration of the 3rd string is in anti-phase (a driven string is in anti-phase with the driver), it takes the edge off the initial prompt sound and at the same time, excites vibrational modes that are different from those that result when all three are struck in unison. This is why the soft pedal in uprights doesn't work as well — all the strings are struck even when the soft pedal is depressed.

Can you use a half soft pedal on a grand? This should not be controversial, but is. If you use a partial pedal, you will of course get a new sound. There is no reason why a pianist shouldn't be allowed to do that, and if it produces an interesting new effect, there is nothing wrong in that. However, this mode of play was not intentionally designed into the piano and I know of no composer who composed for half soft pedal on a grand. Note that extensive use of partial soft pedals on the grand will cause the string to shave off one side of the hammer. Also, it is impossible for the piano technician to regulate the piano in such a way that the third string will always miss the hammer at the same pedal travel for all the hammers at the same time. Thus the effect will be uneven, and different from piano to piano. Therefore, unless you have experimented and are trying to produce some strange new effect, half-pedaling is not recommended for the soft pedal on a grand. Nonetheless, anecdotal accounts seem to indicate that use of partial soft pedal on a grand does occur, probably because of ignorance on the part of the pianist about how it works.

In the double and single string sections, the strings have much larger diameters, so when the action moves sideways, the strings hit the side walls of the grooves, thus giving them a horizontal motion and increasing the after sound component. This mechanism is indeed fiendishly ingenious!

The need to excite large vertical normal modes for loud sounds explains why the loudest piano sounds are produced by rapid double strikes. This is why so many pieces of music with loud endings frequently finish with full, double strike, chords. Since the hammer hits the strings close to one end, the initial hit creates running waves traveling down the string. If the hammer is struck again immediately after the first strike, a new wave of energy is supplied, producing a louder sound. This second wave does not dissipate rapidly like the first wave because all available oscillation modes have already been excited. Thus the second strike produces the loudest sound that a piano can make. A third strike becomes unpredictable because the strings are now moving and the strings and hammer can be out of phase, in which case the third strike can deaden the sound.

In summary, the name soft pedal is a misnomer for a grand. Its main effect is to change the timbre of the sound. If you play a loud sound with the soft pedal depressed, it will be almost as loud as without the soft pedal. This is because you have put roughly the same amount of energy into making the sound. On the other hand, it is easier to play softly using the soft pedal on most pianos. Provided that the hammer is in good condition, you should be able to play just as softly without the soft pedal. **A partial soft pedal will produce all sorts of unpredictable, uneven effects and should not be used for a grand.**

1.2.25 Hands Together: Chopin's Fantaisie Impromptu

We can now finally start putting the hands together (HT)! This is where some students encounter the most difficulties, especially in the first few years of piano lessons. Although the methods presented here should immediately help you to acquire technique faster, it will take about two years for you to be able to really take advantage of everything that the methods of this book has to offer, especially for someone who has been using the intuitive method. Therefore, work on learning the *method* as much as using it to learn a particular piece of music. The main question here is, what must we do in order to be able to play HT quickly? In answering that question, we will learn why we devoted so much of this section on HS practice. As we shall soon see, putting HT is not difficult if you know how.

Playing HT is almost like trying to think about two different things at the same time. There is no known, pre-programmed coordination between the two hands like we have between our two eyes (for judging distance), our ears (for determining the direction of oncoming sound) or our legs/arms (for walking). Therefore, learning to coordinate the two hands accurately is going to take some work. The preceding HS work makes this coordination much easier to learn because we now only have to concentrate on coordinating, and not coordinating AND developing finger/hand technique at the same time.

The good news is that there is only one primary "secret" for learning HT quickly (of course, there are numerous other tricks, such as the "adding notes" method, outlining, etc., discussed below). That "secret" is adequate HS work. **All technique acquisition must be done HS.** Putting it another way, **don't try to acquire technique HT that you can acquire HS.** By now, the reasons should be obvious. If you try to acquire technique HT that you can acquire HS, you will run into problems such as (1) developing stress, (2) unbalancing the hands (the RH tends to get stronger), (3) acquiring bad habits, especially incorrect fingerings, that are impossible to change later on, (4) creating speed walls, (5) incorporating mistakes, etc. Note that all speed walls are *created*; they result from incorrect play or stress. Therefore everybody has a different set of speed walls. Premature HT practice can create any number of speed walls. Incorrect fingering is another major problem; some fingerings appear more natural when played slowly HT but become impossible when speeded up. The best example of this is "thumb under" play (section 1.3.5).

What this boils down to is that you will need some criterion for deciding when you have done adequate HS practice. The first criterion is HS speed. Typically, the maximum HT speed you can play is 50% to 90% of the slower HS speed. This slower speed is usually the LH. Suppose that you can play the RH at speed 10 and the LH at speed 9. Then your maximum HT speed may be 7. The quickest way to raise this HT speed to 9 would be to raise the RH speed to 12 and the LH speed to 11. Don't try to raise it HT. **Raising the speed HT is probably the biggest cause of problems with the intuitive method.** As a general rule, get the HS speed up to about 50% above final speed. Therefore, the criterion we were seeking above is this; if you can play HS at about 150% of final speed, relaxed, and in control, then you are ready for HT practice. Do not take this "150%" too literally; it is not necessary to measure the HS speed with a metronome. Just make sure that the HS speed is much faster than HT, then try HT. If you still have trouble, go back to HS and raise its speed a little more. If you had done sufficient HS work, the HT play will come very quickly.

There is a world of difference in how the brain handles tasks in one hand and tasks that require two-hand coordination. HS practice improves your ability to manipulate one hand. It does not tend to form habits not directly controlled by the brain because the brain controls each function directly. HT motions, on the other hand, can be cultivated only by repetition, creating a reflex habit. One indication of that is the fact that HT motions take longer to learn. **Therefore, bad HT habits are the worst because, once formed, they take forever to eliminate. The best way to acquire technique quickly is to avoid this category of bad habits.** This is why it is so important to delay HT practice until you are sure that the HS preparation is adequate.

The ability to coordinate, yet independently control, the two hands is one of the hardest skills to learn in piano. The flip side is that this makes HT habits nearly impossible to undo — nobody has yet figured out a way to erase HT habits quickly. This is the main reason why so many students spend so much time trying to learn

HT — they transition to HT before they are ready and end up trying to acquire technique HT. Now, this does not mean that you should never try HT in the beginning; you can start preliminary HT work at any time — just don't try to improve technique HT yet. HS practice is fundamentally different; you can change fingerings and hand motions relatively quickly. You can increase speed with much less chance of picking up bad habits. But it is not enough to get up just to final speed HS; you must be able to play *much faster* before you are ready for HT. Only by going to such fast speeds can you guarantee that all your finger/hand/arm positions and motions are optimized. **If you perform enough preparatory HS work, you will find that HT play at final speed comes surprisingly quickly and easily.** You have effectively scaled all potential HT speed walls by avoiding the mistakes that create them. For example, you can cultivate accurate chords and jumps best HS. It can be forbiddingly difficult to practice fast runs, accurate chords, or jumps HT, and there is no need to create such difficulties.

So here is a suggested routine for ensuring adequate HS work. Suppose that the final speed is 100. First, memorize and learn HS to 80 or even 100 (whole piece, or a large section, at least several pages; doesn't have to be perfect at this stage). This may take two or three days. Then start HT at 30 to 50. The objectives are (1) memorize HT, (2) make sure that the fingerings, hand positions, etc., work HT. This may take another day or two. You will in general need to make some modifications, such as when the two hands collide or one needs to cross over/under the other, etc. Then work on the technically difficult sections HS to speeds over 100. When you can comfortably play at speeds of 120 to 150, you are now ready to seriously start practicing HT. Vary HT practice speed; as soon as you start to get confused HT, clear up the confusion using HS play. For difficult material, you will be alternating between HS and HT for days, if not weeks, with the HT progressively taking over. As you improve HT play, always keep the HS play well ahead of the HT speed, because this is the fastest way to improve HT.

Now we can understand why some students get into trouble when they try to learn pieces that are too difficult by practicing mostly HT. The result is an unplayable piece full of stress, speed walls and bad habits that completely block any improvement because the problem motions are locked in. If this happens, no amount of practice will help. By contrast, **there is nothing that is too difficult with the methods of this book** (within reason). But it is still not a good idea to tackle pieces that are too far above your skill level because of the tremendous amount of HS practice that will be needed before you can start HT. Many people would become impatient, start HT or abandon HS prematurely, and end up getting into trouble anyway.

There are more benefits to acquiring technique HS before HT, in addition to saving time and trouble. (1) You will develop the independence of the two hands which is so necessary for controlling the expression. (2) You will find that the piece will have a much more solid foundation than if you started HT too early, and you will feel that there is better control. (3) You can more easily play through mistakes or hide them. If you had learned the piece HT only and one hand makes a mistake, the other hand will stop. But if you had learned it HS first, then the other hand can keep going; in fact, you can often change fingerings as you play. (4) You will memorize it much better with fewer blackouts. (5) Best of all, you will acquire technique that you could not acquire by practicing only HT. Because you can play much faster HS than HT, you can acquire technique HS that you cannot even dream of, playing HT. It is this extra technique that builds a solid foundation for controlled HT playing. (6) If you can play accurately at 150% of performance speed HS, you will find that nervousness during the performance will be greatly reduced because of the increased confidence that you can handle the piece. In fact, using this method, you should eventually be able to play the piece at far above performance speed, which is what you need to do in order to have adequate control.

Most of the HT practice procedures are similar to the HS methods (shorten difficult passages, continuity rule, rules for fast and slow play, relaxation, etc.). Therefore, although there appears to be relatively few HT rules stated here compared to the HS section, you already know many of them from the HS section. There is no need to repeat them here because you will readily recognize their applicability if you had carefully studied the HS section.

As stated earlier, there are additional HT methods that can help. One is outlining, discussed in section 1.3.8. Another is the method of "adding notes". Suppose that you had followed all of the above procedures, but still have trouble playing HT. That is, you can play HS at much faster speeds than final speed, yet HT does not work. Then try the following. Take a short segment of the difficult section. Then play the more difficult hand HS, repeating it continuously (this is called cycling, see section 1.3.2). Now start adding the easier hand note by note; first add only one note, until you can play it satisfactorily. Then add another, etc., until the segment is complete. Very often, the reason why you cannot play HT although you can play HS is that there is an error in one hand. Frequently, this error is in the rhythm. Therefore, as you add notes, try to find out if there is a rhythmic error in one hand.

Another source of HT difficulty is insufficient memorization. Note that HS memorization and HT memorization is not the same thing. Therefore, just because you have it memorized HS does not mean that you have memorized it HT. When you transition to HT, you need to memorize it all over again, although it should go much faster this time. It is a mistake to assume that, because you know it inside out HS, you also know it HT.

Let us now proceed with a real life example of how to practice HT. I have chosen a non-trivial example to illustrate HT methods, because if the method works, it should work with anything. This is Chopin's Fantaisie-Impromptu, op. 66. This example is good because (1) everyone likes this composition, (2) without good learning methods it can seem impossible to learn, (3) the exhilaration of suddenly being able to play it is unmatched, (4) the challenges of the piece are ideal for illustration purposes, and (5) this is the kind of piece that you will be working on all your life in order to do "incredible things" with it, so you might as well start *now*! In reality, this is a fairly easy piece to learn! Most students who have difficulty do so because they can't get started and the initial hurdle produces a mental block that makes them doubt their ability to play this piece. There is no better demonstration of the efficacy of the methods of this book than showing how easily you can learn this composition. For somewhat easier pieces, see section 1.3.6.12 (Bach's Inventions).

We start by making sure that you have done all the preliminary homework with HS practice. Although the last page might be most difficult, we will break the rule about starting at the end and start at the beginning because this piece is difficult to start correctly but, once started, sort of takes care of itself. You need a strong, confident beginning. So we will start with the first two pages, up to the slow cantabile part. The LH stretch and continuous workout makes endurance a major issue. Those without sufficient experience and especially those with smaller hands, may need to work on the LH for weeks before it becomes satisfactory. Fortunately, the LH is not that fast, so speed is not a limiting factor and most students should be able to play the LH HS faster than final speed in less than two weeks, completely relaxed, without fatigue.

For bar 5 where the RH first comes in, the suggested LH fingering is 5321245-42123. You might start by practicing bar 5, LH, by cycling it continually until you can play it well. See section 1.3.7.5 for how to stretch your palm — you should stretch the *palm* during playing, not the *fingers*, which can lead to stress and injury. We all know that you can spread the fingers to increase your reach. However, you also have a separate set of palm muscles just for spreading the palm. Learn to use these two sets of muscles independently: the palm muscles for spreading only and the fingers for playing.

Practice without the pedal. First a few bars, then the entire section (up to the cantabile), all memorized and up to speed, HS.

Practice in small segments. Suggested segments are: bars 1–4, 5–6, 1st half of 7, 2nd half of 7, 8, 10 (skip 9 which is the same as 5), 11, 12, 13–14, 15–16, 19–20, 21–22, 30–32, 33–34, then 2 chords in 35. If you cannot reach the 2nd chord, play it as a very fast ascending broken chord, with emphasis on the top note. After each segment is memorized and satisfactory, connect them in pairs. Then play the whole LH from memory by starting from the beginning and adding segments. Bring it up to final speed.

When you can play this entire section (LH only) twice in succession, relaxed, without feeling tired, you have the necessary endurance. At this point, it is a lot of fun to go much faster than final speed. In preparation for HT work, get up to about 1.5 times final speed. Raise the wrist slightly when playing the pinky and lower it as you approach the thumb. By raising the wrist, you will find that you can put more power into the pinky, and by lowering the wrist you avoid missing the thumb note. In Chopin's music, the pinky and thumb (but especially the pinky) notes are most important, so practice playing them with authority. The Cartwheel method, explained in section 1.3.5, may be useful here.

When you are satisfied with it, insert the pedal; basically, the pedal should be cut with every chord change which generally occurs either once every bar or twice every bar. The pedal is a rapid up and down ("cutting the sound") motion at the first beat, but you can lift the pedal earlier for special effects. For the wide LH stretch in the second half of bar 14 (starting with E2), the fingering is 532124 if you can reach it comfortably. If not, use 521214. The thumb under method (see section 1.3.5) should be used here.

At the same time, you should have been practicing the RH, switching hands as soon as the working hand feels slightly tired. The routines are almost identical to those for the LH, including the initial practice without the pedal. Start by splitting bar 5 into two halves and learn each half separately up to speed, and then join them. For the rising arpeggio in bar 7, use the thumb over method, not thumb under because it is too fast to be played thumb under. Although you may not be playing it that fast now, you will eventually play it much faster. The fingering should be such that both hands tend to play the pinky or thumb at the same time; this makes it easier to play HT. This is why it is not a good idea to fool around with the fingerings of the LH — use the fingerings as marked on the score.

Now practice HT. You can start with either the first or second half of bar 5 where the RH comes in for the first time. The second half is probably easier because of the smaller stretch of the LH and there is no timing problem with the missing first note in the RH, so let's start with that. **The easiest way to learn the 3, 4 timing is to do it at speed from the beginning. Don't try to slow down and figure out where each note should go, because too much of that will introduce an unevenness in**

your playing that you may have a hard time eliminating later on. Here we use the "cycling" method — see "Cycling" in section 1.3.2 for more details. First, cycle the six notes of the LH continually, without stopping (no pedal). Then switch hands and do the same for the eight notes of the RH, at the same (final) tempo as you did for the LH. Next cycle only the LH several times, and then let the RH join in. Initially, you only need to match the first notes accurately; don't worry if the others aren't quite right. In a few tries, you should be able to play HT fairly well. If not, stop and start all over again, cycling HS. Since almost the whole composition is made up of things like the segment you just practiced, it pays to practice this well, until you are very comfortable. To accomplish this, change the speed. Go very fast, then very slow. As you slow down, you will be able to take notice of where all the notes fit with respect to each other. You will find that fast is not necessarily difficult, and slower is not always easier. Now add the pedal. This is when you should develop the habit of accurately pumping the pedal.

If you are satisfied with the second half of bar 5, repeat the same procedure for the first half. Then assemble the two halves together. You now have all the tools to learn the rest of this composition by yourself! It should be clear from this example that **the general methodologies for HT practice are essentially parallel to those for HS practice.** Therefore, the best way to learn HT practice is to learn the HS rules well. And it will pay handsomely if you can put HT at final speed instead of slowly at first. But this is not an absolute rule. For some pieces it may be better to slow down. In the above example, it was best to start HT at speed because of the 3, 4 timing problem.

The cantabile section is just the same thing repeated four times. Therefore, learn (and memorize) the 4th repetition first, and the rest will be easy. The quickest way to learn the 4th repetition is to first analyze and partially learn the beginning (1st repetition) since it is simpler and easier to analyze. As with many Chopin pieces, memorizing the LH well is the quickest way for building a firm foundation for memorizing because the LH usually has a simpler structure that is easier to analyze, memorize and play. This is because Chopin will often create several versions of the RH while repeating essentially the same notes in the LH.

The trill in the 1st bar (4th repetition), combined with the 2, 3 timing, makes the 2nd half of this bar difficult. Practice it first without the trill. Since there are 4 repetitions, you might play it without the trill the first repetition, then an inverted mordent the 2nd time, a short trill the 3rd, and a longer trill the last time around. This will make it much easier to play than trying to trill it all four times.

The third section is similar to the first section, so if you managed to learn the first section, you are almost home free. Note that in the final 20 bars or so, the RH pinky and thumb carry notes of major thematic value, all the way to the end. This section may require a lot of HS practice with the RH.

The 3, 4 timing is a mathematical device Chopin used to produce the illusion of hyper-speed in this piece. The mathematical explanations and additional salient points of this composition are further discussed under "Cycling" in section 1.3.2. You will probably practice this composition HS for years after you initially complete the piece because it is so much fun to experiment with this fascinating composition.

If you play any composition at full speed (or faster) too often, you may suffer what I call "fast play degradation" (FPD). The following day, you might find that you can't play it as well any more, or during practice, you can't make any progress. This happens mostly with HT play. HS play is more immune to FPD and can in fact be used to correct it. FPD occurs probably because the human playing mechanism (hands, brain, etc) gets confused at such speeds, and therefore occurs only for complex procedures such as HT play of conceptually or technically difficult pieces. Easy pieces do not suffer FPD. FPD can create enormous problems with complex music like Bach's or Mozart's compositions. Students who try to speed them up HT can run into all sorts of problems, and so the standard solution is to simply keep practicing slowly. However, there is a neat solution to this problem — increase speed using HS practice!

One disadvantage of the HS-HT approach is that practically all technique acquisition is accomplished HS, possibly resulting in poorly synchronized HT play. Therefore you should be aware of this possibility and practice HT with the objective of attaining very accurate synchronization of the two hands.

1.2.26 Summary

This concludes the basic section. You have the essentials to devise routines for learning practically any new piece. This is the minimum set of instructions you need to get started. However, note that the simplicity of each topic belies the endless possibilities that they present. It is important to understand that each procedure may have a myriad of uses and to constantly learn these new applications as you come across them, and to keep your eyes open for new possibilities. Take HS practice, for example. It is not just a method for learning quickly, but is useful for practicing as hard as you want without risking injury and it is used for removing hand memory and substituting it with more permanent memory that you can depend on for recovering from blackouts. It helps you to analyze a composition and its underlying simplifying concepts, it is used to balance the hands so that one is not weaker than the other, it allows you to take advantage of the ability of one hand to teach the other, etc. In section 1.3, we shall explore more uses for these basic steps, as well as introduce more ideas on how to solve some common problems.

1.3 Selected Topics in Piano Practice

Updated:
November 9, 2003

1.3.1 Tone, Rhythm, and Staccato

1.3.1.1 What is "Good Tone"?

Tone is the quality of the sound; it is a subjective judgment of whether the sum total of all the properties of the sound is appropriate for the music. There is controversy over whether a pianist can control the "tone" of each note on the piano. If you were to sit at the piano and play one note, it seems nearly impossible to alter the tone except for things like staccato, legato, loud, soft, etc. On the other hand, there is no question that different pianists produce differing tones. Two pianists can play the same composition on the same piano and produce music with very different tonal quality. Most of this apparent contradiction can be resolved by carefully defining what "tone" means. For example, a large part of the tonal differences among famous pianists can be attributed to the particular pianos they use, and the way those pianos are regulated or tuned. Controlling the tone of a single note is probably just one minor aspect of a multi-faceted, complex issue. The most important distinction we must make initially is whether we are talking about a single note or a group of notes. Most of the time, when we hear different tones, we are listening to a group of notes. In that case, tone is easier to explain. It is mostly produced by the control of the notes relative to each other. This almost always comes down to precision, control and musical content. **Therefore, tone is mainly a property of a group of notes and depends on the musical sensitivity of the pianist.**

However, it is also clear that we can control the tone of a single note in many ways. We can control it by use of the soft and damper pedals. We can also change the harmonic content (the number of overtones) by playing louder or softer. These methods control the timbre and there is no reason why timbre should not be part of tone. The soft pedal changes the timbre by reducing the prompt sound relative to the after sound. When a string is struck with a higher force, more harmonics are generated. Thus when we play softly, we produce sound containing stronger fundamentals. If the piano is played loudly with the soft pedal depressed, we hear an after sound with higher harmonic content. The damper pedal also changes the timbre by adding vibrations from the non-struck strings.

The tone or timbre can be controlled by the tuner, by working on the hammer or by tuning differently. A harder hammer produces a more brilliant tone (larger harmonic content) and a hammer with a flat striking area produces a harsher tone (more high frequency harmonics). The tuner can change the stretch or control the amount of detuning among the unisons. Up to a point, larger stretch tends to produce brighter music and insufficient stretch can produce a piano with unexciting sound. When detuned within the sympathetic vibration frequency range, all strings of a note will be in perfect tune (vibrate at the same frequency), but will interact differently with each other. For example, the note can be made to "sing" which may be an after sound whose volume wavers. Note that the importance of the after sound is often overblown because the prompt sound typically lasts over several seconds and most notes are not held that long. Thus most of the "singing" quality of sound from good pianos must be attributed to sustain, tone, and timbre, and not to the after sound.

Finally, we come to the difficult question: **can you vary the tone of a single note by controlling the key drop?** Most of the arguments over tone control center on the free flight property of the hammer before it strikes the strings. Opponents (of single note tone control) argue that, because the hammer is in free flight, only its velocity matters and therefore tone is not controllable for a note played at a specified loudness. But the assumption of free flight has never been proven, as we shall now see. **One factor affecting tone is the flex of the hammer shaft.** For a loud note, the shaft may be significantly flexed as the hammer is launched into free flight. In that case, the hammer can have a larger effective mass than its original mass when it hits the strings. This is because the force, F, of the hammer on the strings, is given by $F = Ma$ where M is the mass of the hammer and a is its deceleration upon impact with the strings. Positive flex adds an extra force because, as the flex recovers after the jack is released, it pushes the hammer forwards; when F increases, it doesn't matter if M or a increases, the effect is the same. However, a is more difficult to measure than M (for example you can easily simulate a larger M by using a heavier hammer) so we usually say, in this case, that the "effective mass" has increased, to make it easier to visualize the effect of the larger F on how the strings respond. In reality, however, positive flex increases a. For a note played staccato, the flex may be negative by the time the hammer strikes the strings, so that the tone difference between "deep" playing and staccato may be considerable. These changes in effective mass will certainly change the distribution of overtones and affect the tone we hear. **Since the shaft is not 100% rigid, we know that there is always a finite flex. The only question is whether it is sufficient to affect tone as we hear it.** It almost certainly is. If this is true, then the tone of the lower notes, with the heavier hammers, should be more controllable because the heavier hammers will cause a larger flex. Although one might expect the flex to be negligible because the hammer is so light, the knuckle is very close to the hammer flange bushing, creating a tremendous leverage. The argument that the hammer is too light to induce flex is not valid because the hammer is sufficiently massive to hold all of the kinetic energy required to make even the loudest sounds. That is a lot of energy!

Note that the static hammer let-off is only several millimeters and this distance is extremely critical for tone. Such a small let-off suggests that the hammer is designed to be in acceleration when it hits the string. The hammer is not in free flight after the jack releases because for the first few millimeters after release the hammer is being accelerated by the recovery of the shaft flex. The let-off is the smallest controllable distance that can maintain the acceleration without any chance of locking the hammer onto the strings because the jack could not release. The flex explains four otherwise mysterious facts: (i) the tremendous energy that such a light hammer can transfer to the strings, (ii) the decrease in tone quality (or control) when the let-off is too large, (iii) the critical dependence of the sound output and tone control on hammer weight and size, and (iv) the clicking sound that the piano makes when the hammer shank bushing deteriorates. The clicking is the sound of the bushing snapping back when the jack releases and the shank flex takes over — without the flex unwinding, the bushing will not snap back; therefore, without flex, there will be no click. Since the clicking can be heard even for moderately soft sounds, the shank is flexed for all except the softest sounds.

This scenario also has important implications for the pianist. It means that the tone of a single note can be controlled. It also tells us how to control it. First of all, for *ppp* sounds, there is negligible flex and we are dealing with a different tone from louder sounds. Pianists know that, to play *pp*, you press down with a constant velocity — note that this minimizes flex because there is no acceleration at release. When playing pianissimo, you want to minimize flex in order to minimize the effective mass of the hammer. Secondly, for maximum flex, key drop should accelerate at the bottom. This makes a lot of sense: "deep tone" is produced by leaning into the piano and pressing firmly, even with soft sounds. That is exactly how you maximize flex, which is equivalent to using a larger hammer (larger effective mass, see above). This information is also critical for the piano technician. It means that the optimum hammer size is one which is sufficiently small so that flex is zero somewhere around *pp*, but sufficiently large so that flex is significant starting around mf. This is a very clever mechanical arrangement that allows the use of relatively small hammers that enable rapid repetitions and can still transmit a maximum amount of energy to the strings. It means that it is a mistake to go to larger hammers to produce more sound because you will lose repetition speed and tone control. The clicking sound of worn bushings can now be explained. During the key drop, the pin is pressed against the bottom of the enlarged bushing hole. Upon release, the flex recovery will snap the bushing down, causing the pin to hit the top of the bushing hole with the familiar clicking sound.

Can the difference in tone of a single note be heard on the piano by playing just one note? Usually not; most people are not sensitive enough to hear this difference with most pianos. You will need a Steinway B or better piano, and you will start to hear this difference (if you test this with several pianos of progressively higher quality) with the lower notes. Tone is more important for lower notes because the hammers are heavier and the lower notes contain more harmonics than higher notes.

When actual music is played, the human ear is amazingly sensitive to how the hammer impacts the strings, and this tone difference can be easily heard, even with lesser pianos than the Steinway B. This is analogous to tuning: most people (including most pianists) will be hard pressed to hear the difference between a super tuning and an ordinary tuning by playing single notes or even testing intervals. However, practically any pianist can hear the difference by playing a piece of their favorite music. You can demonstrate this yourself. Play an easy piece twice, in an identical way except for touch. First, play with arm weight and "pressing deeply" into the piano, making sure that the key drop accelerates all the way down. Then compare this to the music when you press shallowly so that there is complete key drop, but there is no acceleration at the bottom. You may need to practice a little to make sure that the first time is not louder than the second. You should hear an inferior tone quality for the second mode of play. In the hands of great pianists, this difference can be quite large. Of course, we discussed above that tone is controlled most strongly by how you play successive notes, so that playing music to test the effect of single notes is clearly not the best way. However, it is the most sensitive test.

In summary, tone is primarily a result of uniformity and control of playing and depends on the musical sensitivity of the player. **Tone control is a very complex issue involving any aspect that changes the nature of the sound and we have seen that there are many ways to change the piano sound.** It all starts with how the piano is regulated. Each pianist can control the tone by numerous means, such as by playing loudly or softly, or by varying the speed. For example, by playing louder and at a higher speed, we can produce music consisting mainly of the prompt sound. And there are innumerable ways in which to incorporate the pedal into your playing. We saw that the tone of a single note can be controlled because the hammer shank has flex. It is small wonder that, as far as I know, there has not been any definitive study of tone control, because the subject is so complex.

1.3.1.2 What is Rhythm?

Rhythm is the (repetitive) timing framework of music. When you read about rhythm (see Whiteside), it often seems like a mysterious aspect of music that only "inborn talent" can express. Or perhaps you need to practice it all your life, like drummers. Most frequently, however, **correct rhythm is simply a matter of accurate counting, of correctly reading the music, especially the time signatures. This is not as easy as it sounds; difficulties often arise because most indications for rhythm are not explicitly spelled out everywhere on the music score since it is part of things like the time signature that appears only once at the beginning** (there are too many such "things" to be listed here, such as the difference between a waltz and a mazurka). In many instances, the music is created mainly by manipulating these rhythmic variations so that rhythm is one of the most important elements of music. In short, most rhythmic difficulties arise from not reading the music correctly. This often happens when you try to read the music HT; there is just too much information for the brain to process and it can't be bothered with rhythm, especially if the music involves new technical skills. That initial reading mistake then becomes incorporated into the final music that you practice.

Definition of Rhythm: Rhythm consists of 2 parts: timing and accents, and they come in 2 forms, formal and logical. The mysteries surrounding rhythm and the difficulties encountered in defining rhythm arise mainly from the "logical" part, which is at once the key element and the most elusive. So let's tackle the simpler formal rhythms first. Just because they are simpler does not mean that they aren't important; too many students make mistakes with these elements which generally renders the music unrecognizable in terms of what it should sound like.

Formal Timing: The formal timing rhythm has a name, "Time Signature", and is indicated at the very beginning of any music score. The major time signatures are waltz (3/4), common time (4/4), "cut time" (2/2), and 2/4. The waltz has 3 beats per bar (measure), etc.; the number of beats per bar is indicated by the numerator. 4/4 is the most common and is often not even indicated, although it should be indicated by a "C" at the beginning (you can remember it as "C stands for common"). Cut time is indicated by the same "C", but with a vertical line down the center (cuts the "C" in half). The reference note is indicated by the denominator, so that the 3/4 waltz has 3 quarter-notes per bar, and 2/4 is, in principle, twice as fast as 2/2 cut time.

Formal Accents: Each time signature has its own formal accent (louder or softer beats). If we use the convention that 1 is the loudest, 2 is softer, etc., then the waltz has the formal accent 133 (the famous oom-pha-pha); the first beat gets the accent. Common time has the formal accent 1323, and cut time and 2/4 have the accent 12. The Mazurka has the accent 331, and a syncopation is a rhythm in which the accent is placed at an arbitrary (but fixed) location within a bar; for example a syncopated 4/4 might be 2313 or 2331. Note that the 2331 rhythm is fixed throughout the composition, but the 1 is at a non-conventional location.

Logical Timing and Accents: This is where the composer injects his music. It is a change in timing and loudness from the formal rhythm. Although rhythmic logic is not necessary, it is almost always there. Well known components of timing rhythmic logic are accel. (to make things more exciting), decel. (perhaps to indicate an ending) or rubato. Examples of dynamic rhythmic logic are increasing or decreasing loudness, forte, PP, etc.

An interesting composition in which the formal and logical rhythms can be discerned fairly easily is Beethoven's Tempest Sonata (Op. 31, #2), especially in the 3rd movement. For example, in the 3rd movement, the first 3 bars are 3 repetitions of the same structure, and they simply follow the formal rhythm. However, in bars 43–46, there are 6 repetitions of the same structure in the RH, but they must be squeezed into 4 formal rhythmic bars! If you make 6 identical repetitions in the RH, you are wrong! In addition, in bar 47, there is an unexpected "*sf*" that has nothing to do with the formal rhythm, but is an absolutely essential logical rhythm.

If rhythm is so important, what guidance can one use, in order to cultivate it? Obviously, **you must treat rhythm as a separate subject of practice for which you need a specific program of attack.** Therefore, during the initial learning of a new piece, set aside some time for working on the rhythm. A metronome, especially one with advanced features, can be helpful here. First, you must double check that your rhythm is consistent with the time signature. This can't be done in your mind even after you can play the piece — you must revisit the sheet music and check every note. Too many students just play a piece a certain way "because it sounds right"; you can't do that. You must check with the score to see if the correct notes carry the correct accent strictly according to the time signature. Only then, can you decide which rhythmic interpretation is the best way to play and where the composer has inserted violations of the basic rules (very rare); more often the rhythm indicated by the time signature is strictly correct but sounds counter-intuitive. An example of this is the mysterious "arpeggio" at the beginning of Beethoven's Appassionata (op. 57). A normal arpeggio (such as CEG) would start with the first note (C), which should carry the accent (downbeat). However, Beethoven starts each bar at the third note of the arpeggio (the first bar is incomplete and carries the first two notes of the "arpeggio"); this forces you to accent the third note, not the first note, if you follow the time signature correctly. We find out the reason for this odd "arpeggio" when the main theme is introduced in bar 35. Note that this "arpeggio" is just an inverted, schematized (simplified) form of this theme. Beethoven had psychologically prepared us for the main theme by giving us only the rhythm! This is why he repeats it, after raising it by a curious interval — he just wanted to make sure that we recognized the unusual rhythm (he used the same device at the beginning of his 5th symphony, where he repeated the 4-note motif at a lower pitch). Another example is Chopin's Fantaisie-Impromptu. The first note of the RH (bar 5) must be softer than the second. Can you find at least one reason why? Although this piece is in double time, it may be instructive to practice the RH as 4/4 to make sure that the wrong notes are not emphasized.

Check the rhythm carefully when you start HS. Then check again when you start HT. When the rhythm is wrong, the music usually becomes impossible to play at speed. Thus, if you have unusual difficulty in getting up to speed, it is a good idea to check the rhythm. In fact, incorrect rhythmic interpretation is one of the most common causes of speed walls and why you have trouble HT. When you make an rhythmic error, no amount of practice will enable you to get up to speed! This is one of the reasons why outlining works: it simplifies the job of correctly reading the rhythm. Conversely, when outlining, concentrate on rhythm. Also, when you first start HT, you may have more success by exaggerating the rhythm. Rhythm is another reason why you should not attempt pieces that are too difficult for you. If you don't have sufficient technique, you will not be able to control the rhythm. What can happen is that the lack of technique will impose an incorrect rhythm into your playing, thus creating a speed wall.

Next, look for the special rhythmic markings, such as "*sf*" or accent marks. Finally, there are situations in which there are no indications on the music and you simply have to know what to do, or listen to a recording in order to pick up special rhythmic variations. Therefore, as part of your practice routine, you should experiment with rhythm, accenting unexpected notes, etc., so see what might happen.

Rhythm is also intimately associated with speed. This is why you need to play most Beethoven compositions above certain speeds; otherwise, the emotions associated with the rhythm and even the melodic lines can be lost. Beethoven was a master of rhythm; thus you cannot play Beethoven successfully without paying special attention to rhythm. He usually gives you at least two things simultaneously: (i) an easy-to-follow melody that the audience hears, and (ii) a rhythmic device that controls what the audience *feels*. Thus in the first movement of his "Pathétique" (op. 13), the agitated LH tremolo controls the emotions while the audience is preoccupied with listening to the curious RH. Therefore a mere technical ability to handle the fast LH tremolo is insufficient — you must be able to control the emotional content with this tremolo. Once you understand and can execute the rhythmic concept, it becomes much easier to bring out the musical content of the entire movement, and the stark contrast with the Grave section becomes obvious.

There is one class of rhythmic difficulties that can be solved using a simple trick.

This is the class of complex rhythms with missing notes. A good example of this can be found in the 2nd movement of Beethoven's "Pathétique". The 2/4 time signature is easy to play in bars 17 to 21 because of the repeated chords of the LH that maintain the rhythm. However, in bar 22, the most important accented notes of the LH are missing, making it difficult to pick up the somewhat complex play in the RH. The solution to this problem is to simply fill in the missing notes of the LH! In this way, you can easily practice the correct rhythm in the RH.

In summary, the "secret" of great rhythm is no secret — it must start with correct counting (which, I must re-emphasize, is not easy). For advanced pianists, it is of course much more; it is magic. It is what distinguishes the great from the ordinary. It is not just counting the accents in each bar but how the bars connect to create the developing musical idea. For example, in Beethoven's Moonlight (op. 27), the beginning of the 3rd movement is basically the 1st movement played at a crazy speed. This knowledge tells us how to play the 1st movement, because it means that the series of triplets in the 1st movement must be connected in such a way that they lead to the culmination with the three repeated notes. If you simply played the repeated notes independently of the preceding triplets, they will lose their real impact. Rhythm is also that odd or unexpected accent that our brains somehow recognize as special. Clearly, rhythm is a critical element of music to which we must pay special attention.

1.3.1.3 Staccato

Staccato is defined as the mode of play in which the finger is quickly bounced off the key so as to produce a brief sound with no sustain. It is somewhat astonishing that most books on learning piano discuss staccato, but never define what it is! This paragraph gives a fairly complete definition. In staccato play, the backcheck is not engaged and the damper cuts off the sound immediately after the note is played. There are two notations for staccato, the normal (dot) and hard (triangle). In normal staccato, the jack is generally released; in hard staccato, the finger moves down and up more rapidly and generally leaves the key before the jack is released. Thus in normal staccato, the key drop may be about half way down, but in hard staccato, it is generally less than half way. In this way, the damper is returned to the strings faster, resulting in a shorter note duration. Because the backcheck is not engaged, the hammer can "bounce around", making repetitions tricky at certain speeds. Thus if you have trouble with rapidly repeated staccatos, don't immediately blame yourself — it may be the wrong frequency at which the hammer bounces the wrong way. By changing the speed, amount of key drop, etc., you may be able to eliminate the problem. **Clearly, in order to play staccato well, it helps to understand how the piano works.**

Staccato is generally divided into three types depending on how it is played: (1) finger staccato, (1) wrist staccato, and (3) arm staccato. (1) is played mostly with the finger in a pull motion, holding the hand and arm still, (2) is neutral (neither pull nor thrust), played mostly with wrist action, and (3) is usually best played as a thrust, with the playing action originating at the upper arm. As you progress from (1) to (3) you add more mass behind the fingers; therefore, (1) gives the lightest staccato and is useful for single, soft notes, and (3) gives the heaviest feeling and is useful for loud passages and chords with many notes. (2) is in between. In practice, most of us probably combine all three. Some teachers frown on the use of wrist staccato, preferring mostly arm staccato; however, it is probably better to have a choice of all three. For example, you might be able to reduce fatigue by changing from one to the other.

Because you cannot use the arm weight for staccato, the best reference is your steady body. Thus the body plays a major role in staccato play. Speed of staccato repetition is controlled by the amount of up-down motion: the smaller the motion, the faster the repetition rate.

1.3.2 Cycling (Chopin's Fantaisie Impromptu)

Cycling is the best technique-building procedure for things like new or fast passages you cannot handle. Cycling (also called "looping") is taking a segment and playing it repeatedly; usually continually, without breaks. If the conjunction needed for cycling continually is the same as the first note of the segment, this segment cycles naturally; it is called a self-cycling segment. An example is the CGEG quadruplet. If the conjunction is different, you need to invent one that leads to the first note so you can cycle without breaks.

Cycling is basically pure repetition, but it is important to use it almost as an anti-repetition procedure, a way to avoid mindless repetition. The idea behind cycling is that you acquire technique so rapidly that it eliminates unnecessary, mindless repetition. In order to avoid picking up bad habits, change the speed and experiment with different hand/arm/finger positions for optimum play and always work for relaxation; try not to cycle the exact same thing too many times. Play softly (even loud sections) until you attain the technique, get up to speeds at least 20% above final speed and, if possible, up to 2 times final speed. Over 90% of your cycling time should be at speeds that you can handle comfortably and accurately. Then cycle down gradually to very slow speeds. You are done when you can play at any speed for any length of time, without looking at the hand, completely relaxed, and with full control. You might find that certain intermediate speeds give trouble. Practice these speeds because they may be needed when you start HT. For segments with chords or jumps, make sure that you can cycle without looking at the hand. Practice without the pedal (partly to avoid the bad habit of not pressing down completely through the key drop) until the technique is attained. **Change hands frequently to avoid injury.**

If a technique requires 10,000 repetitions (a typical requirement for really difficult material), cycling allows you to get them done in the shortest possible time. Representative cycle times are about 1 sec, so 10,000 cycles is less than 4 hours. If you cycle this segment for 10 min. per day, 5 days a week, 10,000 cycles will take almost a month. Clearly, very difficult material will take months to learn using the best methods, and *much* longer if you use less efficient methods.

Cycling is potentially the most injurious of any piano practice procedure, so please be careful. Don't over-do it the first day, and see what happens the next day. If nothing is sore the next day, you can continue or increase the cycling workout. Above all, whenever you cycle, always work on two at a time, one for the RH and another for the LH so that you can switch hands frequently. For young people, over cycling can result in pain; in that case, just stop cycling and the hand should recover in a few days. In older people, over cycling can cause osteo-arthritic flare-ups that can take months to subside.

Let's apply cycling to Chopin's FI: the left hand arpeggio, bar 5. The first six notes cycle by themselves, so you might try that. When I first tried it, the stretch was too much for my small hands, so I got tired too quickly. What I did was to cycle the first 12 notes. The second, easier six notes allowed my hands to rest a little and therefore enabled me to cycle the 12 note segment longer and at higher speed. Of course, if you really want to increase speed (not necessary for the LH but might be useful for the RH in this piece) cycle only the first parallel set (the first three or four notes for the LH).

Just because you can play the first segment does not mean that you can now play all the other arpeggios. You will need to start practically from scratch even for the same notes one octave down. Of course, the second arpeggio will be easier after mastering the first one, but you may be surprised at how much work you need to repeat when a very small change is made in the segment. This happens because there are so many muscles in your body that your brain can choose a different set of muscles to produce motions that are only slightly different (and it usually does). Unlike a robot, you have little choice about which muscles your brain is going to pick. Only when you have done a very large number of such arpeggios does the next one come easily. Therefore, you should expect to have to cycle quite few arpeggios.

In order to understand how to play this Chopin piece, it is helpful to analyze the mathematical basis of the 3 versus 4 timing part of this composition. The RH plays very fast, say 4 notes per half second (approximately). At the same time, the LH is playing at a slower rate, 3 notes per half second. If all the notes are played very accurately, the audience hears a note frequency equivalent to 12 notes per half second, because this frequency corresponds to the smallest time interval between notes. **That is, if your RH is playing as fast as it can, then by adding a SLOWER play with the LH, Chopin succeeded in accelerating this piece to 3 times your maximum speed**!

But wait, not all of the 12 notes are present; there are actually only 7, so 5 notes are missing. These missing notes create what is called a Moiré pattern, which is a third pattern that emerges when two incommensurate patterns are superposed. This pattern creates a wavelike effect within each measure and Chopin reinforced this effect by using a LH arpeggio that rises and falls like a wave in synchrony with the Moiré pattern. The acceleration of a factor of 3 and the Moiré pattern are mysterious effects that sneak up on the audience because they have no idea what created them, or that they even exist. Mechanisms that affect the audience without their knowledge often produce more dramatic effects than ones that are obvious (such as loud, legato, or rubato). The great composers have invented an incredible number of these hidden mechanisms and a mathematical analysis is often the easiest way to flush them out. Chopin probably never thought in terms of incommensurate sets and Moiré patterns; he just intuitively understood these concepts because of his genius.

It is instructive to speculate on the reason for the missing 1st note of the measure (bar 5) in the RH because if we can decipher the reason, we will know exactly how to play it. Note that this occurs at the very beginning of the RH melody. At the beginning of a melody or a musical phrase, composers always run into two contradictory requirements: one is that any phrase should (in general) begin softly, and the second is that the first note of a measure is a downbeat and should be accented. The composer can neatly satisfy both requirements by eliminating the first note, thus preserving the rhythm and yet start softly (no sound in this case)! You will have no trouble finding numerous examples of this device — see Bach's Inventions. Another device is to start the phrase at the end of a partial measure so that the first downbeat of the first full measure comes after a few notes have been played (a classic example of this is the beginning of the first movement of Beethoven's Appassionata). This means that the first note of the RH in this measure of Chopin's FI must be soft and the second note louder than the first, in order to strictly preserve the rhythm (another example of the importance of rhythm!). We are not used to playing this way; the normal play is to start the first note as a downbeat. It is especially difficult in this case because of the speed; therefore this beginning may need extra practice.

This composition begins by gradually drawing the audience into its rhythm like an irresistible invitation, after calling attention to itself with the loud octave of bar 1 followed by the rhythmic arpeggio in the lower staff. The missing note in bar 5 is restored after several repetitions, thus doubling the Moiré repeat frequency and the effective rhythm. In the second theme (bar 13), the flowing melody of the RH is replaced by two broken chords, thus giving the impression of quadrupling the rhythm. This "rhythmic acceleration" culminates in the climactic forte of bars 19–20. The audience is then treated to a breather by a "softening" of the rhythm created by the delayed RH melodic (pinky) note and then its gradual fading, accomplished by the diminuendo down to *pp*. The whole cycle is then repeated, this time with added elements that heighten the climax until it ends in the descending crashing broken chords. For practicing this part, each broken chord might be individually cycled. These chords lack the 3, 4 construct and bring you back out from the mysterious 3, 4 nether-world, preparing you for the slow section.

As with most Chopin pieces, there is no "correct" tempo for this piece. However, if you play faster than about 2 seconds/bar, the 3×4 multiplication effect tends to disappear and you are usually left with mostly the Moiré and other effects. This is partly because of decreasing accuracy with speed but more importantly because the 12× speed becomes too fast for the ear to follow. Above about 18 Hz, repetitions begin to take on the properties of sound to the human ear; at 2 sec/bar, the repetition rate is 12 Hz. Therefore the multiplication device works only up to a certain speed; above that, you get a different effect, which may be even more special than simple speed. It is curious that Chopin chose a speed that is near the maximum range of the 12× effect for the human ear, almost as if he knew that something special happened above this transition speed. It is quite possible that Chopin played it at speeds above the critical transition. He may be have been sufficiently skillful to play it above the transition at which "speed" turns into a new magical "sound".

The slow middle section was described briefly in section 1.2.25. The fastest way to learn it, like many Chopin pieces, is to start by memorizing the LH. This is because the chord progression often remains the same even when Chopin replaces the RH with a completely new melody, because the LH mainly provides the accompaniment chords. Notice that the 4, 3 timing is now replaced by a 2, 3 timing played much more slowly. It is used for a different effect, to soften the music and allowing a freer tempo rubato.

The third part is similar to the first except for the ending, which is difficult for small hands and may require extra RH cycling work. In this section, the RH pinky carries the melody, but the answering thumb octave note is what enriches the melodic line. The piece ends with a nostalgic restatement of the slow movement theme in the LH. Distinguish the top note of this LH melody (G♯ — bar 7 from the end) clearly from the same note played by the RH by holding it slightly longer and then sustain it with the pedal.

The G♯ is the most important note in this piece. Thus the beginning *sf* G♯ octave is not only a fanfare introducing the piece, but a clever way for Chopin to implant the G♯ into the listeners' minds. Therefore, don't rush this note; take your time and let it sink in. If you look throughout this piece, you will see that the G♯ occupies all the important positions. In the slow section, the G♯ is an A♭, which is the same note. This G♯ is another one of those devices in which a great composer is "hitting the audience on the head with a two-by-four", but the audience has no idea what hit them. For the pianist, knowledge about the G♯ helps interpret and memorize the piece. Thus the conceptual climax of this piece comes at the end (as it should) when both hands must play the same G♯ (bars 8 and 7 from the end); therefore, this LH-RH G♯ must be executed with the utmost care, while maintaining the continuously fading RH G♯ octave.

Our analysis brings into sharp focus, the question of how fast to play this piece. High accuracy is required to bring out the 12-note effect. If you are learning this piece for the first time, the 12-note frequency may not be audible initially because of lack of accuracy. When you finally "get it" the music will all of a sudden sound very busy. If you play too fast and lose the accuracy, you can lose that factor of three — it just washes out and the audience hears only the 4 notes. For beginners the piece can be made to sound faster by slowing down and increasing the accuracy. Although the RH carries the melody, the LH must be clearly heard, or else both the 12-note effect and the Moiré pattern will disappear. This being a Chopin piece, there is no requirement that the 12-note effect be heard; this composition is amenable to an infinity of interpretations, and some may want to suppress the LH and concentrate of the RH, and still produce something equally magical.

An advantage of cycling is that the hand is playing continually which simulates continuous playing better than if you practiced isolated segments. It also allows you to experiment with small changes in finger position, etc., in order to find the optimum conditions for playing. The disadvantage is that the hand movements in cycling may be different from those needed to play the piece. The arms tend to be stationary while cycling whereas in the actual piece, the hands usually need to move along the keyboard. Therefore, in those cases in which the segment does not naturally cycle, you may need to use segmental practice also. First, cycle until you are comfortable; then change to segmental practice. The segmental practice allows you to use the correct conjunction and hand motion. Segmental practice is closer to the real thing, and you can join them to construct your piece.

The above treatment of cycling discussed it in its narrowest definition. **The broader definition of cycling is any practice routine that is repeated or looped.** Thus you can cycle the cycling by cycling at differing speeds. Cycle fast, then gradually slow down, then speed up again, and cycle the fast-slow cycle. It is useful to develop many different types of cycling, so I will mention a few of them here (there are too many to list; your imagination is the limit).

1. Cycle the speed (just mentioned).

2. It is useful to cycle between HT and HS when first struggling with passages that are difficult HT.

3. Another useful cycling is over a longer time frame — perhaps several weeks. When, after days of hard work, you are clearly entering a stage of diminishing returns, it often pays to just ignore this piece for several days or weeks, and then come back to it; i.e., cycling between hard practice and laying off. This laying off period can have unexpected advantages in that the needed technique tends to improve due to post practice improvement, but the bad habits tend to fade because most bad habits develop from too much repetition.

4. Listening — practicing cycles: record your playing, listen to it, make changes,

re-record, and see if your changes have made any improvements. Listen particularly carefully for rhythmic errors.

5. Memory cycling: as part of your memory maintenance program, recycle your "finished" pieces, going back to HS, and re-memorizing your old pieces after learning new pieces. Wait till you have partly forgotten a piece, and then re-memorize.

6. Cycling between easy and difficult pieces; don't fall into the trap of practicing only difficult, new pieces. Playing easy pieces is extremely important for developing technique, especially for eliminating stress. Most importantly, these easy finished pieces allow you to practice making music and playing at full speed.

These general concepts of cycling are important because how you practice and how you solve certain problems depend on how you are cycling your practice routines. For example, if you want to answer the question "How long should I practice this particular segment?", the answer will depend on which part of what type of cycle you are at. For type (i) above, it may be about 5 minutes; for type (ii), about a few days, and for type (iii) perhaps a few weeks. It is important for each student to create as many of these cycles as possible in order to follow a structured learning procedure that is optimally efficient, and to know which cycle to use in order to solve a particular problem.

1.3.3 Trills & Tremolos

1.3.3.1 Trills

There is no better demonstration of the effectiveness of the parallel set exercises (chord attack) than using them to learn the trill. There are only two problems to solve in order to trill: (1) speed (with control) and (2) to continue it as long as desired. The parallel set exercises were designed to solve exactly these problems and therefore work very well for practicing trills. Whiteside describes a method for practicing the trill which, upon analysis, turns out to be a type of chord attack. Thus use of the chord attack for practicing the trill is nothing new. However, because we now understand the learning mechanism in more detail, we can design the most direct and effective approach by using parallel sets.

The first problem to solve is the initial two notes. **If the first two notes are not started properly, learning the trill becomes a very difficult task. The importance of the first two notes applies to runs, arpeggios, etc., also.** But the solution is almost trivial — apply the two note parallel set exercise. Therefore, for a 2323… trill, use the first 3 as the conjunction and get the first two notes right. Then practice the 32, then 232, etc. It's that simple! Try it! It works like magic!

Don't just concentrate of parallel sets and speed because that will usually be insufficient. You must try different hand motions, such as quiet hands, flat finger positions (see 1.3.4.2 below), etc.

Relaxation is even more critical for the trill than almost any other technique because of the need for rapid momentum balance; that is, the parallel sets, being only two notes, are too short for us to rely solely on parallelism to attain speed. Thus we must be able to change the momenta of the fingers rapidly. Stress will lock the fingers to the larger members such as palms and hands, thus increasing the effective mass of the fingers. Larger mass means slower motion: witness the fact that the hummingbird can flap its wings faster than the condor and small insects even faster than the hummingbird. This is true even if the air resistance were ignored; in fact, the air is effectively more viscous to the hummingbird than to the condor and for a small insect, the air is almost as viscous as water is to a big fish. It is therefore important to incorporate complete relaxation into the trill from the very beginning, thus freeing the fingers from the hand. Trill is one skill that requires constant maintenance. If you want to be a good triller, you will need to practice trilling every day. The chord attack is the best procedure for keeping the trill in top shape, especially if you had not used it for a while and feel like you might be losing it, or if you want to continue improving it.

Finally, the trill is not a series of staccatos. The fingertips must be at the bottom of the keydrop as long as possible; i.e., the backchecks must be engaged for every note. Take careful note of the minimum lift necessary for the repetition to work. Those who practice on grands should be aware that this lift distance can be about twice as high for an upright. Faster trills require smaller lifts; therefore, on an upright, you may have to slow down the trill.

1.3.3.2 Tremolos (Beethoven's "Pathétique", 1st Movement)

Tremolos are practiced in exactly the same way as trills. Let's apply this to the sometimes dreaded long octave tremolos of Beethoven's "Pathétique" Sonata (opus 13). For some students, these tremolos seem impossible, and many have injured their hands, some permanently, practicing them. Others have little difficulty. If you know how to practice them, they are actually quite simple. **The last thing you want to do is to practice this tremolo for hours in the hopes of building endurance — that is the surest way to acquire bad habits and suffer injury.**

Since you need the octave tremolos in both hands, we will practice the LH and alternate with practicing the RH; if the RH catches on faster, you can use it to teach the LH. I will suggest a sequence of practice methods; if you have any imagination, you should be able to create your own sequence that may be better for you — my suggestion is just that: a suggestion for illustration purposes. **For completeness, I have made it too detailed and too long. Depending on your specific needs and weaknesses, you should shorten the practice sequence.**

In order to practice the C2–C3 tremolo, first, practice the C2–C3 octave (LH). Bounce the hand up and down, comfortably, repeating the octave, with emphasis on relaxation — can you keep bouncing it without fatigue or stress, especially as you speed it up? If you get tired, find ways of repeating the octave without developing fatigue by changing your hand position, motion, etc. If you still get tired, stop and change hands; practice the RH A♭4–A♭5 octave that you will need later on. Once you can bounce the octave, 4 times per beat (i.e., include the correct rhythm) without fatigue, try speeding it up. At sufficient speed, you will develop fatigue again, so either slow down or try to find different ways of playing that reduces fatigue. Change hands as soon as you feel tired. **Do not play loud; one of the tricks for reducing fatigue is to practice softly. You can add dynamics later, once you have the technique.** It is extremely important to practice softly so that you can concentrate on technique and relaxation. In the beginning, as you exert yourself to play faster, fatigue will develop. But when you find the right motions, hand positions, etc., you will actually feel the fatigue draining out of the hand and you should be able to rest and even rejuvenate the hand *while playing rapidly*. You have learned to relax.

Now add the parallel set exercises. First the 5, 1 parallel set. Start with the repeated octaves, then gradually replace each octave with a parallel set. For example, if you are playing groups of 4 octaves (4/4 time), start by replacing the 4th octave with a parallel set. Soon, you should be practicing all parallel sets. If the parallel sets become uneven or the hand starts to tire, go back to the octave to relax. Or change hands. Work the parallel sets until you can play the 2 notes in the parallel set almost "infinitely fast" and reproducibly, and eventually, with good control and complete relaxation. At the fastest parallel set speeds, you should have difficulty distinguishing between parallel sets and octaves. Then slow down the parallel sets so that you can play at all speeds with control. Note that in this case, the 5 note should be slightly louder than the 1. However, you should practice it both ways: with the beat on the 5 and with it on the 1, so that you develop a balanced, controllable technique. Now repeat the whole procedure with the 1, 5 parallel set. Again, although this parallel set is not required to play this tremolo (only the previous one is necessary), it is useful for developing a balanced control. Once both the 5, 1 and 1, 5 are satisfactory, move on to the 5, 1, 5 or 5, 1, 5, 1 (played like a short octave trill). If you can do the 5, 1, 5, 1 right away, there is no need to do the 5, 1, 5. The objective here is both speed and endurance, so you should practice speeds that are *much* faster than the final tremolo speed, at least for these short tremolos. Then work on the 1, 5, 1, 5.

Once the parallel sets are satisfactory, start playing groups of 2 tremolos, perhaps with a momentary pause between groups. Then increase to groups of 3 and then 4 tremolos. The best way to speed up the tremolos is to alternate between tremolos and octaves. Speed up the octave and try to switch to the tremolo at this faster speed. Now all you have to do is alternate hands and build up endurance. Again, building endurance is not so much building muscle, as knowing how to relax and how to use the correct motions. De-couple the hands from your body; do not tie the hand-arm-body system into one stiff knot, but let the hands and fingers operate independently from the body. You should breathe freely, unaffected by what the fingers are doing.

In the end, you will be playing the tremolo mostly with hand rotation, which means that the hand will be rotating back and forth around an axis through the forearm. That axis is a straight line extending through the hand towards the fingertips. Therefore, the palm should extend straight out from the forearm and the three free fingers (2, 3, 4) should stretch out like the spokes of a wheel and almost touch the keys; do not lift them up, except to the extent that they move with the hand rotation. For those with small hands, the hand rotation should be accompanied by a small sideways motion so that you can reach the keys without having to fully stretch the fingers. This should help reduce stress.

For the RH, the 1 should be louder than the 5, but for both hands, the softer notes should be clearly audible, and their obvious purpose is to double the speed compared to playing the octaves. Remember to practice softly; you can play louder whenever you want later, once you have acquired the technique and endurance. It is important to be able to play softly, and yet be able to hear every note, at the fastest speeds. Practice until, at the final speed, you can play the tremolos longer than you need in the piece. The best way to develop this endurance is to practice at even faster speeds. The final effect is a constant roar that you can modulate in loudness up and down. The lower note provides the rhythm and the upper note doubles the speed. Then play the different successive tremolos as indicated on the music. That's it! You are done!

1.3.4 Hand, Body Motions for Technique

1.3.4.1 Hand Motions

Certain hand motions are required in order to acquire technique. For example we discussed parallel sets above, but did not specify what types of hand motions are needed to play them. **It is important to emphasize from the start that the required hand motions can be extremely small, almost imperceptible.** After you have become expert, you can exaggerate them to any extent you desire. Thus during a concert by any famous performer, most of the hand motions will not be discernible (they also tend to happen too fast for the audience to catch) so that most of the visible motions are exaggerations. Thus two performers, one with apparently still hands, and one with flair and aplomb, may in fact be using the same hand motions of the type we discuss here. **The major hand motions are pronation and supination, thrust (or push) and pull, claw and throw, flick, and wrist motions. They are almost always combined into more complex motions.** Note that they always come in pairs (there is a right and left flick, and similarly for wrist motions). They are also the major natural motions of the hands and fingers.

All finger motions must be supported by the major muscles of the arms, the shoulder blades in the back, and the chest muscles in front that are anchored to the center of the chest. The slightest twitch of the finger, therefore, involves all of these muscles. **There is no such thing as just moving one finger — any finger motion involves the entire body.** Stress reduction is important for relaxing these muscles so that they can respond to, and assist in, the movement of the fingertips. The major hand motions are discussed only briefly here; for more details, please consult the references (Fink, Sandor).

Pronation and Supination The hand can be rotated around the axis of the forearm. The inward rotation (thumbs downward) is called **pronation** and the outward rotation (thumbs upward) is called **supination**. These motions come into play, for example, when playing octave tremolos. There are two bones in your forearm, the inside bone (radius, connecting to the thumb) and the outside bone (ulna, connecting to the pinky). Hand rotation occurs by rotation of the inner bone against the outer one (hand position referenced to that of the piano player with palm facing down). The outer bone is held in position by the upper arm. Therefore, when the hand is rotated, the thumb moves much more than the pinky. A quick pronation is a good way to play the thumb. For playing the octave tremolo, moving the thumb is easy, but the pinky can only be moved quickly using a combination of motions. Thus the problem of playing fast octave tremolos boils down to solving the problem of how to move the pinky.

Thrust and Pull Thrust is a pushing motion, towards the fallboard, usually accompanied by a slightly rising wrist. With curved fingers, the thrust motion causes the vector force of the hand moving forward to be directed along the bones of the fingers. This adds control and power. It is therefore useful for playing chords. The pull is a similar motion away from the fallboard. In these motions, the total motion can be larger than or smaller than the vector component downward (the key drop), allowing for greater control. Thrust is one of the main reasons why the standard finger position is curved. Try playing any large chord with many notes, first lowering the hand straight down as in a gravity drop, then using the thrust motion. Note the superior results with the thrust. Pull is useful for some legato and soft passages. Thus, when practicing chords, always experiment with adding some thrust or pull.

Claw and Throw Claw is moving your fingertips into your palm and throw is opening the fingers out to their straight position. Many students do not realize that, in addition to moving the fingertips up and down, they can also be moved in and out during play. These are useful additional motions. They add greater control, especially for legato and soft passages, as well as for playing staccato. Just as for the thrust and pull, these motions allow a large motion with a much smaller keydrop. Thus, instead of always trying to lower the fingers straight down for the key drop, try experimenting with some claw or throw action to see if it will help. Note that the claw movement is much more natural and easier to conduct than a straight down. The straight down motion of the fingertip is actually a complex combination of a claw and a throw. The key drop action can sometimes be simplified by flaring the fingers out flat and playing with only a small claw movement. This is why you can sometimes play better with flat fingers than curved.

Flick The flick is one of the most useful motions. It is a quick rotation and counter-rotation of the hand; a fast pronation-supination combination, or its reverse. We have seen that parallel sets can be played at almost any speed. When playing fast passages, the problem of speed arises when we need to connect parallel sets. There is no single solution to this connection problem. The one motion that comes closest to a universal solution is the flick, especially when the thumb is involved, as in scales and arpeggios. Single flicks can be conducted extremely quickly with zero stress, thus adding to the speed of play; however, quick flicks need to be "re-loaded"; i.e., continuous fast flicks is difficult. But this is quite suitable for connecting parallel sets because the flick can be used to play the conjunction and then be re-loaded during the parallel set. To re-emphasize what was pointed out at the beginning of this section, these flicks and other motions do not need to be large and are in general imperceptibly small; thus the flick can be considered more as a momentum flick than an actual motion.

Wrist Motion We already saw that the wrist motion is useful whenever the thumb or pinky is played; the general rule is to raise the wrist for the pinky and lower it to play the thumb. Of course, this is not a hard rule; there are plenty of exceptions. The wrist motion is also useful in combination with other motions. By combining wrist motion with pronation-supination, you can create rotary motions for playing repetitive passages such as LH accompaniments, or the first movement of Beethoven's Moonlight Sonata. The wrist can be moved both up and down, and side-to-side. Every effort should be made such that the playing finger is parallel to the forearm; this is accomplished with the side-to-side wrist motion. This configuration puts the least amount of lateral stress on the tendons moving the fingers and reduces the chances of injuries such as Carpal Tunnel Syndrome. If you find yourself habitually playing (or typing) with the wrist cocked at a sideways angle, this may be a warning sign to expect trouble. A loose wrist is also a pre-requisite for total relaxation.

Summary The above is a very brief review of hand motions. An entire book can be written on this subject. And we did not even touch on the topics of adding other motions of the elbow, upper arm, shoulders, body, feet, etc. The student is encouraged to research this topic as much as possible because it can only help. The motions just discussed are seldom used alone. Parallel sets can be played with any combination of most of the above motions without even moving a finger (relative to the hand). This was what was meant, in the HS practice section, with the recommendation to experiment with and to economize the hand motions. Knowledge of each type of motion will allow the student to try each one separately to see which is needed. It is in fact the key to the ultimate in technique.

1.3.4.2 Playing with Flat Fingers

We noted in section 1.2.2 that the starting finger shape for learning the piano is the partially curled position. Many teachers teach the curled position as the "standard" position for playing the piano. However, V. Horowitz demonstrated that the flat, or straight, finger position is also very useful. **Here we discuss why the flat finger position is not only useful but is also an essential part of technique and all accomplished pianists use it.**

We will initially define "Flat Finger Position" (FFP) as the one in which the fingers are basically stretched straight out from the hands, in order to simplify the discussions. We will later generalize this definition to mean specific types of "non-curled" positions, which is a very important concept in piano playing because it is necessary for acquiring some of the most basic as well as advanced technical skills.

The most important advantages of the FFP are that it simplifies the finger motion and allows complete relaxation; that is, the number of muscles needed to control the finger motion is smaller than in the curled position because all you have to do is to pivot the entire finger around the knuckle. In the curled position, each finger must uncurl by just the right amount every time it hits a note, in order to maintain the correct finger angle to the key top surface. The motion of the FFP uses only the main muscles needed to depress the keys. **Practicing the FFP can improve technique because you are exercising only the most relevant muscles and nerves.** In order to demonstrate the complexity of the curled position, try the following experiment. First, stretch the forefinger of your RH out straight (FFP) and wiggle it up and down rapidly as you would when playing the piano. Now, keep this wiggling motion and gradually curl the finger in as far as you can. You will find that, as you curl the finger, it becomes more difficult to wiggle the finger tip until it becomes impossible when completely curled. I have named this phenomenon **"curl paralysis"**. If you do succeed in moving the finger tip, you can only do it very slowly compared to the straight position because you need to use a whole new set of muscles. In fact, the easiest way to move the finger tip rapidly in the completely curled position is to move the entire hand.

Therefore, with the curled position, you need more skill to play at the same speed compared to the FFP. **Contrary to the beliefs of many pianists, you can play faster with flat fingers than with the curled position because any amount of curl will invite a certain amount of curl paralysis.** This becomes particularly important when the speed and/or lack of technique produces stress while practicing something difficult. The amount of stress is greater in the curled position and this difference can be sufficient to create a speed wall.

There are discussions in the literature (Jaynes, Chapter 6), in which it is claimed that the lumbrical and interossei muscles are important in piano playing, but there is no research to support these claims, and it is not known whether these muscles play a part in FFP. It is generally believed that these muscles are used mainly to control the curvature of the fingers, so that FFP uses only the muscles in the arms to move the fingers and the lumbricals simply hold the fingers in position (curled or FFP), thus simplifying the movement and allowing for greater control and speed for FFP. Thus there is uncertainty today about whether the lumbricals enable higher speed or whether they cause curl paralysis.

Although the FFP is simpler, **all beginners should learn the curled position first and not learn the flat position until it is needed.** If beginners start with the easier FFP, they will never really learn the curled position well. Beginners who try to play fast with the flat position are likely to use fixed phase parallel set playing instead of finger independence. This leads to loss of control and uneven speeds. Once these bad habits are formed, it is difficult to learn finger independence. For this reason, many teachers will forbid their students to play with flat fingers, which is a terrible mistake. Sandor calls the FFPs "wrong positions" but Fink recommends certain positions that are clearly FFPs (we will discuss several different FFPs below).

Most pianists who learn on their own use mostly FFPs. Very young children (below 4 years of age) usually have difficulty curling their fingers. For this reason, jazz pianists use FFPs more than classical pianists (because many were initially self-taught), and classical teachers correctly point out that early jazz pianists had inferior technique. In fact, early jazz had much less technical difficulty than classical music. However, this lack of technique resulted from a lack of instruction, not because they used FFPs. Thus FFPs are nothing new and are quite intuitive and are a natural way to play. Therefore, the road to good technique is a careful balance between practicing with curled fingers and knowing when to use the FFPs. **What is new in this section is the concept that the curled position is not inherently superior and that FFPs are a necessary part of advanced technique.**

The 4th finger is particularly problematic for most people. Part of this difficulty arises from the fact that it is the most awkward finger to lift, which makes it difficult to play fast and avoid hitting extraneous notes inadvertently. These problems are compounded in the curled position because of the complexity of motion and curl paralysis. In the simplified flat finger configuration, these difficulties are reduced and the 4th finger becomes more independent and easier to lift. If you place your hand on a flat surface in the curled position and lift the 4th finger, it will go up a certain distance; now if you repeat the same procedure with the flat finger position, that finger tip will go up *twice* as far. Therefore, it is easier to lift the fingers, and particularly the 4th finger, in the FFP. The ease of lifting reduces the stress when playing fast. Also, when trying to play difficult passages fast using the curled position, some fingers (especially fingers 4 and 5) will sometimes curl too much creating even more stress and the need to fling these fingers out in order to play a note. These problems can be eliminated by using FFP.

Another advantage of the FFP is that it increases your reach because the fingers are stretched out straighter. For this reason, most pianists (especially those with small hands) already use the flat position for playing wide chords, etc., often without realizing it. However, such people can feel "guilty" about the lack of curl and try to incorporate as much curl as possible, creating stress.

Yet another advantage of the FFP is that the fingers are pressing the keys with the part of the fingers with more flesh than at the finger tips. The fleshy part is also more sensitive to touch, especially because there is less interference from the fingernails. When people touch anything to feel it, they always use this part of the finger, not the fingertip. **This extra cushion and sensitivity can provide better feel and control, and greater protection against injury.** For the curled position, the fingers are coming down almost vertically to the key surfaces so that you are playing with the finger tips where there is the least amount of cushion between the bone and key top. If you injured the fingertips by practicing too hard using the curled position, you can give the fingertips a rest by using the FFP. Two types of injuries can occur at the finger tip when using the curled position and both injuries can be avoided using flat fingers. The first is simple bruising from too much pounding. The second is the detachment of the flesh from under the fingernail, which frequently results from cutting the fingernails too short. This second type of injury is dangerous because it can lead to painful infections. Even if you have fairly long fingernails, you can still play using the FFP.

More importantly, with flat fingers, **you can play the black keys using most of the large underside areas of the fingers; this large surface area can be used to avoid missing the black keys** that are easy to miss in the curled position because they are so narrow. Thus it is a good idea to play the black keys with flatter fingers and the white keys with more curled fingers.

When the fingers are stretched out flat, you can reach further back towards the fallboard. In this position, it requires a little more force to depress the keys because of the lower leverage resulting from the shorter distance to the key bushing (at the balance rail pin). **The resulting (effectively) heavier key weight will allow you to play softer *pp*. Thus the ability to move closer to the key bushing results in the ability to increase the effective key weight.** The heavier key weight allows more control and softer pianissimo. Although the change in key weight is small, this effect is greatly magnified at high speed.

The FFP also allows louder fortissimo, especially for the black keys. There are two reasons. First, the area of the finger available for contact is larger and there is a thicker cushion, as explained above. Therefore, you can transmit a larger force with less chance of injury or pain. Second, the increased accuracy resulting from the larger contact area helps to produce an authoritative and reproducible fortissimo. In the curled position, the probability of missing or sliding off the narrow black keys is sometimes too high for full fortissimo.

The ability to play fortissimo more easily suggests that the FFP can be more relaxing than the curled position. This turns out to be true, but there is an additional mechanism that increases the relaxation. With FFP, you can depend on the tendons under the finger bones to hold the fingers straight when you push down on the keys. That is, unlike the curled position, you need almost no effort to keep the fingers straight (when pressing down on the keys) because unless you are multiple jointed, the tendons on the palm side of the fingers prevent them from bending backwards. Therefore, when you practice FFP, learn to make use of these tendons to help you relax. Be careful when you first start using FFP for playing fortissimo. If you relax completely, you can risk injury to these tendons by hyper-extending them, especially for the pinky, because the pinky tendons are so small. If you start to feel pain, either stiffen the finger during key drop or stop the FFP and curl that finger. When playing fortissimo with curled fingers, you must control both the extensor and flexor muscles of every finger in order to keep them in the curled position. In the flat position, you can completely relax the extensor muscles and use only the flexor muscles, thus almost totally eliminating stress (which results from the two sets of muscles opposing each other), and simplifying the operation by over 50% when pressing the key down.

The best way to start practicing FFP is to practice the B major scale. In this scale, all fingers play the black keys except the thumb and pinky. Since these two fingers do not generally play the black keys in runs, this is exactly what you want. The fingering for the RH is standard for this scale, but the LH must start with the 4th finger on B. You may want to read the following section (1.3.5) on playing fast scales before going on with this practice because you will need to know how to play thumb over and to use the glissando motions, etc. Practice only one octave HS for fastest improvement. Keep the fingers close to the keys so that you can feel the keys before you play them. Feeling the keys is easy because you can use the large surface areas of the undersides of the fingers. By feeling the keys, you will never miss a single note because you know where the keys are ahead of time. For playing scales, the forearms must point inward at an angle close to 45 degrees at middle C. This angle is created because of two effects. Consider the RH; the right shoulder is to the right of middle C, so that the forearm naturally points inward (to your left; the LH will point to the right at middle C) if you do not move the body. In addition, the pinky is a short finger so that this angle allows the pinky to reach the black keys more easily when the fingers are stretched out flat. This angle also facilitates the thumb-over motion. However, now the fingers are not parallel to the keys. This lack of parallel alignment is actually an advantage because you can use it to increase the accuracy of hitting the black keys. If one hand is weaker than the other, this difference will show up more dramatically with flat fingers. The flat finger position reveals the technical skills/deficiencies more clearly because of the difference in leverage (the fingers are effectively longer) and your fingers are more sensitive. In that case, use the stronger hand to teach the weaker one how to play. Practicing with flat fingers may be one of the quickest ways to encourage the weaker hand to catch up to the other because you are working directly with the main muscles relevant to technique.

If you encounter any difficulties playing the FFP, try the black key parallel set exercises. Play all five black keys with the five fingers: the two-note group with thumb and forefinger and the three-note group with the remaining three fingers. Unlike the B major scale, this exercise will also develop the thumb and pinky. With this exercise (or with the B major scale), you can experiment with all kinds of hand positions. Unlike the curled position, **you can play with the palm of the hand touching the surface of the white keys. You can also raise the wrist so that the fingers actually bend backwards (opposite to the curl direction), as in the cartwheel motion. There is also an intermediate flat finger position in which the fingers remain straight, but are bent down only at the knuckles.** I call this the “pyramid” position because the hand and fingers form a pyramid with the knuckles at the apex. This pyramid position can be effective for very fast passages because it combines the advantages of the curled and straight positions.

The usefulness of these various positions makes it necessary to expand the definition of “flat finger” playing. The straight FFP is just an extreme case, and there are any number of variations of positions between the totally flat position we defined at the beginning of this section and the curled position. In addition to the pyramid position, you can bend the fingers at the first joint from the knuckle. This will be called the “spider position”. **The critical point here is that the last joint (closest to the fingernail) must be totally relaxed and allowed to straighten out when you press down on the key. Thus the generalized definition of FFP is that the third phalange is totally relaxed and straight.** Phalange (also called phalanx; plural is always phalanges) is the name for the small bones beyond the knuckle; they are numbered 1–3 (thumb has only 1 and 2), and the 3rd phalange is the “nail phalange”. We shall call both the pyramid and spider positions “flat finger” positions because all three FFPs share two important properties: the third phalange of the finger is never curled in and is always relaxed, and you play with the sensitive palm side of the finger tip. From here on, we shall use this broader definition of FFP. Although the fingers are bent in many of these positions, we shall call them FFP to distinguish them clearly from the curled position. Most of curl paralysis comes from bending the third phalange. This can be demonstrated by bending only the third phalange (if you can) and then trying to move that finger raidly. Note that total relaxation of the third phalange is now part of the definition of FFP. The FFP simplifies the computation in the brain because you almost totally ignore the flexor muscle of the third phalange. That is 10 fewer flexor muscles to control, and these are particularly awkward and slow muscles; therefore, ignoring them can increase finger speed. We have arrived at the realization that **the curled position is outright wrong for playing advanced material. The generalized flat finger position is what you need in order to play at the speeds needed by advanced players!** However, as discussed below, there are certain situations in which you need to quickly curl certain individual fingers for reaching some white keys and to avoid poking the fallboard with your fingernails. The importance of the generalized FFP cannot be over-emphasized because it is one of the key elements of relaxation that is often entirely ignored.

The flat finger position gives much more control because the palm side of the finger tip is the most sensitive part of the finger. Another reason for increased control is that the relaxed third phalange acts like a shock absorber in the FFPs. If you have difficulty bringing out the color in a composition, using the FFPs will make it easier. **Playing with the fingertip using the curled position is like driving a car without shock absorbers, or playing a piano with worn hammers. The tone will tend to come out harsh or non-legato. You are effectively restricted to one tone color.** By using FFP, you can feel the keys better and control tone and color more easily. Because you can completely relax the third phalanges and also ignore some of the extensor muscles, the flat finger motions are simpler and you can play faster, especially for difficult material such as fast trills.

We have therefore arrived at a most important general concept: we must liberate ourselves from the tyranny of the single fixed curled position. We must learn to use all of the available finger positions because each has its advantages.

You may want to lower the bench in order to be able to play with the flat part of the fingers. When the bench is lowered, it usually becomes necessary to move it farther away from the piano so as to provide enough room for the arms and elbows to move between the keyboard and the body. In other words, many pianists sit too high and too close to the piano, which is not noticeable when playing with curled fingers. Thus the FFPs will give you a more precise way to optimize the bench height and location. At these lower heights, the wrists, and even the elbows might sometimes fall below the level of the keyboard while you are playing; this is perfectly permissible. Sitting farther away from the piano also gives you more space to lean forwards in order to play fortissimo.

All the flat finger positions can be practiced on a table. For the totally flat position, simply place all the fingers and the palm flat on a table and practice lifting each finger independently of the others, especially finger 4. Practice the pyramid and spider positions by just pressing down with the fleshy underside of the finger tips contacting the table and completely relaxing the third phalange so that it actually bends backwards. For the pyramid position, this becomes something like a stretching exercise for all the flexor tendons, and the last 2 phalanges are relaxed. You may also find that FFP works very well when typing on a keyboard.

The 4th finger in general gives everybody problems and you can perform an exercise to improve its independence using the spider position. At the piano, place fingers 3 and 4 on C♯ and D♯, and the remaining fingers on white keys. Press down all five keys. The first exercise is to play finger 4, lifting it as high as you can. In all these exercises, you must keep all the non-playing fingers down. The second exercise is to play fingers 3 and 4 alternately, lifting 4 as high as you can, but lifting 3 only sufficiently to play the note, and keeping it always in contact with the key top (quite difficult). Most people can lift the 4th finger highest in the spider position, indicating that this may be the best position for general playing. During key drop, play finger 3 louder than 4 (accent on 3). Repeat using fingers 4 and 5, with the accent on 5 and keeping it on the key as much as possible. In the 3rd and final exercise, play (3, 4), (4, 3), (5, 4), and (4, 5) parallel sets. These exercises may seem difficult at first, but you may be surprised at how quickly you will be able to play them after just a few days; however, do not stop just because you can do these exercises, practice until you can do them very fast, with complete control and relaxation. These exercises simulate the difficult situation in which you are playing fingers 3 and 5 while lifting 4 above the keys.

The extra reach, the large contact area, and the added cushion under the fingers make legato playing easier and quite different from legato using the curled position. The FFP also makes it easier to play two notes with one finger, especially because you can play with the fingers not parallel to the keys and use a very large area under the finger to hold more than one key down. Because Chopin was known for his legato, was good at playing several notes with one finger, and recommended practicing the B major scale, he probably used flat finger playing. Mlle. Combe, who was the initial inspiration for this book, taught FFP and noted that it was particularly useful for playing Chopin. One legato trick she taught was to start with FFP and then roll the finger up to the curled position so that the hand can move without lifting the finger off the key. The reverse can also be done when moving down from black keys to the white keys.

If you had been taught only the curl position all your life, learning the FFPs may appear awkward at first, but playing the FFPs is a necessary skill. When you make the switch, you will:

1. Feel total relaxation because of the relaxation in the final finger phalange. This relaxation should feel "good" and can even become addicting. It may be easiest to start practicing this position on a table by using the spider position and pressing down with all fingers until all the third phalanges of fingers 2 to 5 are flared outwards, thus stretching the tendons to those phalanges. The most important consequence of this relaxation is that you will be able to play faster.

2. Be able to play softer pianissimo because of the higher sensitivity of the fingertips and the extra shock absorber effect of the relaxed third phalange.

3. Be able to play louder and more authoritative fortissimo because of the larger finger area available for pressing the keys down. No more slipping off from the black keys!

4. Be able to play with most of the fingers and even the palm of the hands touching the keys for more precise feel and control. Too much "feeling around" can result in too much legato when more agitated playing is appropriate. In such instances, the trick is to quickly feel the key to know exactly where it is, and

then to bounce up sufficiently to produce the agitated or forceful playing. Advanced pianists will perform this "feeling" operation so quickly that it is not visible to the untrained eye.

5. Be able to produce better tone color and expression because of the more sensitive control of each finger and each key drop.

6. Be able to play a better legato — when playing Chopin, there is nothing like playing legato using techniques that were almost certainly used by Chopin.

7. Eliminate a majority of mistakes; note that, if you had done everything else correctly, thumb-under and curl paralysis cause almost all of your mistakes. Of course, just playing FFP is not enough for eliminating curl paralysis mistakes; you must learn to feel the keys at all times, not only with the fingertips but also with the entire finger and the palm. This is one of the reasons why quiet hands is so important. In the curl position, it is difficult to feel the keys not only because the finger tip is less sensitive, but also because there is no shock absorber — either the finger is on the key or off it. In the automobile, the purpose of the shock absorber is not only to provide more comfort, but also to keep the tires in contact with the road.

8. When you use FFP, wide chords and runs are much more similar; they are both played with FFP, so that it becomes easier to play when both are required. If you use curled fingers, then you have to use FFP for wide chords (otherwise you can't reach the notes) and then change to curled fingers to play runs.

9. In music with hand collisions, such as the Bach Inventions, you can play flat FFP with one hand and the pyramid position with the other to avoid the collision.

10. The FFPs are more compatible with thumb-over and cartwheel methods than the curled position.

You can demonstrate the usefulness of the FFP by applying it to anything that is giving you difficulty. For example, I was running into stress problems with speeding up Bach's inventions because they require finger independence, especially fingers 3, 4, & 5. While practicing with the curled position only, I felt that I was beginning to build speed walls at a few places where I didn't have enough finger independence. When I applied the flat finger position, they became much easier to play. This eventually allowed me to play at faster speeds and with greater control. The Bach Inventions are good pieces to use for practicing the FFPs.

A discussion of FFP would be incomplete without discussing why you need the curled position, and some of its disadvantages. This position is not really an intentionally curled position but a relaxed position in which, for most people, there is a natural curl. For those whose relaxed position is too straight, they may need to add a slight curl in order to attain the ideal curled position. In this position, all the fingers contact the keys at an angle between 45 degrees and 90 degrees (the thumb might make a somewhat smaller angle). There are certain movements that are absolutely necessary for playing the piano that require the curled position. Some of these are: playing certain white keys (when the other fingers are playing black keys), playing between the black keys, and for avoiding poking your fingernails into the fallboard. Especially for pianists with large hands, it is necessary to curl fingers 2, 3, and 4 when

1 and 5 are playing the black keys in order to avoid jamming fingers 2, 3, and 4 into the fallboard. **Thus, the freedom to play with any arbitrary amount of curl is a necessary freedom. One of the biggest disadvantages of the curled position is that the extensor muscles are not sufficiently exercised, causing the flexor muscles to overpower them and creating control problems. In FFP, the un-used flexor muscles are relaxed and not exercised; in fact, the associated tendons are stretched, which makes the fingers more flexible.**

The FFP is superior to the curled position in a majority of situations, especially for speed, legato, pianissimo, fortissimo, relaxation, sensitivity, and accuracy. The mistaken perception that FFP is bad for technique arises from the fact that it can lead to bad habits related to the incorrect use of parallel sets. This happens because with flat fingers, it is a simple matter to lay the fingers flat and jam them all down on the piano to play parallel sets masquerading as fast runs. This can result in uneven playing and beginning students might use it as a way of playing fast without developing technique. By learning the curled position first and learning how to use parallel sets correctly, we can avoid this problem. In my numerous communications with teachers, I have noticed that the best teachers are familiar with the usefulness of the FFP. This is especially true of the group of teachers whose teaching lineage traces to F. Liszt, because Liszt used this position. Liszt was Czerny's student, but did not always follow Czerny's teachings, and used FFP to improve tone (Boissier, Fay, Bertrand). In fact, it is hard to imagine that there are any advanced pianists who do not know how to use FFP. As proof, next time you attend a concert or watch a video, see if you can spot these FFPs (totally flat, pyramid, spider positions and the totally relaxed third phalange) — you will find that every accomplished pianist uses them extensively. It is gratifying that the most celebrated pianist often chose to ignore his own teacher, Czerny, as recommended here.

It is now abundantly clear that we must learn to take advantage of as many finger positions as possible. One natural question to ask is, "What is the order of importance of all these positions — which is the 'default' position that we should use most often?". The spider position is the most important. The insect kingdom did not adopt this position without a good reason; they found out that it works best after hundreds of millions of years of research. Note that the distinction between the spider position and the curled position can be subtle, and many pianists who think they are using the curled position may in fact be using something closer to FFP. The second most important position is the flat out position because it is needed for playing wide chords and arpeggios. The third position is the curled position and the pyramid position comes in fourth. The pyramid position uses only one flexor muscle per finger, the spider position uses two, and the curled position uses all three plus the extensor muscles during key drop.

In general, you can use the following rule to decide which finger position to use: play the black keys using the completely flat FFP, and use the curled or pyramid position for the white keys. The spider position is quite versatile if you acquire it while young and can play both black and white keys. Note that if, within a group of notes, you must play both black and white keys, it is usually advantageous to use two types of finger positions. This might appear to be an added complication at first, but at high speed, this might be the only way. There are, of course, numerous exceptions; for example, in difficult passages involving the 4th finger, you may need more FFPs than curled positions even when most or all the keys are white.

The above discussions on FFP are substantial, but they are by no means complete. In a more detailed treatment, we need to discuss how we apply FFP to specific skills such as legato, or playing two notes with one finger while controlling each note individually. Chopin's legato is documented to be particularly special, as was his staccato. Is his staccato related to the FFP? Note that in all the FFPs, you can take advantage of the spring effect of the relaxed third phalange, which might be useful in playing staccato. Clearly we need more research to learn how to use the FFPs. In particular, there is controversy as to whether we should play mostly with the curled position and add the FFP whenever necessary, as has been taught by most teachers, or vice versa, as Horowitz did, and as recommended here. FFP is also related to bench height. It is easier to play with flat fingers when the bench is lowered. There are numerous accounts of pianists discovering that they can play much better with a lower bench position (Horowitz and Glen Gould are examples). They claim to get better control, especially for pianissimo and speed, but no one has provided an explanation for why this is so. My explanation is that the lower bench height allowed them to use more FFPs. However, there appears to be no good reason to sit overly low, as Glen Gould did, because you can always lower the wrist to get the same effect.

In summary, Horowitz had good reasons to play with flat fingers and the above discussions suggest that part of his higher technical level may have been achieved by using more FFPs than others. **The single most important message of this section is that we must learn to relax the third phalange of the finger and play with the touch-sensitive part of the finger tip.** The aversion to, or even prohibition of, FFP by some teachers turns out to be a mistake; in fact, any amount of curl will invite some degree of curl paralysis. However, beginners must learn the curled position first because it is necessary for playing the white keys and is more difficult than the FFPs. If students learn the easier flat finger method first, they may never learn the more difficult curled position adequately. FFP is a necessary skill for developing technique. It is useful for speed, increasing your reach, playing multiple notes with one finger, avoiding injury, "feeling the keys", legato, relaxation, playing pianissimo or fortissimo, and adding color. Although the curled position is necessary, the statement "you need the curled position to play technically difficult material" is a misleading myth. Playing with flat fingers liberates us to use many useful and versatile finger positions. We now know how to play all those black keys and not miss a single note! Thank you, Mr. Horowitz and Mlle. Combe.

1.3.4.3 Body Motions

Many teachers encourage "use of the whole body for playing the piano" (see Whiteside). What does that mean? Are there special body motions that are required for technique? Not really; technique is in the hands and relaxation. However, because the hands are connected to and supported by the body, you can't just sit in one position and hope to play. When playing the upper registers, the body should follow the hands and you might even extend one leg in the opposite direction in order to balance the body, if it is not needed for the pedals. Also, even the smallest motion of any finger requires the activation of a series of muscles that lead all the way to at least the center of the body (near the sternum), if not all the way to the legs and other members that support the body. Relaxation is as important in the body as in the hands and fingers, because of the shear size of the muscles involved. Therefore, although most of the required body motions can be understood from simple common sense, and do not seem to be that important, they are nonetheless absolutely essential to piano playing. So let's discuss these motions, some of which may not be totally obvious.

The most important aspect is relaxation. It is the same type of relaxation that you need in the hands and arms — use of only those muscles required for playing, and only for the brief instants during which they are needed. Relaxation also means free breathing; if your throat is dry after a hard practice, you are not swallowing properly, a sure sign of tenseness. **Relaxation is intimately related to independence of every part of the body. The first thing you must do, before considering any useful body motions, is to make sure that the hands and fingers are totally decoupled from the body. If they are not decoupled, the rhythm will go awry, and you can make all sorts of unexpected mistakes. If, in addition, you don't realize that the body and hands are coupled, you will wonder why you are making so many strange mistakes for which you cannot find the cause.** This decoupling is especially important in HT play, because the coupling will interfere with the independence of the two hands. Coupling is one of the causes of mistakes: for example, a motion in one hand creates an involuntary motion in the other through the body. This does not mean that you can ignore body decoupling during HS practice; on the contrary, the decoupling should be consciously practiced during HS work. Note that decoupling is a simple concept and easy to execute once you learn it but, physically, it is a complex process. Any motion in one hand *necessarily* produces an equal and opposite reaction in the body, which is automatically transmitted to the other hand. Thus decoupling requires active effort; it is not just a passive relaxation. Fortunately, our brains are sufficiently sophisticated so that we can easily grasp the concept of decoupling. This is why decoupling must be actively practiced. When you learn any new composition, there will always be some coupling until you practice it out. The worst type of coupling is the one acquired during practice, if you practice with stress or try to play something that is too difficult. During the intense efforts needed to try to play difficult material, a student can incorporate any number of unnecessary motions, especially during HT practice, which will eventually interfere with the playing as the speed increases. By getting up to speed HS, you can avoid most of these HT coupling mistakes.

Another important use of the body is in playing softly or forte. Truly loud and authoritative sound can be generated only through the use of the shoulders. The body should lean forwards and the weight of the shoulders should be used. Thus the sound is produced by a larger mass, and the audience can hear this. We all know that $F = Ma$ where "F" is the force applied to the key drop, "M" is the mass of the finger, arm, etc., and "a" is the acceleration of the key drop. Since you can humanly accelerate the finger tip by only a certain amount, the mass M determines the force because M can be made very large by adding the body and shoulders. With this larger force, you can drive the hammer to a higher velocity and with more hammer shaft flex, compared to if you just used the arm. A hammer hitting the strings with more force and shaft flex stays on the strings longer because it must wait for the flex to unwind before it can bounce back. The larger force compresses the hammer felt more, which also contributes to longer residence time on the strings. The longer residence causes the higher overtones to be attenuated more efficiently (because they have more chances to escape through the hammer, etc.), resulting in a "deeper" tone. In other words, with more mass behind the key drop, you transfer energy to the strings more efficiently. A golf ball bouncing off a concrete wall at high speed will leave the wall with almost all of its initial kinetic energy, which means that it transferred little energy to the wall. It also creates a high frequency pinging sound. A heavy wrecking ball, on the other hand, has a larger mass, and although it may be traveling more slowly than the golf ball, can transfer enough energy to destroy the wall. It also tends to create a deep, roaring sound. Although the piano hammer cannot change its mass, the shaft flex produces an effect similar to that of a larger mass. This is why teachers tell students to "press deeply into the keys" in order to produce a loud, authoritative sound. This motion results in maximum mass behind the key drop, and maximum hammer shaft flex. The shaft flex is maximized by providing the greatest acceleration near the bottom of the key drop, just at the time when the jack releases. If you don't "press deeply" you tend to stop the acceleration before reaching the bottom (this need to accelerate at impact is the reason why the "follow through" is so important in golf). Note that the shaft flex starts to unwind as soon as the hammer goes into free flight, even before the hammer hits the strings. Because of this effect, good piano tuners do their utmost to minimize the let-off distance when regulating the action, so as to provide maximum tone control. Therefore, if a few hammers stick in their upper position right after your tuner regulated the piano, don't be angry at the tuner because s/he made a much greater effort than most tuners to "get it just right" by minimizing the let-off distance. Keep exercising those notes, and the leather at the knuckle will compress and those notes will soon start to play normally.

The body is also used for playing softly because in order to play softly, you need a steady, constant platform from which to generate those small, controlled forces. The hand and arm, by themselves, have too many possible motions to serve as a steady platform. When attached securely to a steady body, you have a much more stable reference platform. Thus the soft stillness of the pianissimo should emanate from the body, not the fingertips. And in order to reduce mechanical "noise" from extraneous finger motions, the fingers should be on the keys as much as possible. In fact, feeling the keys provides another stable reference from which to play. Once the finger leaves the key, you have lost that valuable reference, and the finger can now wander anywhere, making it difficult to accurately control the next note.

1.3.5 Playing (Fast) Scales and Arpeggios (Chopin's Fantaisie Impromptu and Beethoven's Moonlight, 3rd Movement)

1.3.5.1 Scales

Updated: January 25, 2004

Scales and arpeggios are the most basic piano passages; yet the most important method for playing them is often not taught at all! Arpeggios are simply expanded scales and can therefore be treated similarly to scales; thus we shall first discuss scales in detail and then note how similar rules apply to arpeggios. There is one fundamental difference on how you must play the arpeggio (a flexible wrist) compared to the scale; once you learn that simple difference, arpeggios will become much easier, even for small hands.

There are two ways to play the scale. The first is the well-known "thumb under" method (TU) and the second is the "thumb over" method (TO). In the TU method, the thumb is brought under the hand in order to pass the 3rd or 4th finger for playing the scale. This TU operation is facilitated by the unique structure of the thumb, located below the palm. **In the TO method, the unique structure of the thumb is ignored and it is treated like the other 4 fingers. Both methods are required to play the scale but each is needed under different circumstances;** the TO method is needed for fast, technically difficult passages and the TU method is useful for slow, legato passages, or when some notes need to be held while others are being played.

The TU method is more frequently taught probably (1) for historical reasons and (2) because the TO method is not needed (though it may be preferable) up to the intermediate level. In fact, with sufficient effort and work, it is possible to play fairly difficult passages using the TU method and **there are professional and excellent pianists who think that TU is the only method they need. In reality, for sufficiently fast passages, they have subconsciously learned (through very hard work) to modify the TU method in such a way that it approaches the TO method.** This modification is necessary because for such rapid scales, it is physically impossible to play them using the TU method and stress becomes unavoidable at high speeds. Therefore it is important for the student to start learning the TO method as soon as they are past the novice stage, before the TU habit becomes ingrained into passages that should be played TO.

Many students use the method of playing slowly initially and then ramping up the speed. They do fine using TU at slow speed and consequently acquire the TU habit and find out, when they get up to speed, that they need to change to the TO method. This change can be a very difficult, frustrating, and time consuming task, not only for scales, but also for any difficult, fast passage — another reason why the ramping up method is not recommended in this book. The TU motion is one of the most common causes of speed walls. Thus once the TO method is learned, it should always be used to play the scale except when the TU method gives better results. Even with the methods taught here, you will find that you can "get away with" certain motions at slower speeds while you cannot at higher speeds. We show below how to find the necessary motions using parallel set exercises and to apply them at the appropriate speeds.

The main piano playing muscles for the thumb are in the forearm, just as for the other 4 fingers. However, the thumb has other muscles in the hand that are used to move the thumb sideways in the TU method. The involvement of these extra muscles for the TU motion makes it a more biologically complex operation, thus slowing down the maximum speed attainable. The extra complication and stress at high speeds also causes mistakes. **Some teachers claim that for those who use TU exclusively, 90% of their flubs originate with the TU motion.**

You can demonstrate the disadvantage of the TU method by observing the loss of thumb mobility in its tucked-in position. First, stretch your fingers out so that all the fingers are in the same plane. You will find that all the fingers, including the thumb, have mobility up and down (the motion needed to play the piano). Now, wiggle the thumb up and down rapidly — you will see that the thumb can move 4 or 5 cm vertically with ease (without rotating the forearm), quite rapidly. Then, while still wiggling at the same rapid frequency, gradually pull the thumb under the hand — you will see that as it goes under, it loses vertical mobility until it becomes immobile, almost paralyzed, when it is under the middle finger.

Now stop the wiggling and thrust the thumb down (without moving the wrist) — it moves down! This is because you are now using a different set of muscles. Then, using these new muscles, try to move the thumb up and down as fast as you can — you should find that these new muscles are much clumsier and the up and down motion is slower than the wiggle rate of the thumb when it was stretched out. Therefore, in order to be able to move the thumb in its tucked position, you not only need to use a new set of muscles but, in addition, these muscles are much more awkward. It is the introduction of these clumsy muscles that creates mistakes and slows down the play in the TU method. The objective of the TO method is to eliminate these problems. The obvious question is, "what price do you pay for it?"

The TU method works well for slow scales. This is why scales (and arpeggios) are some of the most abused exercises in piano pedagogy — novice students are taught the TU method and are frequently never taught the TO method, leaving them unable to acquire proper techniques for runs and arpeggios. Not only that, but as the scale is speeded up, stress begins to mysteriously build up. **Beginners should be taught the TO method as soon as they are ready. The TO method is no harder to learn than the TU method because it does not require the sideways contortions of the thumb, hand, arm, and elbow.** It is not harmful to teach beginners the TU method first and then the TO method when faster scales are needed (within the first two years of lessons) because for a beginner, the TU method is more complex and difficult to learn. Clearly, anyone beyond novice must learn the TO method in order to avoid the trauma and wasted time trying to play fast scales TU. Worse still, the student could end up with a large number of learned music with wrong habits that may need to be laboriously corrected later. For talented students, the TO method must be taught within 6 months of their first lessons, or as soon as they master TU.

Because there are two ways to play the scale, there are two schools of teaching on how to play it. One school is the TU school. In fact, a disproportionately large fraction of students are presently being taught only the TU method because most private teachers (who account for the majority of beginning students) have students that are not that advanced and therefore do not need the TO method. **Many private teachers aren't even aware of the TO method.** The TU school (Czerny, Leschetizky) claims that TU is the only way that legato scales can be played and that, with sufficient practice, TU can play scales at any speed. The TO school (Whitesides, Sandor) is now taking over and the more insistent adherents *forbid* the use of TU, under any circumstances. **See the Reference section for more discussions on TU vs. TO teaching.** Both extreme schools are wrong because you need both skills.

The TO teachers claim that the TU method is the cause of a majority of flubs and that if you practiced each method the same amount of time, you will be playing far superior scales with the TO method. They are understandably angered by the fact that advanced students passed to them by private teachers often do not know the TO method and it takes six months or more just to correct hours of repertoire that they had learned the wrong way. One disadvantage of learning both TU and TO is that when sight reading, the thumb might become confused and not know which way to go. This confusion is one reason why some teachers in the TO school actually forbid the use of TU. I recommend that you standardize to the TO method and use the TU as an exception to the rule. Note that Chopin taught both methods (Eigeldinger, p. 37). **Thus learning TO is not just a matter of preference; it is a necessity.**

So, what exactly is the TO metion? Let us start by analyzing the basic fingering of scales. Consider the RH, C major scale. We begin with the easier part, which is the RH descending scale, played 5432132, 1432132, 1 etc. Since the thumb is below the hand, the 3 or 4 finger rolls over the thumb easily, the thumb naturally folds under those fingers, and this descending scale fingering works well. This motion is similar to the TU motion; therefore, for the RH descending scale, there is little apparent difference between the TU and TO methods. We will need to make a slight but crucial modification to this below in order to make it into a true TO method, but that subtle modification will be difficult to understand until we master the TO method. We shall postpone the discussion of this modification till later.

Now consider the RH, C major ascending scale. This is played 1231234, etc. **In the TO method, the thumb is played just like the 3 and 4 fingers; i.e., it is simply**

raised and lowered without the sideways TU motion under the palm. Since the thumb is shorter than the other fingers, it can be brought down almost parallel to (and just behind) the passed finger without colliding with it. For scales such as the C major, both the thumb and passed finger are on white keys and will necessarily crowd each other somewhat. In order to avoid any possibility of collision, the 3 or 4 finger must be quickly moved away as the thumb comes down. This is the operation that must be practiced in order to play a smooth TO scale. In the TO method, it is not possible to hold the 3 or 4 finger down until the thumb plays, unlike the TU method, and the thumb cannot pass over these fingers. For these reasons, some people object to the name TO because it is misleading. When you first try the TO method, the scale will be uneven and there may be a "gap" when passing the thumb. **The trick in learning the TO method is to reduce the "gap" between playing the 3 or 4 finger and the thumb so that the gap becomes inaudibly small.** Therefore, the transition must be very quick even in a scale played slowly. As you improve, you will notice that a quick flick/rotation of the wrist/arm is helpful. It may be easier to learn the TO motion initially by playing staccato. We shall go into much more detail on how to practice TO below.

The logic behind the TO method is the following. **The thumb is used like any other finger; it is not unique.** The thumb only moves up and down. This simplifies the finger motions and, in addition, the hand, arms, and elbows do not need to contort to accommodate the thumb movements. Without this simplification, technically difficult passages can become impossible, especially because you still need to add new hand motions to attain such speeds, and most of these motions are incompatible with TU. Thus the hand and arm maintain their optimum angle to the keyboard at all times and simply glide up and down with the scale. Most importantly, **the movement of the thumb to its correct location is controlled mostly by the hand** whereas in the TU method, it is the compound motion of the thumb and hand that determines the thumb location. Because the hand motion is smooth, the thumb is positioned more accurately than with the TU method, thus reducing missed notes and hitting of wrong notes and at the same time bestowing better tone control to the thumb. Also, the ascending scale becomes similar to the descending scale, because you always roll the fingers *over* for passing. This also makes it easier to play hands together since all fingers of both hands are always rolling over. Another bonus is that the thumb can now play a black key. It is this large number of simplifications, the elimination of the stress that results from the paralyzed thumb, and certain other advantages discussed below, that reduces the potential for mistakes and enables arbitrarily fast play. There are, of course, exceptions: slow, legato passages, or some scales containing black keys, etc., are executed more comfortably with a TU-like motion. Acquiring the necessary techniques for the TO method is not automatic — it will need a certain minimum of practice, otherwise it will initially yield only choppy scales. In fact, **most students who "grew up" using only TU will initially have a terrible time trying to understand how anyone can play anything TO.** This is the clearest indication of the harm done by not learning TO; for these students, the thumb is not "free" as explained below. We shall see that the free thumb is a very versatile finger. But don't despair, because it turns out that all TU students already know how to play TO — they just don't know it.

The LH is the reverse of the RH; the TO method is used for the descending scale. If your RH is more advanced than the LH, perform the explorations to faster TO speeds using the RH until you decide exactly what to do, then pick up that motion with the LH. You can save a lot of time this way. It is a good idea to get into the habit of using the better hand to teach the other one. Naturally, if the LH is weaker than the RH, you will eventually need to practice it more to let it catch up. **The LH must be stronger than the RH because the hammers in the bass are larger and the strings are more massive, which makes the action feel heavier at faster speeds.**

We now discuss procedures for practicing fast TO scales. The RH C major ascending scale consists of the parallel sets 123 and 1234. Parallel sets (see section 1.4.2) are groups of notes that can be played as a "chord" (all at once). First, use the chord attack (see section 1.2.9) or the parallel set exercises (section 1.3.7) to attain a fast 123, with 1 on C4. Then practice 1231 with the thumb going up and then coming down behind the 3, quickly moving the 3 out of the way as the thumb comes down. Most of the sideways motion of the thumb is accomplished by moving the hand. The last 1 in the 1231 is the conjunction required by the continuity rule (see 1.2.8). Repeat with 1234, with 1 on F4, and then 12341, with the last 1 rolling over, just behind the 4, and landing on C5. Make sure that you can play these two combinations very rapidly and smoothly, completely relaxed. Play fingers 234 close to the black keys in order to give the thumb more area to land on. Then connect the two parallel sets to complete the octave. After you can do one octave, do two, etc.

When playing very fast scales, the hand/arm motions are similar to those of a glissando (but not identical). Note that the thumb can be brought very close to the passed finger (3 or 4) if it is kept just behind all the other fingers (almost like TU). The glissando type motion allows you to bring the thumb even closer to the passed fingers because all the fingers 2 to 5 are pointing slightly backwards. You should be able to play one fast octave (about 1 octave/sec.) this way after a few minutes of practice (let's not worry about evenness yet!). Practice relaxing to the point where you can feel the weight of your arm. When you become proficient with TO, you should find that long scales are no more difficult than short ones and that HT is not as difficult as TU. This happens mainly because the contortions of the elbow, etc., for TU become more difficult at the high and low ends of the scales (there are many other reasons). It is important to stress here that there is never any real need to practice scales HT and, until you become quite proficient, HT practice will do more harm than good mainly because you can waste a lot of time practicing HT at this stage. There is so much urgent material we must practice immediately HS, that there should be little time left for HT practice. In addition, if you ask "What will I gain practicing HT?" the answer is "Almost nothing". Most advanced teachers (Gieseking) consider practicing fast HT scales to be a waste of time. However, the ability to play great scales HS is a necessity.

In order to control the phase angle in the parallel set accurately, raise your wrist (ever so slightly) as you play the parallel sets 123 or 1234. Then make the transition to the next parallel set by lowering the wrist to play TO. These wrist motions are extremely small motions, almost imperceptible to the untrained eye, and become even smaller as you speed up. You can accomplish the same thing by rotating the wrist clockwise (cw) to play the parallel sets and cycling back by rotating ccw to lower the thumb. However, the up and down wrist motion is preferred over the rotation because it is simpler, and the rotation can be reserved for other uses (Sandor). If you now try to play several octaves, it may initially come out like a washboard. It might take several weeks to attain fast smooth scales over 5 octaves up and down continuously HS, depending on your level.

The fastest way to speed up scale playing is to practice only one octave. One you are up to the faster speeds, cycle 2 octaves up and down continually. At high speeds, these shorter octaves are more useful because it is easier to learn the runs but it is more difficult to reverse direction at the top and bottom as the speed is increased. With longer runs, you don't get to practice the ends as often, and the added stretch of the arm to reach the higher/lower octaves is just an unnecessary distraction from concentrating on the thumb. **The way to play fast reverses at the top and bottom is to play them with a single downward pressure of the hand.** For example, to reverse at the top, play the last parallel set, the conjunction, and the first parallel set coming down, all in one downward motion. In this scheme, the conjunction is effectively eliminated by incorporating it into one of the parallel sets. This is one of the most effective ways of playing a fast conjunction — by making it disappear!

Remember the glissando type of motion mentioned above. In the glissando, the hands are supinated or pronated in such a way that the fingers point away from the direction of motion of the hand. In these hand positions, the keydrop motions of the fingers are not straight down, but have a horizontal backward component that enables the fingertips to linger a little longer on the keys as the hand moves along the keyboard. This is especially helpful for playing legato. In other words, if the fingers were coming straight down (relative to the hand) and the hand is moving, the fingers would not come straight down onto the keys. By rotating the hand slightly in the glissando direction, this error can be compensated. Thus the glissando motion allows the hand to glide smoothly instead of moving up in jerks. You can practice this motion by cycling one octave up and down; the hand should resemble the motion of a skater, with alternate feet kicking sideways and the body alternately tilting while s/he skates forward. The hand should pronate or supinate with each change of direction of the octave. As in skating, where you must lean in the opposite direction before you can change the direction of motion, the rotation of the hand (reversal of glissando hand position) must precede the change in direction of the scale.

Do not take the glissando analogy too literally, because there are differences. For playing scales, the fingers are doing the work; therefore, it is important to keep the fingers parallel to the arm so as not to strain the tendons and cause injury or create stress.

For the RH descending TO scale, practice the parallel set 54321, and the other relevant parallel sets, with and without their conjunctions. **You just need to make a small modification to avoid letting the thumb fold completely under the hand while the next parallel set is rolling over the thumb.** Lift the thumb as early as possible while keeping the scale smooth, by raising and/or rotating the wrist to pull the thumb up — almost the reverse of what you did for the ascending scale. If you fold the thumb completely under the palm, it will become paralyzed and difficult to move to the next position. This is the "slight modification" referred to above and is very similar to the thumb motion for the ascending scale. For TU play, the thumb can be allowed to fold completely under the palm. **Because this motion is somewhat similar in TO and TU, and differ only in degree, it can be easily played incorrectly.** The difference becomes important in technically difficult passages.

For ultra-fast scales (over one octave per second), think not in terms of individual notes, but in units of parallel sets. For the RH, naming 123=A, 1234=B, play AB instead of 1231234, i.e., two things instead of seven. For even faster play, think in units of pairs of parallel sets AB,AB, etc. As you progress in speed and start thinking in terms of larger units, the continuity rule should be changed from A1 to AB1 to ABA (where the final member is the conjunction). It is a bad idea to over-practice fast, at speeds you can not comfortably manage. The forays into very fast play are useful only for making it easier to practice accurately at a slightly slower speed. Therefore practice most of the time at slightly slower than maximum speed; you will gain speed faster that way. Do not practice for long periods at maximum speed because that will condition the hands to play the wrong way. And don't forget to play slowly at least once before you change hands or quit.

Try the following experiment in order to get the feel of truly fast scales. Cycle the 5 finger parallel set 54321 for the RH descending scale, according to the scheme described in the parallel set exercises. Note that, as you increase the repetition speed, you will need to orient the hand and use a certain amount of thrust or rotation in order to attain the fastest, smooth, and even parallel play. You may need to study the arpeggio section below on "thrust" and "pull" before you can do this correctly. An intermediate level student should be able to get up to faster than 2 cycles per second. Once you can do this rapidly, comfortably, and relaxed, simply continue it down one octave at the same fast speed, making sure to play it TO. You have just discovered how to play a very fast run! How fast you can play depends on your technical level, and as you improve, this method will allow you to play even faster scales. Do not over practice these fast runs if they start to become uneven because you can end up with uneven playing habits. These experiments are valuable mainly for discovering the motions needed at such speeds.

It is best not to start playing scales HT until you are very comfortable HS. **The maximum HT speed is always slower than the maximum HS speed of the slower hand.** Start HT practice with one octave, or part of one, such as one parallel set. For practicing by parallel sets, the C major scale is not ideal because the thumbs are not synchronized — see below for a better scale to use (B major). Cultivate the habit of transitioning to HT at a fast speed (although it may seem much easier to start at slow speed and then gradually ramp up). To do this, play one octave LH at a comfortable fast speed several times, repeat the RH at the same speed several times, and then combine them at the same speed. Don't worry if at first the fingers don't match absolutely perfectly. First match the starting notes; then match both the start and final notes; then cycle the octave continually; then work on matching every note.

Suppose that you can play at speed 10 with your RH and 9 with the LH. Then your maximum speed HT may be 7. If you want to increase this HT speed to 9, don't do it HT. Do it by increasing the RH speed to 12, then the LH speed to 11. Now you can increase the HT speed to 9. In this way, you save a lot of time and will avoid picking up bad habits and developing stress. That is, practically all technique acquisition should be conducted HS because that is the fastest, most error-free way. Many students will need to practice the LH more than the RH, which is another reason for practicing HS.

Before going too far with the C major scale, consider practicing the B major scale. See table below for scale fingerings. In this scale, only the thumb and pinky play the white keys, except for the bottom finger (4) of the LH. All other fingers play the black keys. This scale has the following advantages:

1. It is easier to play initially, especially for those with large hands or long fingers. Each key falls naturally under every finger, the fingers never crowd each other, and there is plenty of room for every finger. For this reason, Chopin taught this scale to beginners before teaching the C major scale.

2. It allows you to practice playing the black keys. The black keys are more difficult to play (easier to miss) because they are narrower, and require greater accuracy.

3. It allows play with flatter fingers (less curled), which may be better for practicing legato and for tonal control.

4. TO play is much easier with this scale. This is the reason why I used the C major scale to illustrate the TO method. With the B major, it is more difficult to see the difference between the TU and TO motions. However, for purposes of practicing the proper motions, B major may be superior, if you already understand the difference between TU and TO because it is easier to get to the faster speeds without acquiring bad habits.

5. The thumbs are synchronized in this scale, making it possible to practice HT, parallel set by parallel set. Thus HT play is easier than for the C major scale. Once you become proficient with this scale HT, learning C major HT becomes simpler, thus saving you lots of time. You will also understand exactly why the C major is more difficult.

This paragraph is for those who grew up learning TU only and must now learn TO. At first, you have acquired might feel as if the fingers get all tangled up and it is difficult to get a clear idea of what TO is. The main cause of this difficulty is the habit you have acquired playing TU which must be unlearned. The first obvious point is that you must not try to learn TO HT; practice HS. It is a new skill you need to learn and is no harder to learn than a Bach Invention. **But the best news of all is that you probably already know how to play TO! Try playing a very fast chromatic scale.** Starting with C, play 13131231313 ... The flat finger position may be useful here. If you can play a very fast chromatic scale, the thumb motion is exactly the same as for TO because it is impossible to play a fast chromatic scale TU. Now transfer this motion to the B major scale; think of this scale as a chromatic scale in which only a few white keys are played. Once you can play the B major TO, transfer this motion to C major. This scale is more difficult because the fingers are more crowded, you need more curl, and you cannot freely use the flat finger positions. It might help to turn the hand/arm inwards slightly so that the thumb is already positioned slightly ahead of where it would be if the arm were strictly perpendicular to the keyboard.

The emphasis in this section has been on speed because that is where the technical difficulties lie and where TO becomes a necessity. **It should be re-emphasized here that practicing fast all the time and pushing your fingers to go faster is precisely the wrong way. Wait for the fingers to eagerly accelerate on their own instead of pushing them.** High speed practice is necessary in the sense that you must constantly vary the speed. The tendency is to practice too long with one hand before switching. The resting hand must not be allowed to cool off; otherwise, its eagerness will dissipate. If you are practicing 5 repetitions and then switching hands, it is usually best to play fastest the first time, then gradually slow down, or play fast 4 times, and slower the final time.

Of course, learning scales and arpeggios (below) TO is only the beginning. The same principles apply to any situation involving the thumb, in any piece of music, anywhere that is reasonably fast. Once the scale and arpeggios are mastered, these other TO situations should come almost as second nature. For this to develop naturally, you must use a consistent and optimized scale fingering; these are listed in the tables below.

Those who are new to the TO method and have learned many pieces using the TU method will need to go back and fix all the old pieces that contain fast runs and broken chords. Ideally, all the old pieces that were learned using TU should be redone so as to completely get away from the TU habit. It is a bad idea to play some pieces TU and others TO for similar fingerings. One way to accomplish the switch to TO is to practice scales and arpeggios first so that you become comfortable with TO. Then learn a few *new* compositions using TO. After about 6 months or so, when you have become comfortable with TO, you can start converting all your old pieces.

It is obvious that we need both TO and TU. They should be considered as the extremes of two different ways to use the thumb. That is, there are many other motions in between, half of them would be more TO and the other half would be more TU. **One unexpected benefit of learning TO is that you become much better at playing TU. This happens because your thumb becomes technically more capable: it becomes free.** And you gain the ability to use all those in-between motions (between extreme TO and TU) that may be required depending on what other notes are being played or what type of expression you want to create. **The thumb is now free to use all of its available motions and for controlling tone. This freedom, plus the ability to now play much more technically difficult material correctly, is what transforms the thumb into a very versatile finger.**

Repeating scales and exercises mindlessly is discouraged in this book. However, it is critically important to develop the skill to play exquisite scales and arpeggios, in order to acquire some very basic technique and standard fingerings for routine playing and sight reading. Scales and arpeggios in all the major and minor keys should be practiced until you are very familiar with them. The standard fingerings should be practiced until they are like second nature. They should sound crisp and authoritative, not loud but confident; just listening to them should lift up one's spirits.

The standard **major scale ascending fingerings** are 12312341 (RH), 54321321(LH) for C, G, D, A, E major scales (with 0, 1, 2, 3, 4 sharps, respectively); these fingerings will be abbreviated as S1 and S2, where **S stands for "standard".** The sharps increase in the order F, C, G, D, A, (G major has F♯, D major has F♯ and C♯, A major has F♯, C♯, and G♯, etc.) and for the F, B♭, E♭, A♭, D♭, G♭ major scales, the flats increase in the order B, E, A, D, G, C; every interval between adjacent letters is a fifth. They are therefore easy to remember, especially if you are a violinist. Look at B or G♭ major scales in a music book and you will see how the 5 sharps or 6 flats line up. Thus 2 sharps will have sharps at F, C, three sharps will be F, C, G, and so on. The flats increase in reverse order compared to the sharps. See table below for the remaining ascending major scales (reverse the fingerings for descending scales):

RH	LH	Scale	Sharps/Flats
S1=12312341	S2=54321321	C, G, D, A, E	0, 1, 2, 3, 4 sharps
S1	43214321321	B	5 sharps
12341231	S2	F	1 flat
41231234	32143213	B♭	2 flats
31234123	32143213	E♭	3 flats
34123123	32143213	A♭	4 flats
23123412	32143213	D♭	5 flats
23412312	43213214	G♭	6 flats

For the minor scales: (the last column designates the modified note for the minor scale)

RH	LH	Scale	Sharps/Flats	
S1	S2	A	0 sharps	G sharp
S1	S2	E	1 sharps	D sharp
S1	43214321	B	2 sharps	A sharp
34123123	43213214	F♯	3 sharps	E sharp
34123123	32143213	C♯	4 sharps	B sharp
34123123	32143213	G♯	5 sharps	F dsharp
S1	S2	D	1 flat	C sharp
S1	S2	G	2 flats	F sharp
S1	S2	C	3 flats	B nat.
12341231	S2	F	4 flats	E nat.
21231234	21321432	B♭	5 flats	A nat.
31234123	21432132	E♭	6 flats	D nat.

It is easy to get addicted to playing scales and arpeggios. Once you can play scales as fast as you want (which will take many years), it is best not to use scales for warm-ups because of the addiction. We are all lazy to a certain extent and playing scales endlessly requires relatively little mental effort once you become proficient — a classic trap for the lazy brain.

On the other hand, we can never play the scale too well. When practicing scales, always try to accomplish something — smoother, softer, clearer, faster. Make the hands glide, the scale sing; add color, authority or an air of excitement. Quit as soon as you start to lose concentration. There is no such thing as a maximum speed in parallel playing. Therefore, in principle, you can keep increasing the speed and accuracy all your life — which can be quite a bit of fun, and is certainly addicting. If you want to demonstrate your speed to an audience, you can probably do that using scales and arpeggios at least as well as with any piece of music.

1.3.5.2 Arpeggios

Playing arpeggios correctly is technically very complex. This makes arps particularly suitable for learning some important hand motions, such as thrust, pull, and the "cartwheel motion". "Arpeggio", as used here, includes broken chords and combinations of short arpeggic passages. We shall illustrate these concepts here using Beethoven's Moonlight Sonata (3rd Movement) for the thrust and pull, and Chopin's Fantaisie Impromptu (FI) for the cartwheel motion. Recall that suppleness of the hands, especially at the wrist, is critical for playing arps. The technical complexity of arps arises from the fact that in most cases, this suppleness must be combined with everything else: thrust, pull, cartwheel motion, and TU or TO. One note of caution: the Moonlight is difficult because of the required speed. Many Beethoven compositions cannot be slowed down because they are so intimately tied to rhythm. In addition, this movement requires a minimum reach of a 9th, comfortably. Those with smaller hands will have much more difficulty learning this piece than those with adequate reach.

1.3.5.3 The Cartwheel motion Method (Chopin's FI)

In order to understand this motion, place your left palm flat on the piano keys, with the fingers spread out as far as you can like the spokes of a wheel. Note that the fingertips from pinky to thumb fall on an approximate semi-circle. Now place the pinky above C3 and parallel to it; you will have to rotate the hand so that the thumb is closer to you. Then move the hand towards the fallboard so that the pinky touches the fallboard; make sure that the hand is rigidly spread out at all times. If the 4th finger is too long and touches the fallboard first, rotate the hand sufficiently so that the pinky touches the fallboard, but keep the pinky as parallel to C3 as possible. Now **rotate the hand like a wheel counter clockwise (as viewed from above) so that each successive finger touches the fallboard (without slipping) until you reach the thumb. This is the cartwheeling motion in the horizontal plane. If your normal reach is one octave with your fingers spread out, you will find that the cartwheeling motion will cover almost two octaves!** You gain extra reach because this motion makes use of the fact that the center three fingers are longer than the pinky or thumb. Now repeat the same motion with the hand vertical (palm parallel to fallboard), so the fingers point downwards. Start with the pinky vertical and lower the hand to play C3. Now if you roll the hand up towards C4, (don't worry if it feels very awkward), each finger will "play" the note that it touches. When you reach the thumb, you will again find that you have covered a distance almost twice your normal reach. **In this paragraph, we learned three things: (1) how to "cartwheel" the hand, (2) this motion expands your effective reach without making any jumps, and (3) the motion can be used to "play" the keys without moving the fingers relative to the hand.**

In actual practice, cartwheeling is used with the hand somewhere between vertical and horizontal, and the fingers will be slightly curved. Although this cartwheeling motion will add some keydrop motion, you will also move the fingers in order to play. We apply this method to the LH broken chords of Chopin's FI. In section 1.3.2, we discussed the use of cycling to practice the LH. We will now add the cartwheel motion to the cycling. Cycle the first 6 (or 12) LH notes of bar 5 (where the RH first joins in). Instead of just translating the hand sideways to play each note, add the cartwheeling motion. If you position the hand almost horizontally, then practically all the keydrop must be accomplished by finger motion. However, if you raise the hand more and more towards the vertical, the cartwheeling motion will contribute more keydrop and you will need less finger motion to play. **The cartwheeling motion is especially useful for those with small hands because it automatically expands the reach. Cartwheeling also makes it easier to relax because there is less need to keep the fingers spread widely apart in order to reach all the notes. This motion also releases the tension in the wrist because you can't cartwheel with wrist tension. These reductions in stress make the hand more supple. You will also find that your control increases because the motions are now partly governed by the large motions of the hand which makes the playing less dependent on the motion of each finger and gives more uniform, even results.**

1.3.5.4 Thrust and Pull: the two principal ways to play the arpeggio.

For those who learn Beethoven's Moonlight Sonata for the first time, one of the most commonly encountered difficulties is the two-hand arpeggic ending of the 3rd movement (bars 196–198; this movement has 200 bars). By illustrating how to practice this difficult passage, we can demonstrate how arpeggios should be played. Let's try the RH first. In order to simplify the practice, we skip the first note of bar 196 and practice only the following 4 ascending notes (E, G♯, C♯, E), which we will cycle. **As you cycle, make an elliptical, clockwise motion (as seen from above) of the hand.** We divide this ellipse into two parts: the upper part is the half towards the piano and the lower part is the half towards your body. When playing the upper half, you are "thrusting" your hand towards the piano, and when playing the lower half, you are "pulling" the hand away from it. First, play the 4 notes during the upper half and return the hand to its original position using the lower half. This is the thrust motion for playing these 4 notes. Your fingers tend to slide towards the piano as you play each note. Now make a counter clockwise motion of the hand and play the same 4 ascending notes during the lower half of the ellipse. Each finger tends to slide away from the piano as it plays each note. Those who have not practiced both motions may find one much more awkward than the other. Advanced players should find both motions equally comfortable.

The above was for the RH ascending arp. For the RH descending arp, let's use the first 4 notes of the next bar (same notes as in preceding paragraph, an octave higher, and in reverse order). Here, the pull motion is needed for the lower half of the clockwise motion, and the thrust is used for the upper half of the counter clockwise rotation. For both ascending and descending arps, practice both thrust and pull until you are comfortable with them. Now see if you can figure out the corresponding exercises for the LH. **Notice that these cycles are all parallel sets and therefore can eventually be played extremely fast.** Clearly, this is the most efficient way to get up to speed quickly; we will discuss more details below.

Having learned what the thrust and pull motions are, you might reasonably ask, "why do you need them?" First, it should be pointed out that **the thrust and pull motions use entirely different sets of muscles. Therefore, given a specific application, one motion has to be better than the other.** We will learn below that one motion is stronger than the other. Students who are not familiar with these motions may randomly pick one or switch from one to the other without even knowing what they did. This can result in unexpected flubs, unnecessary stress, or speed walls. The existence of the thrust and pull is analogous to the situation with TU and TO. Recall that by learning both TU and TO, you get to fully utilize all the capabilities of the thumb. In particular, at high speed, the thumb is used in a way which is very close to midway between TU and TO; however, the important thing to keep in mind is that the thumb motion must be on the TO side of dead center. If you are even slightly on the TU side, you hit a speed wall. **Just as with thrust and pull, TU and TO use two very different sets of muscles.**

The analogy of thrust and pull to TU and TO go even further, because thrust and pull also have a neutral motion, just as TU and TO have a range of motions in between. **You get the neutral motion by reducing the minor axis of the ellipse to zero**; i.e., you simply translate the hand right and left without any elliptical motion. But here again, it makes a big different whether you approach the neutral position from the thrust side or the pull side, because the seemingly similar neutral motions (approached from thrust or pull side) are actually being played using a different set of muscles. Let me illustrate this with a mathematical example. Mathematicians will be horrified if you tell them that $0 = 0$, which at first glance seems to be correct. Reality, however, dictates that we must be very careful. This is because we must know the true meaning of zero; i.e., we need a mathematical definition of zero. It is defined as the number $1/N$, when N is allowed to go to infinity. You get to the "same" number zero, whether N is positive or negative. Unfortunately, if you try to divide by zero: $1/0$, you get a different answer depending on whether N is positive or negative. $1/0 = +\infty$ when N is positive, and $1/0 = -\infty$ when N is negative! If you had assumed the two zeros to be the same, your error after the division could have been as big as two infinities depending on which zero you used! In a similar way, the "same" neutral position achieved by starting with TU or TO are fundamentally different, and similarly with thrust and pull. That is, under certain circumstances, a neutral position approached from either thrust or pull is better. This is why you need to learn both.

OK, so we have established that thrust and pull are both needed, but how do we know when to use which? In the case for TU and TO, the rules were clear; for slow passages you can use either one, and for certain legato situations, you need TU; for all others you should use TO. For arps, the rule is to use the strong motions as a first choice and the weak motions as a secondary choice. Strong and weak are defined as follows:

> Strong: for RH ascending, use pull; for RH descending use thrust, and
>
> for LH ascending, use thrust; for LH descending use pull.
>
> Weak: for RH ascending, use thrust; for RH descending, use pull, and
>
> for LH ascending, use pull; for LH descending, use thrust.

Some students may initially find it difficult to follow this rule because of the way they had practiced previously. For example, they may have learned a piece using one motion and changing it at a later time may not be worthwhile. And there are situations under which these rules should be ignored. For instance, **with the Moonlight Sonata example here, with both hands ascending or descending together, some may find it easier to play both hands thrust or both hands pull, instead of playing one thrust and the other pull.** For advanced players, the difference between strong and weak motions may be very small. For very fast play, the strong motions tend to produce better results and the weak motions are more prone to the "collapsing pinky" syndrome.

Finally, one can ask the question, "why not always play neutral — neither thrust nor pull?" Or just learn one (say thrust only), and simply become very good at it? Here again, we are reminded of the fact that there are two ways to play neutral depending on whether you approach it from the thrust side or pull side, and for a particular application, one is usually better than the other. As for the second question, note that the strong motions require both thrust and pull. Not only that, but in order to play the strong motions well, you must know how to play the weak motions. Therefore, whether you decide to use thrust or pull for a particular passage, you should always practice the other one also. That is the only way that you will know which motion is best for you. For example, **as you practice this ending of Beethoven's sonata, you should find that you make faster technical progress by practicing every cycle using both thrust and pull.** In the end, most students should end up playing very close to neutral, although a few may decide to use exaggerated thrust or pull motions. Practice this ending of the sonata by first practicing each cycle HS until you can play it comfortably and relaxed at final speed (or faster!). Remember, these are parallel sets and therefore, speed is usually not a limiting factor. Then connect two cycles, then three, etc., to gradually build up the whole ending, first HS only, and then HT.

There is much more new material to practice in this 3rd movement before we should be playing HT, so at this stage, you probably do not need to practice anything HT, except as experimentation to see what you can or cannot do. In particular, trying HT at the highest speeds will be counter productive and is not recommended. However, cycling a single cycle HT can be quite beneficial, but this also should not be over-practiced if you still cannot play it satisfactorily HS. The main difficulties in this movement are concentrated in the arps and Alberti accompaniments ("do-so-mi-so" type); once these are mastered, you have conquered 90% of this piece. For those without sufficient technical skill, you should be satisfied with getting up to vivace speed. Once you can play the entire movement comfortably at vivace, you might try to mount an effort towards presto. It is probably not a coincidence that with the 4/4 signature, presto corresponds to the rapid heart beat rate of a very excited person. Note how the LH accompaniment of bar 1 actually sounds like a beating heart.

It should be clear by now that playing arpeggios is technically very complex. **Thrust and pull also apply to scales, and the rules for scales are the same as for the arps (the strong motion is the first choice but both strong and weak should be practiced).** However, with scales, the difference between thrust and pull is more difficult to illustrate for novice players; this is why we demonstrated them using arps above. Note that **both thrust and pull become awkward when playing TU.** This is another reason for avoiding TU. In fact, **thrust and pull are very basic motions and apply to practically anything you play, including parallel sets.** Therefore, it pays to practice them well, and to think about which one you are using whenever you play anything. The complexity of arps results from the fact that you can combine thrust, pull, the cartwheel motion, TU, TO, pronation, and supination in any permutation. This is a mind boggling array of combinations. If you did not know the various components and simply let your hand pick its own movement, the chances of hitting the optimum combination is practically zero. The result is often a speed wall.

We shall now outline our plan of attack for learning this movement. We started with the most difficult part, the two-hand arp at the end. Most students will have more difficulty with the LH than the RH; therefore, once the RH is fairly comfortable, start practicing the RH arp of the first two bars of this movement, while still practicing the LH part of the ending. One important rule for playing arps rapidly is to keep the fingers near the keys as much as possible, almost touching them. Do not lift the fingers off the keys. Note that we are looking for short practice segments for both hands so that we can alternate rapidly between the two hands. Do not cycle one hand for too long because of the danger of injury. After some practice, you will be able to cycle one hand for long periods of time; however, the effects of the injury are sometimes not felt until several days later, so it is a good insurance policy to develop the habit of changing hands frequently even if you feel no fatigue or pain.

The pedal is used in only two situations in this piece: (1) at the end of bar 2, at the double staccato chord and all following similar situations, and (2) bars 165–166. The next segment to practice is the tremolo type RH section starting at bar 9. Make sure that you understand the fingering of this RH section. Then comes the LH Alberti accompaniment starting at bar 21, and similar RH parts that appear later. The Alberti accompaniment can be practiced using parallel sets, as explained starting at section 1.2.8. The next difficult segment is the RH trill of bar 30. This first trill is best performed using 3, 5 fingering and the second one requires 4, 5. For those with small hands, these trills are just as difficult as the ending, so they should be practiced from the very beginning, when you first start learning this movement. These are the basic technical requirements of this piece. If you can learn these skills, you can play the entire movement.

Start HT practice after all these technical problems are solved HS. There is no need to practice using the pedal until you start HT. Note that bars 163, 164, are played without pedal. Then application of the pedal to bars 165, 166, gives meaning to these last 2 bars. Because of the fast pace, there is a tendency to practice too loud. This is not only musically incorrect, but technically damaging. Practicing too loud can lead to fatigue and speed walls; the key to speed is relaxation. It is the *p* sections that create most of the excitement. For example, the *ff* of bar 33 is just a preparation for the following *p*, and in fact, there are very few *ff*'s in the entire movement. The whole section from bar 43 to 48 is played *p*, leading to just one bar, #50, played F. Whereas the objective during HS practice was to get up to speed (or faster) quickly, slow practice becomes paramount during HT play. Except when cycling HT, always practice HT slightly slower than your maximum speed. **You will make faster progress by practicing at a speed at which *your fingers* want to go faster, than to force the fingers to play faster than they can.** Thus the choice of practice speed for HS and HT practice is diametrically opposite: the objective is speed for HS and accuracy for HT. There is no need to push for speed HT because (if you had practiced correctly), that was already achieved HS, so that HT speed will automatically come as soon as the two hands become coordinated. In HT practice, you are working for coordination, not speed.

Finally, if you have practiced correctly, you should find certain speeds at which it is easier to play faster than slower. This is completely natural in the beginning, and is one of the best signs that you have learned the lessons of this book well. Of course, once you have become technically proficient, you should be able to play at any speed with equal ease.

1.3.5.5 Thumb: the most versatile finger, and Example of Scale/Arpeggio Practice Routine

The thumb is the most versatile finger; it lets us play scales, arpeggios, and wide chords (if you don't believe it, try playing a scale without the thumb!). Most students do not learn how to use the thumb correctly until they practice scales. Therefore it is important to practice scales as soon as possible. Repeating the C major scale over and over, or even including the B major, is not the way to practice scales. It is important to practice all the major and minor scales and arpeggios; therefore we will examine an example of a scale practice routine and point out what needs to be done and what the benefits are.

For simplicity, we will consider only the major scales here, but you should devise similar exercises for the minor scales and corresponding exercises with the arpeggios.

First, a reminder of fundamentals. Play with the tip of the thumb, not the first joint. This makes the thumb effectively as long as possible, which is needed because it is the shortest finger from the wrist joint. In order to produce a smooth scale, all the fingers need to be as similar as possible. In order to play with the tip, you may have to raise the wrist slightly. You will find the tip helpful at high speeds and for better control. Playing with the tip is absolutely necessary when playing arpeggios and chords. It is also important to cultivate the "glissando motion" in which the fingers point away from the direction of motion of the hand. Do not exaggerate the glissando motion, you only need a small amount. Play all scales TO; there is little need to practice TU. Playing with the tip also facilitates TO. Three octaves is probably an optimum span to practice, and the RH span should be one or two octaves above the LH span; in other words, choose a comfortable span for each hand. The optimum arm position is probably not perfectly perpendicular to the keyboard, but pointed slightly inwards to compensate for the fact that the pinky is short and to also help out with the TO motion. Practically all of your work will be done HS; HT is not necessary, and can waste a lot of time; HT should be considered just an interesting option to try once in a while. Those who practice scales HT all the time will develop a strong/weak hand syndrome; usually, the RH becomes stronger. The objective of these exercises is to build these motions and hand positions into your playing so that they become a permanent part of how you play anything. It is that basic. Thus these are some of the few exercises that must be repeated many times, every day, until the motions and positions are habituated so that you don't have to think about them.

There are many ways to generate all the scales, but the simplest and one of the most interesting is to use the circle of fifths. Start with C major, practice it a few times, then go up a fifth and practice G major. You will notice that it has one sharp. If you go up another fifth, you will need two sharps, etc.; with every move up a fifth, you add a sharp. Obviously, if moving up in fifths brings the span too high in the treble for comfort, go down one octave. What is interesting is that when you add a sharp, you keep all the previously used sharps; not only that, but the order in which they appear is the same as the order in which they are written on the music staff! The maximum number of sharps comes at B major (5 sharps), and the next one is 6 flats at G flat major. These flats decrease with successive fifths, again in the same orderly manner, until you return to C major. Thus the circle of fifths takes you to every scale once and only once, in an orderly way, which is what you want.

Note that the black keys provide some special benefits. They allow play with flatter fingers. You may notice a difference in the degree of control depending on whether the fingers are curled or flat. Flat fingers can provide more control because you simply lower the finger to play; with a curled finger, you have to lower the finger and uncurl it slightly, which is a more complex motion. Because the thumb never plays black keys, TO becomes particularly easy when black keys are involved. They are also narrower, requiring higher accuracy. Practice keeping the fingers on the keys; this is particularly easy when there are lots of black keys. Practice relaxation, especially with the fingers resting comfortably on the keys. With electronic pianos, it is difficult to keep the fingers on the keys without inadvertently depressing them; this is one of the advantages of acoustic pianos. Needless to say, correct technique is essential at all times; for example, pay attention to when you lift the fingers as much as when you press down on the keys, and experiment with tone, color, and any other attributes of musical play. Do not play loud; softer play requires greater control and is more beneficial. Speed is not as much an issue as whether you can produce an authoritative scale that marches along with purpose and vigor, with attention to tone, color, and musicality. When you can satisfactorily control the musicality, you will find that the speed is already there because the accuracy required for speed is less than the control required for musicality. Working for speed without musicality is a good way to start erecting speed walls because of stress build-up. However, it can be very useful to use parallel sets to double the speed once in a while to see what type of motions are needed at the next higher level of speed. It is also helpful to use your imagination to produce musical scales. For very slow scales, they might sound like a marching army. For the fastest scales, they sound like the doppler-shifted whistle of a fast train going by.

Now you can devise similar practice routines for the arps.

In summary, although most exercises are not worth using, scales and arps have a special place in piano technique acquisition. Because you can use them to learn so many fundamental technical skills, they must be part of a pianist's learning program. This section has provided a fairly complete compilation of the necessary skills.

1.3.6 Memorizing

Updated:
September 23, 2004;
sections 1, 3–7

1.3.6.1 Why Memorize?

The reasons for memorizing are so compelling that it seems silly to try to justify memorization, but let me cite just a few examples. **Advanced pianists must play from memory because of the high level of technical skill that is expected.** For practically all students (including those who consider themselves to be non-memorizers) the most difficult passages are played almost completely from memory. Non-memorizers may need the sheet music in front of them for psychological support and for small cues here and there, but in fact, they are playing difficult passages almost entirely from "hand memory" (if they are playing them well, see below). **Because of this need to play from memory, memorizing has developed into a scientific procedure that is inseparably woven into the piano study process.** Memorizing is not just repeating something until you can play without looking at the sheet music, it is a complex process of creating associations within the brain with things that you already know.

Memorizing is a way for learning new pieces quickly. In the long run, you learn technically significant pieces much faster by memorizing than by using the score. Memorizing allows the pianist to start playing from anywhere in the middle of a piece, it is a method for recovering from blackouts or flubs, and it helps to develop a better understanding of the composition. It enables "snippet playing" (playing small excerpts from a composition), a very useful ability for casual performances, teaching, and for learning to perform. When you have memorized 10 hours of repertoire, which is readily achievable, you realize the advantage of not having to carry all that music around and to search through them for your piece or snippet. If you want to jump from snippet to snippet, searching for them among a pile of sheet music would be impractical. For grand pianos, the music stand will interfere with the sound, so that you will not be able to hear yourself play if the music stand is up. This effect is especially dramatic in a concert hall or auditorium with good acoustics — the piano can become practically inaudible. But above all, memorizing let's you concentrate 100% on the music. **Piano is a performing art, and a memorized performance is more rewarding to the audience because they recognize the ability to memorize as an additional talent.** Yes, if you memorize, it is not that difficult to look like those genius artists that non-memorizers envy!

The rewards of this book accrue because it is a total package; i.e., the whole is *much* larger than the sum of its parts. Memorizing is a good example. In order to understand this, let's look at those students who do not memorize. Once a new piece is "learned", but not yet perfected, non-memorizers typically abandon the piece and go on to the next one, partly because it takes so long to learn new pieces and partly because reading the score is not conducive to performing difficult pieces. Students who do not memorize, therefore, never really learn any piece well. **Now if they were able to learn quickly and memorize at the same time, they will be making music with all their finished pieces *the rest of their lives*!** We are not just talking about memorizing or not memorizing a piece — we are talking about a *lifetime* of difference in your development as an artist, and whether you really have a chance to make music. It is the difference between a performing artist and a student who never has a performable piece. It is after you finish a piece that you can even start thinking of truly playing it musically. What a pity that students who are not properly informed miss out on the best part of what it means to be a pianist and miss out on the opportunity to develop as an artist.

Finally, memorizing is a brain exercise that must certainly benefit brain development in youth and decelerate its deterioration with age. I believe that memorizing piano music will not only improve your memory in daily life outside of piano playing but will also slow down memory loss with age and even improve the brain's capacity to memorize. At the very least, you will learn some of the methods used to improve memory and develop an understanding of the human memory function. You will become more of a "memory expert" which will give you more confidence in your ability to remember things.

I used to subscribe to the "principle of least knowledge" which posits that the less information you stuff into your brain, the better. This theory is analogous to that for disk memory in a computer: the more clutter you delete, the more memory you have left for use. I now believe that this approach breeds laziness and an inferiority complex that you are not a good memorizer, and is harmful to the brain because it is like saying that the less muscle you use, the stronger you will be because there is more energy left over. The brain has more memory capacity than anyone can jam into it in a lifetime but if you don't learn how to use it, you will never benefit from its full potential. I suffered a lot from my early mistake. I was afraid to go bowling because I could not keep score in my head like everyone else. Since I changed my philosophy so that now I try to memorize everything, life has improved dramatically. I now even try to memorize the slope and break on every golf green I play. That can have a huge effect on the golf score. Needless to say, the corresponding benefits to my piano career have been beyond description.

Memory is an associative function of the brain. Therefore it is almost diametrically opposite to the analogy with the computer memory: the more you memorize, the easier it becomes to memorize more. Good memorizers never seem to "saturate" their memory until the ravages of age take their toll. As more material is put into memory, the number of associations increases geometrically which should improve memory. Thus everything we know about memory tells us that memorizing can only benefit us.

1.3.6.2 Who can, What to, and When to, Memorize.

Anyone can learn to memorize if taught the proper methods. We show here that by combining the memorizing with the initial learning of the composition you can reduce the time required to memorize to a negligible amount. In fact, **a proper integration of the memorizing and learning procedures can reduce the time required to learn, in effect assigning a negative time to memorizing**. **It turns out that almost all of the required elements for memorizing are also the required elements for learning**. **If you separate these processes, you will end up having to go through the same procedure twice. Obviously, the best time to memorize is when you first learn the piece.**

This means that you should memorize just about every worthwhile piece you learn. Look upon memorizing as a free byproduct of the process of learning a new piece of music, simply because there is no faster way to learn.. **Thus in principle, the instructions for memorizing are trivial: simply follow the learning rules given in this book, with the additional requirement that everything you do during those learning procedures be performed from memory.** For example, while learning a LH accompaniment bar-by-bar, memorize that LH bar. Since a bar is typically 6 to 12 notes, memorizing that is trivial. Then you will need to repeat these segments 10, 100, or over 1,000 times, depending on difficulty, before you can play the piece — that is many more repetitions than needed to memorize. You can't help but memorize it!

We saw, in sections 1.1 and 1.2, that the key to learning technique quickly was to reduce the music to trivially simple subsets; those same procedures also make these subsets trivial to memorize. Memorizing can save a tremendous amount of practice time. You don't need to look for the music each time, so you can practice a Beethoven Sonata RH segment and a Chopin Scherzo LH section HS, and jump from segment to segment as you desire. You can concentrate on learning the technique without distractions from having to refer to the music every time. Best of all, the numerous repetitions you need, to practice the piece, will commit it to memory in a way that no other memorizing procedure will ever achieve, at no extra cost of time. These are some of the reasons why memorizing before you learn is the only way. Clearly, anything worth playing should be memorized.

1.3.6.3 Memorizing and Maintenance

A memorized repertoire requires two investments of time: the first is for memorizing the piece initially and a second "maintenance" component for implanting the memory more permanently and for repairing any forgotten sections. During the lifetime of a pianist, the second component should be by far the larger one. Therefore, any discussion of memorization would be incomplete without a discussion of maintenance. For example, maintenance limits the size of a repertoire because after memorizing, say, five to ten hours worth of music, the maintenance requirements may preclude memorizing any more pieces depending on the person. There are several ways to extend your repertoire beyond the maintenance limit. An obvious one is to abandon the memorized pieces and to re-memorize later as needed. It turns out that **pieces that are sufficiently well memorized can be recalled and re-polished very quickly, even if you haven't played them for years.** It is almost like riding a bicycle; once you learn how to ride a bicycle reasonably well, you never need to re-learn it again. We will discuss below several maintenance procedures that can greatly increase your memorized repertoire.

Memorize as many pieces as possible before the age of 20. Pieces learned in those early years are practically never forgotten and, even if forgotten, are most easily recalled. This is why youngsters should be encouraged to memorize all their repertoire pieces. Pieces learned after age 40 require more memorizing effort and maintenance, although many people have no trouble memorizing new pieces past age 60 (albeit more slowly than before). Note the word "learn" in the preceding sentences; they do not have to have been memorized and you can still memorize them later with better retention properties compared to pieces learned or memorized at an older age.

There certainly are times when you do not need to memorize, such as when you want to learn large numbers of easy pieces, especially accompaniments, that would take too long to memorize and maintain. If you have a 5 hour repertoire and you practice only an hour a day, it will take 5 days just to play it once! Besides, you can't do maintenance by just playing it once. Pieces that you can sight read and play well without practice are candidates for not memorizing. Clearly, pieces that are difficult, that you need to practice over and over, can be learned faster by memorizing; however, easy pieces would require a significant investment of time to memorize. By not spending time memorizing these, you can enlarge your repertoire, especially because you cut down on maintenance time. Another class of music that should not be memorized is the group of pieces that you use to practice sight reading. Sight reading is a separate skill that is treated in another section. **Everyone should have a memorized repertoire as well as a sight reading repertoire** to hone the sight reading skills.

If you can play a piece well but had not memorized it, it can be very frustrating to try to memorize it. Too many students have convinced themselves that they are poor memorizers because of this difficulty. This happens because once you can play at speed, that part of the motivation to memorize, that derives from time savings during the initial learning of the piece, is gone. The only remaining motivation is the convenience of performing from memory. A suggestion I have for those who think they are poor memorizers is to learn an entirely new piece you had never studied before by memorizing it from the beginning using the methods of this book. You may be pleasantly surprised by how good you are at memorizing. Most cases of "poor memory" result from the method of learning, not from the memory capability of the brain. Because of the importance of this topic of memorizers versus sight readers, it will be revisited at the end of this section.

1.3.6.4 Hand Memory

A large component of your initial memory will be hand memory, which comes from repeated practice. The hand just goes on playing without your really remembering each note. Although we will discuss all the known types of memory below, we will start with analyzing hand memory first because everybody experiences this type of memory first and the memorizing process becomes a process of diversification into the other methods of memory. "Hand memory" has two components: a reflex hand motion that comes from touching the keys and a reflex in the brain from the sound of the piano. Both serve as cues for your hand to move in a preprogrammed way. For simplicity, we will lump them together and call them hand memory. We show below that hand memory is not the final form of memory you want to keep. Hand memory is useful because it helps you to memorize at the same time that you practice the piece. Therefore, when you start to memorize a new piece, there is no need to consciously avoid hand memory. Once acquired, you will never lose hand memory, and we show below how to use it to recover from blackouts.

The biological mechanism by which the hands acquire hand memory is not well understood but my hypothesis is that it involves nerve cells outside the conscious brain, such as the nerve cells in the spinal chord, in addition to the brain. The number of nerve cells outside the brain is probably comparable to the number in the brain. Although the piano playing commands must originate in the brain, it is quite probable that the rapid playing reflexes do not travel all the way up to the conscious brain. **Thus hand memory must be a type of reflex that involves many types of nerve cells. In response to playing the first note, the reflex plays the second note, which stimulates the third note, etc.** This explains why, when you get stuck, hand memory will not help you restart unless you go all the way back to the first note. In fact, restarting a piece at some arbitrary place is an excellent test of whether you are playing from hand memory or you have another backup memory method. Because it is just a conditioned response, hand memory is not true memory and has several serious disadvantages.

When we talk about hand memory, we usually mean HT memory. **Because it is a memory created by hard-wired reflex nerve connections, it is one of the most dif-**

ficult memories to erase or change. This is one of the main reasons for HS practice — to avoid acquiring incorrect HT habits that will be nearly impossible to change. **Therefore, hand memory is clearly something you want to replace, once you have properly memorized, using the methods described below.**

HS memory is fundamentally different from HT memory. HS play is easier to change because it is controlled more directly from the brain. The signal simply has to go from the brain to the hand. Thus HS memory takes little time to establish, whereas HT memory takes much longer to learn, and is therefore hellishly difficult to change. In HT memory, you need some kind of feedback in order to coordinate the hands (and probably the two halves of the brain) to the accuracy needed for music. Most of this feedback is the sound from the piano, but the body probably uses tactile and reflex feedback also. This explains why HT play is so much harder than HS play, especially because it is not possible to separate technique from hand memory.

Note that it is not possible to draw a clear distinction between technique and memory. A pianist with more technique can, in general, memorize faster. One reason you cannot separate memory from technique is that both are needed to play, and unless you can play, you can demonstrate neither technique nor memory. Therefore, there is a deeper biological basis (besides mere convenience of saving time, etc.) underlying the method of this book by which memory and technique are simultaneously acquired. We are talking here about a practical matter of memorizing so you can play; simply having a photographic memory of the score does not mean that you can play it. This is why photographic memory may not be as useful a tool for memorizing as it might seem. Even those with photographic memory probably end up using hand memory, etc., when it comes to playing technically demanding material.

1.3.6.5 Starting the Memorizing Process

There is no question that the only truly effective way to memorize is to know music theory and to memorize using a detailed musical analysis and a deep understanding of the music. With this type of memory, you will be able to write down the entire score from memory. However, most students don't have such advanced training. Therefore we describe here some general procedures for memorizing that do not depend on music theory. There are two components to memorizing. One is the step-by-step procedural recipe, and the second is the basis for the memory, such as hand memory or photographic memory. We will first discuss the recipe.

Before starting to memorize, familiarize yourself with sections 1.1 and 1.2 on technique. If you had followed those methods, you should have most of the piece memorized by the time you can play it satisfactorily. Because the memorizing procedures are given in bits and pieces in different sections of this book, they are reassembled here for those specifically interested in memorizing; you will notice that the "recipe" for memorizing reads like a rehash of the learning procedures. You may also want to read section 1.3.6.10 on establishing permanent memory before studying this section; in particular, the methods described here apply best to the "keyboard memory" discussed in that section.

Start memorizing by separating the piece into easy and difficult sections. "Difficult" here means either difficult technically, or difficult for you to memorize. For example, a lot of Mozart's music is technically easy to play but often devilishly difficult to memorize well; that is, you may be able to memorize it so that you can play it during practice, but you never know when it will suddenly escape you, especially during a performance. Good methods of memorizing will help you to avoid or to recover from such incidents. **Start memorizing the most difficult passages first.** Memorize the easy sections "for fun" later, at your leisure. In general, start memorizing from the end of the music (difficult sections only), unless there is a particularly difficult section elsewhere. **You may need to memorize bar by bar. Follow the continuity rule, especially when memorizing phrases.** It is also important to follow the rule concerning slow play after each practice "session", so make sure that you know the details of that procedure. See sections 1.3.6.8 below and 1.2.17 for more details of slow play for memory enhancement. Slow play for memory enhancement is slower than slow play for technique development.

Both the difficult and easy sections are memorized most quickly and permanently by memorizing HS. Notice how much easier it is to analyze the structure and to memorize HS than HT. "Analyzing" does not mean simply decomposing the score into recognizable components — such an analysis is adequate for practice purposes and may help you to memorize short term but will not help you to remember it forever. You must *understand* the reason/purpose of the structure. For example, we saw that the G♯ is a key note in Chopin's Fantaisie Impromptu. This G♯ changes to A♭ in the slow section (which is still the same note!) because of a change in key; this understanding of the role of the G♯ makes it virtually impossible to forget how to start the piece and how to start the slow section.

Let me illustrate the importance of understanding something when you want to memorize it. Suppose that you want to memorize the Ten Commandments. It would be much easier if you memorized the meaning of the commandments than if you tried to memorize each letter of the alphabet that spells out the commandments. **Thus the knowledge of music theory can make a big difference in how quickly and how well a person can memorize.** Also, how you remember a piece depends on speed. As you play faster, you tend to remember the music at higher levels of abstraction. At very slow play, you must remember it note by note. At higher speeds, you will be thinking in terms of phrases. At even higher speeds you may be thinking in terms of relationships between phrases or entire musical concepts. These higher level concepts are usually much easier to memorize. During slow HT practice, you can concentrate on each note. Thus as you change speed, you will go through very different modes of memory.

During HS practice, you can go to very high speeds which will force the mind to view the music in a different light. Memorizing the same music from many angles is what is needed to memorize well; thus practicing at different speeds greatly helps memory. It is usually easier to memorize fast than slow. Therefore, when starting a new piece and you can only play it slowly, don't fret that you have difficulty memorizing it. As you speed it up, it usually becomes easier to memorize. Because of this effect, bringing the speed up quickly using HS practice is the quickest way to memorize.

Even if you can easily play a particular section HT, you should memorize it HS, as we will need this later on. This is one of the few instances in which memorizing and learning procedures differ. If you can play a section HT easily, there is no need to practice it HS. However, if you need to perform the piece, you must memorize it HS because you will need it for recovering from blackouts, for maintenance, etc. For example, this rule applies to a lot of Bach's and Mozart's music, which is often technically easy but difficult to memorize. Compositions from these composers are at times more difficult to memorize HS because the notes frequently make no sense when the hands are separated. That is precisely why HS memory is needed — it shows you how treacherous the music can be, unless you had worked it out HS beforehand. If you test the memory (e.g., by trying to play from somewhere in the middle), you will often find that you can not do it unless you had memorized it HS. We describe below, how to "play" the music in your mind away from the piano as part of the memorizing process; this is also much easier to do HS than HT because the mind cannot concentrate on two things at the same time. Therefore, it is almost impossible to avoid HS memorizing, even for easy sections.

Memory is an associative process; therefore there is nothing as helpful as your own ingenuity in inventing methods that help, and the more different methods you can think of, the better. So far, we saw that HT, HS and playing at very different speeds are elements you can combine in this associative process. Any music you memorize will help you memorize future pieces of music. The memory function is far more complex than what we know about it now. The complex nature of memory is the reason why intelligent people are often also good memorizers. They can quickly think of useful associations. **By memorizing HS, you add two more associative processes with much simpler organization.** Once you have memorized a page or more, break it up into logical smaller musical phrases and start playing these phrases randomly; i.e., practice the art of starting play from anywhere in the piece. If you had used the methods of this book to learn this piece, starting randomly should be easy because you learned it in small segments. **It is really exhilarating to be able to play a piece from anywhere you want and this skill never ceases to amaze the audience.**

When you memorize something, it is first stored in temporary or short-term memory. It takes 2 to 5 minutes for this memory to be transferred to long term memory (if it does at all). This has been verified innumerable times from tests on trauma victims: they can remember only up to 2 to 5 minutes before the trauma incident. After transferring to long term memory, the memory fades gradually unless there is reinforcement. If you repeat a passage many times within one minute, you are acquiring hand memory and technique, but the total memory is not reinforced proportionately to the number of repeats. **For memorizing, it is better to wait 2 to 5 minutes and to re-memorize again. This is one reason why you should memorize several things at once during a memorizing session.** Therefore, don't concentrate on just one thing for a long time, thinking that more repetitions will result in better memory.

In summary, memorize in phrases or groups of notes; never try to memorize each note. The faster you play, the easier it is to memorize because you can see the phrases and structure more easily at high speed. This is why memorizing HS is so effective. Many poor memorizers instinctively slow down and end up trying to memorize individual notes when they encounter difficulties. This is precisely the wrong thing to do. Poor memorizers can not memorize, not because their memory is not good, but because they do not know how to memorize. **The actual reason why poor memorizers can't memorize is because they get confused.** This is why memorizing HT is not a good idea; you cannot play as fast as HS and there is more material that can cause confusion. Good memorizers have methods for organizing their material so that there is no confusion. Slowing down and trying to memorize individual notes will cause the maximum amount of confusion. Memorize in terms of musical themes, how these evolve, or the skeletal structure which is embellished to produce the final music.

1.3.6.6 Reinforcing the Memory

One of the most useful memory devices is reinforcement. **A forgotten memory, when regained, is always better remembered.** Many people fret that they forget. The trick is to turn this adversity to advantage. Most people need to forget and re-memorize three or four times before anything is permanently memorized. In order to eliminate the frustrations from forgetting and to reinforce memory, try to purposely forget, for example, by not playing a piece for a week or more and then re-learning it. Or quit before you completely memorize so you must start all over again the next time. Or instead of repeating short sections (the method you used initially to memorize the piece), play the entire piece, only once a day, or several times a day but several hours apart. Find out ways of making you forget (like memorizing many things at once); try to create artificial blackouts — stop in the middle of a phrase and try to restart. These are the kinds of things you need to practice in order to perform flawlessly, and to reduce nervousness.

Memorizing new material tends to make you forget whatever you had memorized previously. This is why spending a lot of time memorizing a small section is not efficient. If you choose just the right number of things to memorize, you can use one to control the "forgetting" of the other so that you can re-memorize it for better retention. This is an example of how experienced memorizers can fine-tune their memorizing routines.

The frustration and fear of forgetting can be treated like the fear of drowning. People who cannot swim are afraid of sinking and drowning. You can often cure this fear by using psychology. First, tell them to take a deep breath and hold it, then hold them horizontally on top of the water face down, with both their face and feet in the water. Stay close to them and support them firmly so that they feel secure (use of a snorkel will help, because then, they don't have to hold their breath). Then tell them to dive underwater, and let go. They will discover that they can't dive because the body tends to float. The knowledge that they can't sink will go a long way towards alleviating their fear of drowning. Thus by trying to forget, you will discover that it is not that easy to forget, and actually be happy when you DO forget so that you can cycle the re-learning process more times to reinforce memory. **Eliminating the frustration caused by the natural process of forgetting can place your mind at ease and make it more conducive to memorizing pieces.** We now describe more methods of reinforcing/implanting memory. Of course, the most important point is that forgetting is a natural process, and we should know that most people have to forget and rememorize several times before anything is permanently memorized.

1.3.6.7 Practicing Cold

Practice playing memorized pieces "cold" (without warming up your hands); this is obviously more difficult than with warmed up hands but practicing under adverse conditions is one way of strengthening your ability to play the piece. This ability to just sit down and play cold, with an unfamiliar piano or environment, or just several times a day when you have a few extra minutes, is one of the most useful advantages of memorizing pieces. And you can do this anywhere, away from home, when your music score may not be available. You would waste a lot of time, if you had to look for printed music every time you wanted to play cold. Practicing cold prepares you to play at a gathering, etc., without having to play Hanon for 15 minutes before you can perform. Playing cold is an ability that is surprisingly easily cultivated. This is a good time to find those passages that are too difficult to play with cold hands and to practice how to slow down or simplify difficult sections. If you make a mistake or have a blackout, don't stop and backtrack, but try to keep at least the rhythm or melody and play right through the mistake.

The first few bars of even the simplest pieces are often difficult to start cold, and will require extra practice, even if it is well memorized. Often, the more technically difficult beginnings are easier to start, so don't get caught flat footed by seemingly easy music. Clearly, it is important to practice the starts of all pieces cold. Of course, don't always start from the beginning; another advantage of memorizing is that you can play little snippets from anywhere in the piece, and you should always practice playing snippets (see section 1.3.14, on "Performances and Recitals").

1.3.6.8 Slow Play

The single most important way to reinforce memory is slow play, VERY slow play, less than half speed. Slow speed is also used to reduce the dependence on hand memory and replace it with "real memory" (we will discuss true memory below) because when you play slowly, the stimulus for hand memory recall is changed and reduced. The stimulation from the piano sound is also materially altered. The biggest disadvantage of slow play is that it takes a lot of your practice time; if you can play twice as fast, you practice the piece twice as often in the same time, so why play slowly? Besides, it can get awfully boring. Why practice something you don't need when playing full speed? You really have to have a good reason to justify practicing very slowly. In order to make slow play pay off, try to combine as many things as possible into your slow play so that it does not waste time. Just playing slowly, without well defined objectives, *is* a waste of time; you must consciously seek certain benefits by knowing what they are. So let's list some of them.

1. Slow play is surprisingly beneficial to good technique, especially for practicing relaxation.

2. Slow play reinforces your memory because there is time for the playing signals to travel from your fingers to the brain and back several times before succeeding notes are played. If you only practiced at speed, you could be reinforcing hand memory and losing true memory.

3. Slow play allows you to practice getting mentally ahead of the music you are playing (next section), which gives you more control over the piece and can even allow you to anticipate impending flubs. This is the time to work on your jumps and chords (sections 1.3.7.5, 1.3.7.6). Always be at least a split second ahead and practice feeling the keys before playing to guarantee 100% accuracy.

4. Slow play is one of the best ways to purge your hands of bad habits, especially those that you might have unconsciously picked up during fast practice (FPD).

5. You now have time to analyze the details of the structure of the music as you play, and pay attention to all the expression markings. Above all, concentrate on making music.

If you combine all the above objectives, the time spent playing slowly will be truly rewarding, and keeping all these objectives going at once will be a real challenge that will leave no room for boredom. Associating all these things with the music is what good memory is all about.

The recommendation to play slowly at least once before quitting is repeated many times in this book, for technique acquisition. **For improving memory, you need to play even more slowly than the slow play for technique.**

1.3.6.9 Mental Timing

When playing from memory, you need to be mentally ahead of what you are playing at all times so that you can plan ahead, be in complete control, anticipate difficulties, and adjust to changing conditions. For example, you can often see a flub coming, and use one of the tricks discussed in this book (see section 1.3.9 on polishing a piece) to get around it. You will not be able to see a flub coming unless you are thinking ahead. One way to practice thinking ahead is to play fast, and then to slow down. By playing fast, you force the brain to think more quickly, so that when you slow down, you are now automatically ahead of the music. You cannot think ahead unless the music is well memorized, so trying to think ahead really tests and improves the memory.

The best way to play very fast, of course, is HS. This is another valuable byproduct of HS practice; you will be surprised at first, what the really fast playing will do to your brain. It is a totally new experience. Since you have to go really fast in order to beat the brain, such speeds are not easily attainable HT. In general, cultivate the ability to mentally detach yourself from those particular notes you are playing, and be able to mentally wander around elsewhere in the music, as you play a given section.

Finally, you need to get rid of the dependence on hand memory. **Each advanced pianist has a memorizing procedure tailored specifically for that person.** This might involve special practice methods such as transposing a piece or even exchanging the LH and RH parts. There may be specific procedures for every composer (you might play Mozart slowly and Bach softly) and perhaps even every piece of music; these are called *particular* rules. Most piano students do not spend sufficient time practicing and studying these methods to know the details of advanced memory procedures or particular rules. They need to start with a few *general* rules. We now examine these general rules.

1.3.6.10 Establishing Permanent Memory

Until now we discussed the memorizing procedures, but we have not discussed the basic principles upon which the memory is based. In a computer, we know that memory is stored as bits and bytes on a memory disk. What do we do for humans? Except for hand memory, most of the memory is in the brain, but what is it in the conscious brain that we consider as our memory? **There are at least five basic approaches to memory; they are: (1) hand memory, (2) music memory, (3) photographic memory, (4) keyboard memory and (5) theoretical memory.** Practically everybody uses a combination of almost all of them. However, it is a good idea to pick one of them as your most important memory principle.

We already discussed **hand memory** above. What we want to do now is to supplement it with more of the others in order to establish a more permanent and reliable memory. Although there is no need to eliminate hand memory, it should not be your most important memory principle because it is too unreliable. Any change in your environment, nervousness, or the physiology of your body can alter the hand memory.

The second is **music memory** in which the memory is based on the music, the melody, the rhythm, expression, emotion, etc. This approach works best for emotional and musical types of persons who have strong feelings associated with their music. Those with perfect pitch will also do well because they can find the notes on the piano just from the memory of the music. People who like to compose also tend to use this type of memory.

The third general approach is the use of **photographic memory.** You memorize the entire sheet music and actually picture it and read it in the mind. Even those who think that they do not have photographic memory, can achieve it if they practice photographic memory routinely as they practice the piece from the *very beginning*. Many people will find that, if they are diligent about this procedure from day one (of when they start the piece), there will be only an average of a few bars per page that are not photographically memorized by the time they can play the piece satisfactorily. One way to photographically memorize is to follow exactly the methods outlined here for technique and memory, but to also photographically memorize the sheet music at the same time, hand by hand, bar-by-bar, and section by section.

Another way to approach photographic memory is to start memorizing the general outline first, like how many lines there are in the page and how many bars per line; then the notes in each bar, then the expression markings, etc. That is, start with the gross features, and then gradually fill in the details. Start photographic memory by memorizing one hand at a time. You really need to take an accurate photograph of the page, complete with its defects and extraneous marks. If you have difficulty memorizing certain bars, draw something unusual there, such as a smiley face or your own markings that will jolt your memory. Then next time you want to recall this section, think of the smiley face first.

One advantage of photographic memorization is that you can work on it without the piano, anytime, anywhere. In fact, once acquired, you must read it in your mind, away from the piano, as often as you can until it is permanently memorized. Another advantage is that if you get stuck in the middle of playing a piece, you can easily restart by reading that section of the music in your mind. Photographic memory also allows you to read ahead as you play which helps you to think ahead. Another advantage is that it will help your sight reading.

The main disadvantage is that most people cannot retain photographic memory for long periods of time because maintenance of this type of memory usually requires more work than other methods. Another disadvantage is that picturing the music in the mind and reading it is a comparatively slow mental process that can interfere with the playing. Thus for the majority of people, the use of photographic memory as the main basis for memory is not a good idea. It is only for those who consider themselves good at photographic memory and enjoy cultivating it.

I don't consciously work for photographic memory except for the first few bars to help me get started. I nevertheless end up with considerable photographic memory in the beginning, when I am learning a new piece, because of the need to refer to the music frequently. Even for those who do not plan to acquire photographic memory, it is a good idea to keep any photographic memory you acquire; i.e., encourage it, don't throw it away. You might be surprised at how long and well it will stay with you, especially if you keep cultivating it. I don't pressure myself to memorize photographically because I know that I will end up mostly with the keyboard memory discussed below. It is amazing how you can often do something much better if there is no pressure, and I naturally acquire quite a bit of photographic memory that I end up keeping for life. I certainly wish that I had done more earlier in life because I suspect that I would have become pretty good at it.

For those who think that they do not have photographic memory, you might try the following trick. First memorize a short piece of music, with as much photographic memory as you can readily achieve, but don't worry if it is only partial. Once each section is memorized, map it back onto the score from which you learned the piece; that is, for each note you play, try to picture the corresponding note on the sheet music. Since you know each part, HS, mapping it back from the keyboard to the sheet music should be possible. Then the only thing you need to re-memorize is where the notes go on the page. You will need to look at the score from time to time to make sure that every note is in the correct position on the right page. Even the expression markings should be mapped back. Go back and forth, playing from photographic memory and mapping back from the keyboard to the sheet music until the photograph is complete. Then you can amaze your friends by writing down the score for the entire piece, starting from anywhere! Note that you will be able to write the whole music, forwards or backwards, or from anywhere in the middle, or even each hand separately. And they thought only Wolfgang could do it!

The forth type of memory is **keyboard memory.** In this method, you remember the sequence of keys and the hand motions, music, as you play. It is as if you have a piano in your mind, and can play it. Start the keyboard memory by memorizing HS, then HT. Then when you are away from the piano, play the piece in your mind, again HS first. Playing HT in your mind is not necessary, especially if you find it to be too difficult, because when you are actually playing, you can usually see only one hand at a time. When playing in your mind, away from the piano, take note of which sections you forgot, then re-memorize them the next time, or go to the music/piano and refresh your memory. You might try photographic memory on parts that you tend to forget using keyboard memory. Note that playing away from the piano is difficult not only because you have to have it memorized, but also because you don't have hand memory or the piano sound to help.

Keyboard memory has most of the advantages of photographic memory but has the added advantage that the memorized notes are piano keys instead of tadpoles on a sheet of paper; therefore, you do not have to translate from tadpoles to the keys. This allows you to play with less effort compared to photographic memory, since there is no need to go through the clumsy process of reading the music. The expression markings are not markings on paper, but mental concepts of the music (music memory). Every time you practice, the keyboard memory naturally enhances itself, another advantage over photographic memory. You can rehearse it without a piano, and you can play ahead, just as with photographic memory.

The most curious observation I noticed when I began consciously using keyboard memory was that I tended to make the same mistakes, and get stuck at the same places, as when I was actually on the piano! Upon reflection, this made sense because all mistakes originate in the brain, whether there is a piano or not. The piano never makes the mistake, I do. I mention this because it suggests that we may be able to practice and improve certain aspects of piano playing by practicing in our minds, without a piano. That would be a truly unique advantage of keyboard memory! Most of the suggestions for memorizing given in this book apply best to keyboard memory. This is another one of its advantages.

For those who are practicing sight singing and absolute pitch (sections 1.3.11 and 1.3.12 below), playing in the mind will be a great help in further develop-

ing those skills. The keyboard method visualizes the keyboard, which also helps in finding the right key for absolute pitch. Therefore, those interested in using this method of memory might also consider practicing sight singing and absolute pitch, since they are already partly there. This is a prime example of how learning one skill (memorizing) helps you to learn many others. Doubtless, this is one of the ways by which the geniuses got to be what they are/were.

Finally, we must all strive to use as much **theoretical memory** as possible. This includes such things as key signature, time signature, chord transitions, harmony, etc. True memory cannot be established without an understanding of the theoretical basis for that particular composition. Unfortunately, most piano students do not receive sufficient theory training to perform such an analysis. However, this analysis can be replaced with a structural analysis that can serve a similar purpose. Every composition has structure: usually a beginning, a body, and an end. The main theme is usually introduced in the beginning and developed in the body, leading to a climax at the end. This structural analysis will reveal various components of the composition and how they combine to create the music.

1.3.6.11 Maintenance

Many of the methods used for polishing a finished piece are applicable to memory maintenance. **One obvious maintenance chore is the restoration of forgotten sections.** If you have forgotten a section, you might practice using hand memory to recover from these to see if this method (use of hand memory) works for you. In order to encourage hand memory, play louder and slightly faster. For me, using hand memory to recover during a performance does not work sufficiently reliably to make it worth while; therefore, I use it for recovery only during practice, when I am too lazy to search for the music score. The best preparation for recovery from flubs during a performance is HS practice, as discussed below. Maintenance time is a good time to revisit the score and check your accuracy, both for the individual notes and the expression marks.

Another maintenance chore is to make sure that you still remember it HS. This can become a real chore for major pieces, but is worth it, because you don't want to find out that you need it during a performance. Note that these HS maintenance sessions are not just for memory. This is the time to try new things, playing much faster than final speed, and generally cleaning up your technique. Extended HT playing often introduces timing and other unexpected errors and this is the time to fix them. **Therefore, playing HS for both memory and technique enhancement is a very worthwhile endeavor.** This is one of the best times to use a metronome to check the accuracy of the rhythm and timing, for both HS and HT play.

The most effective memory maintenance procedure is playing the piece in your mind, away from the piano. Those with photographic memory should picture the whole score. Those with keyboard memory will actually play the piano in your mind. This is useful when you are first learning the piece as well as for later maintenance. Therefore, as soon as you start to learn a piece, make it a habit to play it in your mind whenever you can find time, in bed, before falling asleep, or when you wake up in the morning, etc. This also serves as a true test of whether you have really memorized it and are not playing from hand memory. As with memorization, for most people, it is too late to start "playing in your mind" if you can already play the piece (with the help of the score). If you play in your mind from the beginning, it becomes an easy, almost natural procedure, and is not as difficult as you might think at first.

With a little practice, you will be able to play in your mind at blinding speed, so it does not have to be a time consuming chore. Also, playing it fast in your mind will actually help you play faster on the piano.

What is important for good memory is that you should not abandon "playing in your mind" after you have completely memorized the piece. You only need to do this once in a while to maintain it, so it should not be such a time consuming job.

An excellent test of true memory is to try to play the piece starting at any arbitrary place. Most pianists will not be able to start just anywhere, such as in the middle of a phrase, but you should try to find as many good starting points as possible. These are usually the beginnings of the short segments you used to learn the piece. After you have broken a composition into these phrases, try playing it backwards, starting with the last phrase and working towards the beginning. When you do this, you will often discover many interesting structural relationships that you had not noticed before.

I hope the reader will get the message that memorizing a substantial repertoire (5 to 10 hrs), and playing them is far, far, more rewarding than wasting time on finger exercises such as Hanon. If those students who perform a lot of exercises used that same time to build up a repertoire instead, they can end up with quite an extensive repertoire and even improve their technique and performance capability. Students who over-exercise are usually not good performers. One obvious cure is to put more emphasis on memory and performance.

Maintenance is also required after you memorize a new piece, because memorizing new pieces makes you forget old pieces. Thus, after you have gotten a new piece under your belt, go back over the old pieces to see if they are still OK. In this way, you can identify certain compositions, such as Bach's and Mozart's music, that might require more maintenance than others. This knowledge can alleviate a lot of frustration. Without this knowledge, a person noticing that s/he had forgotten some older pieces after memorizing a new piece might wonder if something happened to her/is memory. Don't worry — this is a common, natural phenomenon.

You should find that compositions memorized using the methods of this book are much better memorized than those that were learned using the intuitive methods, no matter how many years you had been playing them. If you want to improve the memory quality of those old pieces (that you had learned using intuitive methods), you will have to go back and re-learn them HS, etc. This is quite rewarding from the points of view of finding mistakes, improving the technique, and improving the memory. For difficult compositions, there is no choice but to relearn both hands HS, but for simpler pieces, you might be able to get away with just learning one hand, usually the more difficult one which is generally the RH.

In summary, maintenance has the following components:

1. Check with the music score for accuracy of every note and expression.
2. Make sure you can play the entire piece HS. You might practice HS very fast for polishing the technique.
3. Practice starting at arbitrary places in the piece. This is an excellent way to test the memory and your understanding of the structure of the composition.
4. Play slowly; there is no better way to enhance memory.
5. Play "cold". It will greatly strengthen your performance capability.

6. Play "in your mind", at least HS. If you start this from the beginning when you first learned the piece, and maintain it, this is surprisingly easy. And the resulting benefits are really worthwhile.

7. For upcoming recitals, follow the detailed recital preparation routine discussed in section 1.3.14.

1.3.6.12 Sight Readers versus Memorizers: Learning Bach's Inventions

Many good sight readers and good memorizers are good at one but not the other. This problem arises because good sight readers initially find little need to memorize and enjoy sight reading, so that they end up practicing sight reading at the expense of memorizing. The more they sight read, the less memory they need, and the less they memorize, the worse memorizers they become, with the result that one day they wake up and conclude that they are unable to memorize. Of course, there are naturally talented readers who have genuine memory problems, but these comprise a negligibly small minority. Therefore, the difficulty of memorizing arises principally because of a psychological mental block. Good memorizers can experience the reverse problem; they can't sight read. But most memorizers became non-readers because they are so good at playing from memory or by ear that they never gave themselves a chance to practice reading. However, this is not a symmetric problem because practically all advanced pianists know how to memorize, which indicates that **poor memorizers also had the misfortune of never having been taught how to memorize and to acquire difficult technique quickly; that is, the technical level of poor memorizers is generally lower than that of good memorizers.**

"Sight reading" is used loosely in this section to mean true sight reading as well as practicing music with the help of the score. The distinction between sight reading a piece one had never seen and a piece that had been played before is not important here. In the interest of brevity, that distinction will be left to the context of the sentence.

Memorizing, like sight reading or piano technique, requires not only a knowledge of how to memorize but also a minimum dedicated regimen of practice. **It is more important to be able to memorize than to sight read because you can survive as a pianist without good sight reading ability, but you can't become an advanced pianist without the ability to memorize.**

Memorizing is not easy for the average pianist who was not trained in memory. Sight readers who cannot memorize face an even more difficult problem. Therefore, **poor memorizers who wish to acquire a memorized repertoire must do so by starting with a mental attitude that this is going to be a long term project with numerous obstacles to overcome.** As shown above, the solution, in principle, is simple — make it a practice to memorize everything *before* you learn the piece. In practice, the temptation to learn quickly by reading the score is often too irresistible. This tendency to rely on reading is the main reason why sight readers become poor memorizers, not their lack of memorizing ability.

The most difficult problem encountered by sight readers is the psychological problem of motivation. **For these good readers, memorizing seems like a waste of time because they can quickly learn to play many pieces reasonably well by reading.** They might even be able to play difficult pieces by using hand memory, and if they have a blackout, they can always refer back to the music in front of them. Therefore, they can manage without memorizing. After years of practicing piano this way, it becomes very difficult to learn how to memorize because the mind has become dependent on the score. Difficult pieces are impossible under this system, so they are avoided in favor of a large number of easier compositions. With this awareness of potential difficulties, let's try to work through a typical program for learning how to memorize.

The best way to start is to memorize a few short pieces. These should be new pieces you had never practiced before. Once you successfully memorize a few pieces without too much effort, you can start building up your confidence and improving the memorizing skills. When these skills are sufficiently developed, you might even think of memorizing old pieces you had learned by reading.

A "short" piece means something between 2 and 4 pages. Such a piece can be started from the beginning, progressing section by section till the end. **Start by analyzing the structure of the piece.** Good readers have an advantage here because they are familiar with phrases and series of notes that appear frequently together and are therefore good at analyzing the microstructures. Memorize phrase by phrase, as described above (HS, continuity rule, etc.). As each successive phrase is memorized, play them from memory only. As soon as you memorize one phrase, never look at the music again for this phrase unless you have to. This is, of course, the entire basis of the method. Don't worry if you can't play it satisfactorily, just memorize it first.

Memorize the entire piece HS before even thinking of HT. Start HT only after you are very comfortable HS for the entire piece. Work in short phrases of 2 to 10 bars. Begin every practice session with HS play, and then switch to HT until you become comfortable HT. Memorizing becomes easier the faster you play. You will also need to practice HT very slowly. The important thing is to vary the speed. If you start to get confused HT, go back to HS, don't keep struggling with HT. You will find that playing HS very fast (but within your control and relaxation limits) is a lot of fun, good for technique, and helps your memory. If, after memorizing a long section (by memorizing short sub-sections), you start to get confused when trying to play the entire section, don't keep trying to memorize it! Start all over again by memorizing it in short sections.

When I decide to memorize, I concentrate only on memorizing, and spend time on other practice only when I get tired of memorizing and need a break. This is because playing other materials between memory sessions will make me forget whatever I had recently memorized. Newly memorized material is extremely fragile. Thus my piano sessions are either memorizing sessions or practice sessions. During practice sessions, I almost never need the score. Even during memorizing sessions, I use the score only in the beginning and then put it away as soon as I can.

Suppose that the piece is 3 pages long; for simpler pieces, you can memorize all 3 pages HS the first day. By the end of a week, you should be able to play HT reasonably well without looking at the score. See example below. By the second week, you should be practicing the piece HT most of the time. That's it, you are done!

Up to here, we discussed memorizing new pieces. **Memorizing a piece you can already play by reading is not easier and can be quite frustrating, but the method is the same.** Since you will not be repeating each section as many times as you would when practicing a new piece, a newly memorized old piece will never be memorized as well as a new piece memorized when you first learned it. You may discover that the fact, that it is already partly memorized, doesn't help very much. You will not become as frustrated if you go into it knowing that memorizing a piece you can already play usually requires more motivation and mental effort than a new piece. Therefore, my suggestion is, don't start memorizing all your old pieces using this method, but begin with new ones, and to start work on your old ones after you have learned the memorizing methods. In this way, you can compare the results of pieces that were properly memorized from the beginning with your old pieces that were newly memorized. You should find that you can play new pieces that were memorized correctly much better than old pieces that were memorized after you were able to play them.

As an example of short pieces to memorize, let's learn three of Bach's 2-part Inventions. I will lead you through one of them, and you should try the other two by yourself. Three of the easiest ones are #1, #8, and #13. I will go through #8 with you. After learning #8, try #1 yourself and then start on #13. The idea is to learn all three simultaneously, but if that proves too taxing, try two only (#8 and #1), or even just #8. It is important that you try only what you think you can comfortably handle; that is why I am giving you these three choices. The schedule given below is for learning all three at once. We are assuming that you have learned the material of sections 1.1 to 1.3, and that your technical level is such that you are ready to tackle the Bach Inventions.

Bach's Invention #8, day one. Start by memorizing bars 2 to 4 of the LH, including the first two notes (conjunction) of bar 5. It should take less than a minute to memorize; then start playing it at speed. Then do the same for the RH, bars 1 to 4, including the first 4 notes of bar 5. Now return to the LH and see if you can play it without the score, and similarly with the RH. If you can, you should never have to refer to this part of the score again, unless you have a blackout, which will happen once in a while. Go back and forth between the LH and RH until you are comfortable. This should take only a few minutes more. Let's say that this whole procedure takes 5 minutes. A fast learner will need less time.

Now learn bars 5 to 7, including the first 2 notes of the LH and the first 4 notes of the RH in bar 8. This should be completed in about 4 minutes. These are all HS practices; we will not start HT until we finish memorizing the whole piece HS. Once you are comfortable, connect bars 1–7, including the conjunctions in bar 8. It may take another 3 minutes to do both hands.

Next memorize bars 8–11, and add them to the previous sections. Let's assign another 8 minutes to this part, for a total of 20 minutes to memorize bars 1–11 and to bring them up to speed, HS. If you have technical difficulties with some parts, don't worry about it, we will work on that later. You are not expected to play anything to perfection at this time.

Next, we will abandon bars 1–11 (don't even worry about trying to remember them), and work on bars 12–23 only. Break this section up into the following segments (the conjunctions should be obvious): 12–15, 16–19, and 19–23. Note that bar 19 overlaps because this provides extra time to practice the more difficult 4th finger in the LH. Work only on bars 12–23 until you can play them all in succession, HS. This should take another 20 minutes or so.

Then finish off bars 24 to end (34). These might be learned using the following segments: 24–25, 26–29, and 30–end (34). This may require another 20 minutes, for a total of 1hr to memorize the whole thing. You can now either quit and continue tomorrow, or review each of the three segments. The important thing here is not to worry about whether you will remember all this tomorrow (you probably won't), but to have fun, maybe even trying to connect the three sections or to put the beginning parts HT to see how far you can go. Work on parts that give you technical problems when you try to speed them up. Practice these technical workouts in as small segments as you can; this frequently means two-note parallel sets. That is, practice only the notes you can't play satisfactorily. The total time spent on the first day is 1 hour.

Day two: review each of the three sections, then connect them. You might need the sheet music in some places. Then put the music score away — you should never need them again except for emergencies and to double check the accuracy during maintenance. The only requirement on the 2nd day is to be able to play the whole piece HS from beginning to end. Concentrate on bringing up the speed, and go as fast as you can without making mistakes. Practice relaxation. If you start to make mistakes, slow down and cycle the speed up and down. Note that it may be easier to memorize playing fast, and you might get memory lapses playing very slowly, so practice at different speeds. Don't be afraid to play fast, but make sure that you balance this with sufficient intermediate speed and slow play.

If you are completely comfortable HS on the 2nd day, you might start HT, using the same small segments used to learn HS. However, the only requirement on day 2 is to be able to play the entire piece HS from memory. The first note of bar 3 is a collision of the two hands, so use only the LH and skip the RH for this one note, and similarly in bar 18. Play softly, even where "*f*" is indicated, so that you can accentuate the beat notes to synchronize the two hands. Don't worry if you are slightly tense in the beginning, but concentrate on relaxing as soon as possible.

Moderate speed is often the easiest speed to play from memory because you can use the rhythm to keep you going and you can remember the music in phrases instead of individual notes. Therefore, pay attention to the rhythm from the very beginning. Now slow down and work on accuracy. To prevent the slow play from speeding up, concentrate each individual note. Repeat this fast-slow speed cycle and you should improve noticeably with each cycle. The main objectives are to completely memorize it HS and to speed up the HS play as much as possible. Wherever you have technical difficulties, use the parallel set exercises to develop technique quickly. You should not need more than 1 hour.

Day three: learn HT in the three major sections as you did with HS. As soon as you notice confusion setting in HT, go back to HS to clear things up. This is also a good time to further increase the speed HS, up to about two times final speed if possible (more on how to do this later). Of course, those with insufficient technical skill will have to play slower. Keep in mind the reminder that relaxation is more important than speed. You will obviously be playing much faster HS than HT, and practically all attempts at increasing speed should be conducted HS. Since the hands are not yet completely coordinated, you should have some memory lapses and it may be difficult to play HT without mistakes unless you play slowly. From here on, you will have to depend on the slower post practice improvement to gain any major improvement. However, in 3 hours over 3 days, you have basically memorized the piece and can play, perhaps haltingly, HT.

Now start on the second piece, #1, while you polish up the first piece. Practice the two pieces alternately. Work on #1 until you start to forget #8, then go back and refresh #8 and work on it until you start to forget #1. Remember that you *want* to forget a little so that you can relearn, which is what is needed to establish long term memory. For psychological reasons, it is best to use these types of "win-win" programs: if you forget, that is exactly what you were looking for; if you can't forget, that's even better! This type of program will also give you a measure of how much you can/cannot memorize in a given amount of time. Of course, this is only the beginning. Youngsters should find that the amount you can memorize at one time increases rapidly as you gain experience and add more memorizing tricks. This is because you have a run-away situation in which the faster you memorize, the faster you can play, and the faster you play, the easier it becomes to memorize. Increased confidence also plays a major role. Ultimately, the main limiting factor will be your technical skill level, not the memorizing ability. If you have sufficient technique, you will be playing at speed in a few days. If you can't, that just means that you need more technique. It does not mean that you are a poor memorizer.

Day four: There is not much you can do to rush the first piece technically after two or three days. For several days, start practicing #8 by playing HS, then HT, at different speeds according to your whim of the moment. As soon as you feel ready, practice HT, but return to HS if you start making mistakes, have memory lapses HT, or if you have technical problems getting up to speed. Practice playing the piece HT in segments, jumping from segment to segment at random throughout the piece. Try starting with the last small segment and work backwards to the beginning.

Some parts will be easier while others will give you trouble. Isolate the trouble spots and practice them separately. Since you originally learned in segments, this should be easy. Most people have a weaker LH, so bringing the LH up to two times final speed may present problems. For example, the last four notes of the LH in bar 4, 4234(5), where (5) is the conjunction, may be difficult to play fast. In that case, break it up into three parallel sets (there are many more ways to do this): 42, 423, and 2345 and practice them using the parallel set exercises. First bring them up to nearly infinite speed (almost a chord) and then learn to relax at those speeds, playing in rapid quads (see section 1.3.7.2). 423 is not a parallel set, so you may have to play it slower than the others. Then gradually slow down to develop finger independence. Then join the parallel sets in pairs and, finally, string them all together. This is actual technique enhancement and therefore will not happen over-night. You may see little improvement during practice, but you should feel a distinct improvement the next day, and a lot of improvement after a few weeks. On the first day of technique enhancement, the only things you can really work on are relaxation and very fast parallel set exercises.

As soon as you can play the whole piece HS, it is important to start playing the piece at least HS in your mind, away from the piano. When you can play it HT, you might try playing HT in your mind, but the only requirement is to be able to play it HS. Don't stop until you can play the whole piece in your mind HS. This should take a day or two. If you don't complete this task now, for most people, you never will. But if you succeed, it may become a very powerful memory tool for you. You should be able to quickly learn to play it very fast in your mind; this will exercise your brain, foster true memory, and save time.

Some time around day 5 or 6, you should be able to start piece #13 so that you can subsequently practice all three pieces every day. However, if this is too taxing, learn only two pieces. After all, the plan here is to achieve easy success in memorizing a short piece so as to build confidence. **Therefore do not try anything that you feel is difficult.** In fact, another approach is to learn only piece #8 well first, then after you have gone through the entire procedure so that you are familiar with it, start #1 and #13. The main reason for learning several pieces at once is that these pieces are so short that you will be playing too many repetitions in one day if you only practiced one. Remember, from day one, you will be playing at speed, and from day two, you should be playing at least some sections faster than final speed (HS). Also, it is more efficient to learn three at once. That is, it takes longer to learn these three one at a time than three together.

Beyond day two or three, how fast you progress will depend more on your skill level than memory ability. Once you can play the entire piece HS at will, you should consider the piece memorized. This is because, if you are above about intermediate level, you will be able to play it HT very quickly, whereas if you are not that advanced, the technical difficulties in each hand will slow the progress. Memory is not the limiting factor. For HT work, you will obviously have to work with coordinating the two hands. With Bach's music, it is particularly difficult (and necessary) to coordinate the two hands and yet play them independently.

Finally, a very important point concerning technique versus memory: as noted above, once memorized, how well you can play from memory depends on your level of technique as well as how well you have memorized the score. **It is vitally important not to confuse lack of technique with the inability to memorize.** Therefore, at this point, you will need a method for both testing your technique to see if it is sufficient, and for developing technique if it is insufficient. That test starts with HS play. If your technique is sufficient, you should be able to play very comfortably, relaxed and perfectly, at about 1.5 times final speed, HS. For #8, the speed is about MM = 100 on the metronome, so you should be able to play both hands at over 150 HS at a minimum, and perhaps up to 200. At 150, you got Glenn Gould beat (albeit HS)! If you cannot do 150 HS, then you must further develop technique before you can expect to play HT at anything close to 100.

Assuming that you encounter technical problems, let's concentrate on practicing HS. Most people have a weaker LH, so the difficulty will probably be in the LH. Bring the LH technique up as close to the RH level as possible. As illustrated above for bar 4 of the LH, use the parallel set exercises to work on technique. **All technique development work is done HS because with HT you cannot play sufficiently fast, or pay sufficient attention to detail, as you can HS.** Bach is particularly useful for balancing the LH and RH techniques because both hands play similar passages. Therefore, you know immediately that the LH is weaker if it cannot get up to the same speed as the RH for Bach. For other composers, such as Chopin, the LH is sometimes much easier and does not provide a good LH test. Students with inadequate technique may need to work HS for weeks before they can hope to play these inventions HT at speed. In that case, just play HT at comfortably slow tempos and wait for your HS technique to develop before speeding up HT. HS practice is also the best time to change the fingering to fit your playing ability. Once you "lock in" the playing HT, it will be much more difficult to change fingerings.

All three pieces discussed above should be completely memorized in one to two weeks and you should begin to feel comfortable with at least the first piece. Let's say that for two weeks, all you did was to concentrate on memorizing these three pieces. You can play them HT, completely from memory, although they may not be perfect. Now if you go back to old pieces that were memorized previously, you will probably find that you don't remember them as well any more. This is a good time to re-polish them and to alternate this maintenance chore with further polishing of your new Bach pieces. You are basically done. Congratulations!

Bach's music is notoriously difficult to play fast, and is highly susceptible to FPD (fast play degradation, see section 1.2.25). The intuitive solution to this problem has been to patiently practice slowly so that your hands don't get tangled up and stressed, possibly creating permanent problems. You don't have to play very fast to suffer FPD with many of Bach's compositions. If your maximum speed is MM = 50, whereas the suggested speed is 100, then for you, 50 is fast and at that speed, FPD can rear its ugly head. This is why playing slowly HT and trying to speed it up will only generate more confusion and FPD. Those who use the methods of this book already know that the better solution is to use HS practice. You will be amazed at how quickly you can speed up play using HS practice, especially when practicing small segments. For those who had never done this before, you will soon be playing at speeds you never dreamed possible.

Quiet hands. Many teachers justifiably stress “quiet hands” as a desirable objective. **In this mode, the fingers do most of the playing, with the hands moving very little. Quiet hands is the litmus test for demonstrating that you have acquired the technique necessary to play that passage.** The elimination of unnecessary motions not only allows faster play, but also increases control. Many of Bach’s music are particularly suited for practicing quiet hands, almost certainly by design. Some of the unexpected fingerings indicated on the music score were chosen so as to be compatible with, or facilitate, quiet hands play. Some teachers impose quiet hand playing on all students at all times, even for beginners, but I think that such an approach is counter-productive. When playing slowly, or if the student does not have sufficient technique, some extra motion is allowable, and may even be appropriate. Those who already have quiet hands technique can add a lot of extra motion without detriment when playing slowly (or fast). Quiet hands cannot be felt when playing slowly so that teaching “slow quiet hands” to a student teaches her/im nothing, and the student can become completely confused. Only when playing beyond a certain speed does quiet hands become obvious to the pianist, and in fact, necessary. When you acquire quiet hands for the first time, it is absolutely unmistakable, so don’t worry about missing it. When playing sufficiently fast so that you can feel the quiet hands, is the best time to teach the student what quiet hands means, not when playing slowly or when the student still doesn’t have the necessary technique, because without experiencing quiet hands the student has no idea what to do. Once you have this technique, you can then apply it to slow play; you should now feel that you have much more control and a lot more free time between notes. Thus quiet hands is not any specific motion of the hand but a feeling of control and the near total absence of speed walls.

In the case of the Bach pieces discussed here, the quiet hands become necessary at speeds close to final speed. Thus without quiet hands, you will start to hit speed walls at the recommended speeds. HS practice is important for quiet hands because it is much easier to acquire and feel it in your hands when played HS, and because HS play allows you to get to quiet hands speed more quickly than HT. In fact, it is best not to start HT until you can play in the quiet hands mode because this will reduce the chances of locking in bad habits. That is, HT with or without quiet hands is different, so that you don’t want to get into the habit of playing HT without quiet hands. Those with insufficient technique may take too long a time to attain quiet hands, so that such students may have to start HT without quiet hands; they can then gradually acquire quiet hands at a later time, by using more HS practice. This explains why those with sufficient technique can learn these inventions so much faster than those without. Such difficulties are some of the reasons for not trying to learn pieces that are too difficult for you, and provide useful tests for whether the composition is too difficult or appropriate for your skill level. Those with insufficient technique will certainly risk building up speed walls. Although some people claim that the Bach Inventions can be played “at any speed”, that is true only for their musical content; these compositions need to be played at their recommended speeds in order to take full advantage of the piano lessons that Bach had in mind.

For those with stronger RHs, quiet hands will come first with the RH; once you know the feel, you can transfer it to the LH more quickly. Once it kicks in, you will suddenly find that you can play fast much easier. Parallel set exercises can help you to transition into quiet hands quickly, but you must be careful not to use phase locked parallel sets — that is a false form of quiet hands and the hands will move a lot. In true quiet hands play, you have independent control over each finger, while the hands stay relatively motionless.

Bach clearly wrote these Inventions (and many others) with technical development in mind. Thus he gave both hands equally difficult material; in fact this provides more challenges for the LH because the bass hammers and strings are heavier. Bach would have been mortified to see exercises such as the Hanon series because he knew that exercises without music would be a waste of time, as demonstrated by the effort he put into these compositions to incorporate music. Practicing piano without music would be like practicing golf without a golf ball. The amount of technical material he crammed into these compositions is incredible: finger independence (quiet hands, control, speed), coordination as well as independence of the two hands (multiple voices, staccato vs. legato, colliding hands, ornaments), harmony, making music, strengthening the LH as well as the weaker fingers (fingers 4 and 5), all major parallel sets, uses of the thumb, standard fingerings, etc. Note that the ornamentals are excellent parallel set exercises and are not just musical ornaments but are an integral part of technical development. Using the ornaments, Bach asks you to practice parallel sets with one hand while simultaneously playing another part with the other hand, and producing music with this combination!

Be careful not to play Bach too loud, even where F is indicated. Instruments of his time produced much less sound than modern pianos so that Bach had to write music that is filled with sound, and with few breaks. One of the purposes of the numerous ornaments used in Bach's time was to fill in the sound. Thus his music tends to have too much sound if played loudly on modern pianos. Especially with Inventions and Sinfonias, in which the student is trying to bring out all the competing melodies, there is a tendency to play each succeeding melody louder, ending up in loud music. The different melodies must compete on the basis of musical concept, not loudness. Playing more softly will also help to achieve total relaxation and true finger independence.

If you want to learn one of the Sinfonias (3 part Inventions), you might try #15 which is easier than most of the others. It is very interesting, and has a section in the middle where the two hands collide and play many of the same notes. As with all Bach compositions, this one contains a lot more than first meets the eye, so approach it with care. First of all, it is allegro vivace! The time signature is a strange 9/16, which means that the groups of six 1/32 notes in bar 3 must be played as 3 beats, not 2 (three pairs of notes instead of two triplets). This time signature results in the three repeat notes (there are two in bar 3) that have thematic value and they march across the keyboard in characteristic Bach fashion. When the two hands collide in bar 28, raise the RH and slide the LH under it, both hands playing all the notes. If the thumb collision is problematic, you might eliminate the RH thumb and play only the LH thumb. In bar 36, be sure to use the correct RH fingering: (5), (2, 3), (1, 4), (3, 5), (1, 4), (2, 3).

Finally, let's discuss the last necessary step in memorizing — analyzing the structure, or the "story", behind the music. The memorizing process will be incomplete until you understand the story behind the music. We shall use Invention #8. The first 11 bars comprise the "exposition". Here, the RH and LH play basically the same thing, with the LH delayed by one bar, and the main theme is introduced. The "body" consists of bars 12 to 28, where the roles of the two hands are initially reversed, with the LH leading the RH, followed by some intriguing developments. The ending starts at bar 29 and brings the piece to an orderly finish, with the RH reasserting its original role. Note that the ending is the same as the end of the exposition. Beethoven further developed this device of ending a piece multiple times and raised it to incredible heights.

With this basic structure complete, you can start adding refinements. For example, a majority of bars require a staccato in one hand and legato in the other. Once you have analyzed these structures, practice playing each component separately. Then practice playing each in your mind, filling in more refinements as you memorize more details.

We now present some explanations for why developing such a "story" is the best and perhaps the only reliable way to memorize a composition permanently. I believe that is the way in which practically every great musician memorized music.

1.3.6.13 Human Memory Function

The memory function of the brain is only incompletely understood. **All research indicates that there is no such thing as "photographic memory" in the strict sense of the phrase**, though I have used this terminology in this book. **All memory is apparently associative.** Thus when we visually "memorize" a Monet painting, we are actually associating the subjects of the painting with something deeper in our memory, not just a two dimensional picture composed of so many pixels. This is why great paintings or unusual photographs are easier to remember than similar images of lesser significance. How about photographic memory of the music score? It is easy to prove that this, too, is totally associative — in this case, associated with music. If you ask a musician with "photographic" memory to memorize a full page of random music notes, he cannot, although he may have no trouble memorizing an entire sonata quickly. This is why there is no better way to memorize music than from the standpoint of music theory. All you have to do is to associate the music with the theory and you have it memorized. In other words, when humans memorize something, they don't store the data bits in the brain like a computer, but they associate the data with a basic framework or "algorithm" consisting of familiar things in the brain. In this example, music theory is the framework. Of course, a good memorizer (who may not be a musician) can develop methods for memorizing even a random sequence of notes by devising an appropriate algorithm, as we now explain.

The best evidence for the associative nature of human memory comes from tests on good memorizers who can perform incredible feats such as memorizing hundreds of telephone numbers in a phone book, etc. There are numerous memory contests in which good memorizers compete. It turns out that none of them memorize photographically, although the end result is almost indistinguishable from photographic memory. When queried as to how they memorize, it turns out that they all use associative algorithms. The algorithm is different with each individual, but they are all devices for associating the objects to be memorized with something that has a pattern that they can remember.

The amazing thing is the speed with which they can map the object to be memorized onto their algorithm, even for random numbers. It also turns out that these good memorizers are not born that way, although they may be born with mental capabilities that can lead to good memory. **Memorizers develop after much hard work in perfecting their algorithms and practicing every day, just like pianists.**

This "hard work" comes effortlessly because they enjoy it.

For example, if you want to remember the sequence of 14 numbers 53031791389634, you might use the following algorithm. "I woke up at 5:30 AM with my 3 brothers and 1 grandmother; the ages of my brothers are 7, 9, and 13, and my grandmother is 89 years old, and we went to bed at 6:34 PM." This is an algorithm based on life's experience, which makes the random numbers "meaningful". What is so intriguing is that the algorithm contains 38 words, yet it is much easier to remember than the 14 numbers. In fact, you have just memorized 132 letters and numbers with greater ease than the 14 numbers! You can easily test this for yourself. First memorize both the 14 numbers (if you can — it is not easy for me) and the above algorithm. 24 hours later, try to write down the numbers from memory and from the algorithm; you will find the algorithm to be much easier and more accurate. Good memorizers have all devised incredibly efficient algorithms and have cultivated the habit of rapidly transferring any memory job onto their algorithms. You can do a similar thing with piano music by analyzing the structural story of the composition.

It is now possible to understand how memorizers can memorize many pages of phone numbers. They simply end up with a story, instead of a single sentence. Note that a 90 year old man may not be able to memorize a 10 digit number, yet he can sit down and tell you stories for hours or even days. And he doesn't have to be any kind of memory specialist to do this.

So then, what is it about associations that actually enable us to do something we otherwise cannot do? Perhaps the simplest way to describe this is to say that associations enable us to *understand* the subject to be memorized. This is a very useful definition because it can help anyone to do better in school, or in any learning endeavor. If you really understand physics or math or chemistry, you don't need to memorize it, because you can't forget it. This might seem pointless because we just shifted our question from "what is memory?" to "what is association?" and then to "what is understanding?". It is not pointless if we can define *understanding*: it is a mental process of associating a new object with other objects (the more the better!) that are already familiar to you. That is, the new object now becomes "meaningful". This explains why knowledge of music theory is the best way to memorize. Music theory is the perfect algorithm for this purpose because theory helps you to understand the music.

It also explains why keyboard memory works: you associate the music with the particular motions and keys that must be played to create the music. This also tells us how to optimize keyboard memory. Clearly, it is a mistake to try to remember each keystroke; we should think in terms of things like "RH arpeggio starting from C, which is repeated in the LH an octave down, staccato, with happy feeling", etc., and to associate these motions with the resulting music and its structure. You should make as many associations as possible: Bach's music may have certain characteristics, such as special ornaments and colliding hands. What you are doing is making the action of playing "meaningful" in terms of how the music is produced and how the music fits into your mental universe. This is why practicing scales and arpeggios is so important. When you encounter a run of 30 notes, you can remember it simply as a section of a scale, instead of 30 notes to memorize.

This also tells us that learning perfect pitch or at least relative pitch will be very helpful for memory because they can provide many more associations. **These discussions suggest that your memory should improve as you memorize more, and remove much of the mystery from why good memorizers are so good.**

1.3.6.14 A Simple Method for Becoming a Good Memorizer

It is clear, from all of the above, that you cannot become a good memorizer without practice. The good news is that practically anyone can become a good memorizer. Most students have enough desire to memorize and therefore are willing to practice; yet many fail. Do we know why they fail, and is there a simple solution to the problem? Fortunately, the answer is a resounding yes!

The main cause for the failure to memorize is the fear of forgetting. Most of us instinctively try to retain in our brains what we try to memorize — which sounds like a logical thing to do but is in fact, the worst thing to do because it creates a nagging fear of forgetting that prevents us from mental relaxation. The constant presence of this fear and the pressure to retain everything in memory make the memorizing process difficult and unpleasant. We must realize that memory is a natural process that occurs whether we like it or not, and that creating a mental attitude that we must retain what we memorize does not make us memorize better; in fact, it hinders us. This is easy to prove by observing that good memorizers memorize effortlessly, and the only difference is that they have no fear of memorizing. This situation is analogous to that of swimmers and non-swimmers. Non-swimmers fear water, contract all their muscles tightly, which pushes all the air out of the lungs, they become heavier than water, and sink. On the other hand, young kids with no fear of water will jump in and, after a few tries, are having fun swimming.

Here, I describe a two step formula for learning to memorize. The first step is to convince ourselves that we must forget in order to properly memorize. As a working rule, let's say that we never really memorize anything well unless we have forgotten it three times. For example, in memorizing the Bach inventions above, we broke the compositions into small "memorizable" chunks and worked on each one before proceeding to the next. The rule we tried to follow there was that, once one chunk was memorized, we had to play that chunk from memory, never to look at the music again. For those who consider themselves poor memorizers, that rule would create the fear of forgetting, and there is the likelihood that they might give up at that point. This leads to the second step, in which we realize that it is not a crime to forget, that some forgetting is a natural process (just as some memorizing is also natural), and that we can proceed to the next chunk without worrying about making sure that we have completely memorized the first chunk. Thus the two step process consists of (1) learning that forgetting is OK (we will try to forget 3 times before committing to memory), and then (2) practicing memorizing with complete mental relaxation and with no fear of forgetting; in fact, we would like to forget 3 times.

The original rule to memorize one chunk completely and never to look at the music again and the two step memory process are contradictory. You can not let the two step process allow you to try to memorize too many chunks at once, and forgetting them all too many times. First of all, there is an optimum number of 2 to 4 chunks that you can use in the two step process. Secondly, the objective of the two step process is that it is a method for learning how to memorize, how to relax mentally, and how to eliminate the pressure and fear of memorizing, so that you will eventually be able to follow the original rule of learning one chunk completely the first time. However, there is nothing wrong if you find that the two step process is most comfortable for you and you apply it to all your memory work. Typically, those who are not good memorizers cannot memorize anything the first day — each chunk may take several days to properly memorize. The two step process gives you the option of working on several chunks at once. You turn the corner when you lose the fear of forgetting and start to mentally relax and enjoy the memory process; that is when your journey to becoming a good memorizer starts. Obviously, for this to work, you must adopt the policy of memorizing every significant composition that you learn.

1.3.6.15 Summary

To memorize, simply use the rules for learning, with the added proviso that you memorize everything *before* you start to practice the piece. In this way, you are forced to practice from memory. It is this repetition during practice, from memory, that automatically implants the memory with little additional effort compared to the effort needed to learn the piece. The most important element is HS memorization. When you memorize something beyond a certain point, you will almost never forget it. Conversely, if you don't get it to that point, there really isn't any point to memorizing, since you will eventually lose it. The only way to maintain a memorized piece is to never go back to sight reading again. HS play is also the main element in memory maintenance. You should have two repertoires; a memorized one, and another for sight reading. Proper memorizing brings with it a whole new wonderful world of musical capabilities such as playing a piece from anywhere in the middle or playing it in your mind. Memorizing is necessary for learning a piece quickly and well, playing with expression, acquiring difficult technique, performing, etc. A memorized repertoire will give you the confidence that you are a "real" pianist. Many of those miraculous feats that Mozart is fabled to have performed are actually within reach of most of us.

1.3.7 Exercises

1.3.7.1 Introduction : Intrinsic, Limbering, and Conditioning Exercises

Updated: July 11, 2004

Most published finger exercises are not useful because of an overwhelming number of disadvantages [see see section 1.3.7.8]. One objection is that they waste a lot of time. If you are exercising so that you can play difficult pieces, why not spend the time practicing the difficult pieces instead of the exercises? Another objection is that most exercises are too repetitious, requiring no musical input so that you can play them with your musical brain turned off which, according to any knowledgeable piano teacher, is the worst way to practice piano. **Mindless practice is harmful** because exercises are supposed to increase stamina — however, since most of us have plenty of physical stamina to play but insufficient brain stamina, mindless repetitive exercises can actually decrease our total musical stamina. If the students are not carefully guided, they will practice these repetitions mechanically and give piano practice the reputation as a punishment for anyone unfortunate enough to have to listen to it. It is one way to create closet pianists who can practice only when no one is listening because they never practiced making music. Some accomplished musicians use such repetitive exercises for warming up, etc., but this habit arose as a result of early training and concert pianists do not need them for their practice sessions.

Instead of these harmful exercises, I discuss here a whole different class of exercises that help you to diagnose your technical deficiencies, to acquire the technique needed to correct these deficiencies, and to play musically. In section 1.3.7.2 I discuss the exercises for acquiring technique, especially velocity. Section 1.3.7.3 discusses when/how to use them. In sections 1.3.7.4 to 1.3.7.7, I discuss other useful exercises. I have assembled most of the objections against the Hanon type exercises in section 1.3.7.8. Historically, the Hanon type repetitive exercises became widely accepted because of several misconceptions: (i) that you can acquire technique by learning a limited number of simple exercises, (ii) that music and technique can be learned separately, and (iii) that technique requires mostly muscular development without brain development. Such exercises became popular with many teachers because, if they worked, the students could be taught technique with little effort from the teachers! This is not the fault of those teachers because these misconceptions were passed down through the generations, involving such famous teachers as Czerny, Hanon, and many others. The reality is that piano pedagogy is a challenging, time-consuming, knowledge-based profession.

Before we discuss specific exercises, we must understand the different categories of exercises and what they do for us.

If we define technique simply as the ability to play, then it has at least three components. It has an intrinsic technique component, which is simply your skill level. Having the skill, however, doesn't mean you can play. For example, if you haven't played for several days and the fingers are frozen cold, you probably won't be able to play anything satisfactorily. So there is the second component of the degree to which the fingers are "limbered up". There is also a third component, which will be called "conditioning" here. For example, if you had been chopping down huge trees for a week, or you had done nothing but knit sweaters for days, the hands may not be in a good condition to play the piano. The hands have physically adapted to a different job. On the other hand, if you had practiced at least three hours every day for months, your hands will do things that will astound even you. Conditioning involves the entire body and probably the brain in a major way, so that it should not be called "hand conditioning" although hands are obviously the most important parts involved.

Exercises can contribute to all three components of technique (intrinsic, warm-up, and conditioning) and students often confuse warm-up or other ineffective exercises with intrinsic technique acquisition. This confusion arises because practically any exercise can contribute to warm-up and conditioning, but the students can easily mistake these for intrinsic improvement if they are not aware of the three components. This mistake can be detrimental if, as a result of spending too much effort on exercises, the students do not learn all the other, more important, ways of developing intrinsic technique. Knowledge about the components of technique is also important when preparing for recitals because, in that case, you need to ask: what are the best ways to warm up and condition the hands?

The intrinsic skill level and limbering up or warming up of the hands are easy to understand, but conditioning is very complex. The most important factors controlling conditioning are the length and frequency of practice and the state of the brain/nerve/muscle system. **In order to keep the hands in their best playing condition, most people will need to practice every day.** Skip a few days of practice, and the conditioning will deteriorate markedly. Thus, **although it was remarked elsewhere that practicing a minimum of three days a week can yield significant progress, this will clearly not result in the best conditioning.** Conditioning is a much larger effect than some people realize. Advanced pianists are always acutely aware of conditioning because it affects their ability to play musically. It is probably associated with physiological changes such as dilation of blood vessels and the accumulation of certain chemicals at specific locations of the nerve/muscle system. This conditioning factor becomes more important as your skill level rises and as you begin to deal routinely with the higher musical concepts such as color or bringing out the characteristics of different composers. Needless to say, it becomes critical when playing technically demanding material. Thus each pianist must be conscious of conditioning in order to know what can be played or practiced at a particular time.

A more elusive factor that affects conditioning is the state of the brain/nerve system. **Thus for no obvious reason, you can have "good" days and "bad" days.** This is probably analogous to the "slumps" that afflict athletes. In fact you can have "bad days" for extended periods of time. With the awareness of this phenomenon and experimentation, this factor can be controlled to some extent. Just the awareness that such a factor exists can help a student better cope psychologically with those "bad" days. Professional athletes, such as golfers, and those who practice meditation, etc., have long known the importance of mental conditioning. Knowing the common causes of such bad days would be even more helpful. The most common cause is FPD, which was discussed near the end of section 1.2.25. Another common cause is deviation from fundamentals: accuracy, timing, rhythm, correct execution of expressions, etc. Playing too fast, or with too much expression, can be detrimental to conditioning. Possible cures are to listen to a good recording, or enlist the help of a metronome or to revisit the music score. **Playing a composition slowly once before quitting is one of the most effective preventive measures against inexplicable "bad playing" of that composition later on.** Thus conditioning depends not only on how frequently you practice, but also on what and how you practice.

We shall see below that parallel set exercises are useful for developing intrinsic skills, scales and arpeggios are useful for warm-ups, and practically any playing can help conditioning.

1.3.7.2 Parallel Set Exercises for Intrinsic Technical Development

The main objective of exercises is technique acquisition which, for all intents and purposes, boils down to speed, control, and tone. For exercises to be useful, you must be able to identify your weaknesses and use these exercises to strengthen those skills. In order to accomplish this, **we must have a complete set of exercises, and they must be arranged in some logical order so that you can easily locate an exercise that addresses a particular need.** Such an exercise must therefore be based on some basic principle of piano playing that covers all aspects. Also, how do we *identify* our specific weaknesses? Just the fact that you can't play something doesn't tell you why or how to solve the problem.

I propose that the concept of parallel play provides the framework for devising a universal set of exercises for technical development. This is because any arbitrary musical passage can be constructed from combinations of parallel sets (groups of notes that can be played infinitely fast). I describe below a complete set of parallel set exercises that satisfies all the requirements. See section 1.2.11 for an introductory discussion of parallel sets. Of course, parallel sets alone do not comprise a complete set of exercises; conjunctions, repetitions, jumps, stretching, etc., are also needed. These issues are also addressed below. Apparently, Louis Plaidy taught exercises resembling parallel set exercises in the late 1800s.

All the parallel set exercises are HS exercises, so change hands frequently. However, you can practice them HT at any time, and in any compatible combination, even 2 notes against 3, etc. In fact these exercises may be the best way to practice such incommensurate RH-LH combinations. At first, just try a few of each exercise, then read section 1.3.7.3 on how to use them. This is because, if expanded, there will be an infinite number (as they should be, if they are complete), so you will never practice them all. You will never need all of them either, and probably over half are redundant. Use these exercises only when you need them (you will need them *all the time!)*, so that the only requirement at this point is that you become sufficiently familiar with them so that you can instantly call upon a specific, required exercise when the need arises. Therefore, you never waste time doing unnecessary exercises.

Parallel set exercises diagnose your weaknesses as well as build your technique. This means that you first use them to test your technique. **If you are a beginner with no technique, you should fail all of them.** They will all be basically impossible to play at the required speeds. Most students would initially have no idea how to play them correctly. It would be very helpful if you can get someone to demonstrate a few for you if you had never done them before. Intermediate students with 2 to 5 years of lessons should be able to play about half of them satisfactorily. Thus these exercises provide a means for measuring your progress. This is total technique development and therefore involves tone control and musical playing, as will be explained shortly. Advanced students will still need them but, unlike developing students, they will need them only briefly, often for just a few seconds of practice.

Exercise #1. This exercise establishes the basic motion that is needed for all following exercises. **Play just one note**, for example, finger 1, e.g. thumb of RH, as four repetitions: 1111. In this exercise, we are not yet practicing any parallel sets; we are just learning how to repeat them rapidly so that we can save time by playing as many parallel sets as possible in a short time. The "parallel set" we are using here is the trivial set consisting of just one note. Another reason for this exercise is that the ability to play a parallel set rapidly for an indefinite amount of time is the best test that you have acquired the skill to play it.

You can play the 1111 as quadruplets of equal strength, or as units of a 4/4 or a 2/4 measure. **The idea is to play them as fast as you can, up to speeds of over one quad per second.** When you can play a quad to your satisfaction, try two: 1111, 1111. The comma represents a pause of any arbitrary length, which should be shortened as you progress. When you can do two, string four quads in rapid succession: 1111, 1111, 1111, 1111. You "pass" this exercise at about one quad per second, 4 quads in succession, with no rest between quads. Play them softly, completely relaxed, and not staccato, as explained in more detail below. You pass when you can play the quads as long and as fast you want, with complete control and without fatigue. This seemingly trivial motion is much more important than appears at first sight because it is the basis for all velocity motions, as will become apparent when we come to parallel sets involving many fingers such as those in fast alberti accompaniments. That is why we devote so many paragraphs below to this exercise. These paragraphs describe the methods for acquiring critical skills for advanced technique.

If stress builds up as you string these quads together, work on this until you can play 4 quads rapidly stress free. Note that every part of your body must be involved: fingers, hand, arm, shoulder, etc., not just the fingers. This does not mean that every part of your body must move by a visible amount — they may appear stationary, but must participate. A large part of the "involvement" will be conscious relaxation because the brain tends to use too many muscles for even the simplest tasks. Try to isolate only the necessary muscles for the motion and relax all others. The final motion may give the appearance that only the finger is moving. From more than several feet away, few people will notice a 1 mm movement; if each part of your body moved less than one mm, the sum of those motions can easily add up to the several mm needed for the key drop, even without finger movement. Therefore, experiment with different positions of your hand, wrists, etc., for optimum play.

As your speed increases, the fingers/hands/arms will automatically go into positions that are ideal; otherwise, you will not be able to play at those speeds. These positions will resemble those you see of famous pianists playing at a concert — after all, that is why they can play it. Therefore it is important, when attending concerts, to bring your opera glass and watch the details of the motions of professional pianists. The importance of hand/body positions/motions will be particularly true of the more advanced exercises given below, so begin *now* to train yourself to identify these improvements. There may be several motions that work; many suggestions are given below. Try them all; the more, the better.

Beginners, in their first year, will not be able to play at one quad per second and should be satisfied with slower speeds. Do not force yourself to practice at speeds you cannot handle. However, periodic, brief, excursions into your fastest playing are necessary for exploration purposes. Even students with over five years of lessons will find parts of these exercises difficult. In order to save time, you might practice exercise #1 for a while, then practice both #1 and #2 (below) simultaneously. This is because #2 uses the same motion as in #1. Since #2 is so simple, you can combine it with #1 without running into difficulties.

Practice until all stress disappears and you can feel gravity pulling your arm down. As soon as stress builds up, your sense of the gravitational pull will disappear. Don't try too many quads at once if you don't feel that you have complete control. Don't force yourself to keep practicing with stress because playing with stress can become a habit before you realize it. If you keep practicing with stress, you will actually start to slow down. This is a clear sign that you must either slow down or change hands. The material of sections 1.1 and 1.2 should have given you plenty of weapons for attacking this speed/stress problem. Get one quad down very well before adding another one — you will progress faster that way than by rushing many quads at once. The reason for stopping at four quads is that, once you can do four, you can usually do any number in succession. However, exactly how many you need, before you can play an indefinite number in succession, depends on the individual. Therefore, you should test yourself frequently. If, after stringing two quads together, you can then play the quads indefinitely at any speed you want, then you have passed the test for Exercise #1, and you never have to practice it again in your life. These exercises are completely different from the Hanon exercises that you must repeat every day; once you pass, you move on to something more difficult — that is progress!

For the first few days of practice, you should feel some improvements during practice because you are rapidly learning new motions and eliminating wrong ones. In order to make further progress, you will need to use the post practice improvement (PPI), because you are now causing nerve growth throughout your body and brain. Instead of pushing for speed *during* practice, wait for the hand to automatically develop quickness so that you play faster the *next time* you practice; this can happen when you switch hands, or when you practice again the next day. **After the first week or two, most of the quickness will develop between practices, not during practice**; therefore if you don't seem to improve very much even after a hard workout, don't be discouraged — this is normal. Later stages of PPI will develop mostly after a good night's sleep. Most nerve growth seems to occur during sleep, when the body's resources are not needed for daytime activities. Over-practicing, in an attempt to achieve some visible improvement during practice, is one of the major causes of injury, stress, and bad habits. **Your task during practice is to condition your hand for maximum PPI.** Conditioning requires only a certain number of repetitions (generally in the neighborhood of a hundred quads, which takes only a few minutes); beyond that, your gain per repetition declines.

This is technique acquisition, not muscle building. **Technique means making music and these exercises are valuable for developing musical playing.** Do not bang away, like a jack hammer. If you can't control the tone of one note, how can you control it with more? One key trick in controlling tone is to practice softly. By playing softly you get yourself out of the mode of practice in which you totally ignore the nature of the sound and bang away, just trying to achieve the repetitions. Press down on the key completely and hold it down momentarily (very short — a fraction of a second). This ensures that the back check grabs the hammer and stops the oscillations that the hammer picks up when it bounces off the strings. If these oscillations are not eliminated, you cannot control the next strike. **Read section 1.3.4.2 on flat finger playing; this is mandatory reading before you do any serious parallel set exercises.**

In order to increase speed and accuracy, and to control the tone, **keep the playing finger near the key as much as possible.** If the finger does not touch the key once in a while, you lose control. Do not rest the fingers on the keys all the time, but touch the keys as lightly as you can so that you know where they are. This will give you an added feel for where all the other keys are, and when it comes time to play them, your fingers will not hit the wrong notes because you know exactly where they are. **Determine the minimum key lift needed for repetition and practice playing with as little key lift as possible.** The key lift is generally larger for uprights than grands. You can achieve faster speeds with smaller key lifts. When all parts of your entire body: fingers, palm, wrist, arm, shoulder, back and abdomen, etc., are coordinated, each part just has to move a millimeter or less to result in sufficient motion for playing, since all you need to do is lift the key 3 or 4 mm.

The wrist is important in the repetition motion. The wrist governs all three goals we are seeking: speed, control, and tone. Remember, "getting the wrist involved" does not mean an exaggerated wrist motion; its motion may be imperceptible, because it is the momentum, not the motion of the wrist, that you need.

Instead of always working on speed, work on control and tone. Repetitions practiced for control and tone count equally towards conditioning for speed. Both control and velocity require the same skill — accuracy. In fact, fast practice under stress will condition you for stressful playing, which will actually slow down the motion.

You must investigate and perform experiments all the time. If you keep your fingertip in one spot, or if you slide it over the key, will you get a different tone? Practice sliding your finger forwards (towards the piano) and backwards (towards your body). The thumb may be the easiest finger to slide. **Play with the tip of the thumb, not the joint;** this will enable you to slide the thumb and to raise your hand, thus reducing the chances of the other fingers accidentally hitting some keys. Playing with the tip also increases the effective range and speed of the thumb movement; that is, for the same thumb movement, the tip moves farther and faster than the joint. Knowing how to slide the fingers will free you to play with confidence regardless of whether the keys are slippery or if they get wet from perspiration. **Do not develop a dependence on the friction of the key surface for you to be able to play.** Playing with a raised wrist will cause the fingers to slide towards you as you press down. If you lower the wrist, the fingers will tend to slide away from you, especially for fingers 2–5. Practice each of these sliding motions: practice all five fingers with the wrist up for a while; then repeat with the wrist down. At an intermediate wrist height, the fingers will not slide, even if the keys are slippery!

Experiment with controlling the tone using some intentional sliding. Sliding increases control because you are creating a small key drop using a larger motion. The result is that any errors in the motion will be decreased by the ratio of key drop to total motion, which is always less than one. Therefore, you can play more uniform quads by sliding than by coming straight down. You can also play softer. Sliding also simplifies the finger motion because the finger does not have to come straight down — any motion with a downward component will do, which increases your options.

Repeat with all the other fingers. Students who do this exercise for the first time should find that some fingers (typically, 4 and 5) are harder than the others. This is an example of how to use these exercises as a diagnostic tool to find the weak fingers.

The idea here, obviously, is to acquire the skill to play as many repeats for as long as you wish at any desired speed. Only one finger is exercised because this is technique acquisition; in normal playing, repetitions are generally played by changing fingers. Repetition is the basic motion for practicing any parallel set. It is essential for acquiring parallel set skills quickly, as further explained in section 1.3.7.3 below. **Fast repetition is what enables you to practice parallel sets quickly with a minimum of wasted time.** Thus exercise #1 is not just an exercise in itself, but something that you will need in all of the following exercises.

If you encounter difficulties in exercises #1 to #4, those difficulties should be easy to solve with the methods of sections 1.1 to 1.3. You should be able to pass each one after a few weeks of practice. Since you can work on quite a few at a time, the whole set from exercise #1 to #4 should not take more than a few months to bring up to speed, for students with over two years of lessons, although this will naturally depend on your skill level. As mentioned above, **do not try to practice until you "pass" all of them** because there are too many and you will have ample opportunity to practice them while learning new compositions. Relaxation, control, and tone are more important than speed. Try to make the best piano sound that you can achieve — a sound that will make a passer-by say, "*That*'s the sound of a piano!" even if you are playing just one repeated note.

Obviously, the piano must be capable of producing such sound, and must be properly voiced, as explained in section 1.3.14 (performances and recitals) and section 2.7.1. The voicing of the piano is critical to proper execution of these exercises, both for acquiring new skills more quickly and for avoiding non-musical playing. This is because it is impossible to produce soft (or powerful, or deep) musical tones with worn hammers that need voicing.

Exercise #2. The **2-finger parallel set exercises:** play 12 (thumb followed by 2 of the RH on CD) as fast as you can, like a grace note. The idea is to play them rapidly, but under complete control. Obviously, the methods of sections 1.1 and 1.2 will needed here. For example, if the RH can do one exercise easily, but a related exercise is difficult for the LH, use the RH to teach the LH. Practice with the beat on the 1 as well as with the beat on the 2. When that is satisfactory, play one quad as in exercise #1: 12, 12, 12, 12. If you have difficulty with accelerating a 12 parallel set quad, play the two notes together as a "chord" and practice the chord quad just as you did the single note quad in exercise #1. Again, bring the quad up to speed, about a quad per second. Then string 4 quads in succession. Repeat the entire exercise with each of 23, 34 and 45. Then come down: 54, 43, etc. **All the comments about how to practice for exercise #1 apply.**

All the notes in a parallel set must be played as rapidly as possible because parallel sets are used mainly for developing velocity. The purpose of the parallel sets is to teach the brain the concept of extreme velocity, up to almost infinity. It turns out that once the brain gets used to a certain maximum velocity, all slower velocities become easier to execute.

In this and subsequent exercises, the comments in preceding exercises almost always apply to succeeding exercises and will not be repeated. Also, I will list only representative members of a family of exercises and leave it to the reader to figure out all the other members of the family. The total number of exercises is much larger than you would initially think. Furthermore, if you tried to combine different parallel set exercises HT, the number of possibilities quickly becomes mind boggling. For beginners who have difficulty playing HT, these exercises may provide the best way to practice HT play.

Perform all the exercises initially using only the white keys. Once all the white key exercises are done, work on similar exercises including the black keys.

The objective here is not to do all of the exercises, but to get some idea of all the possible exercises, to identify those that give you difficulty, and then to work on them. **These are not exercises you play to limber up your fingers; these are exercises for acquiring technique when the need arises.** Thus, once you can do them satisfactorily, you don't need to come back to them again unless you encounter a new situation that requires even more improvement.

In the beginning, you may be able to play the 2 notes in succession very fast, but without much independent control. You can initially "cheat" and increase speed by "phase-locking" the two fingers, e.g., holding the two fingers in a fixed position (locked phase) and simply lowering the hand to play the two notes. Recall that the phase angle is the delay between successive fingers in parallel play. Eventually, you must play with finger independence. The initial phase locking is used only to get up to speed quickly. **This is one reason why some teachers do not teach parallel play, because they think that parallel play means phase locking, which will destroy the music.** After practicing for a while with locked phase, the fingers should become more and more independent, freeing you to create music. Thus the simple ability to play parallel sets fast isn't sufficient. **After you get up to speed, keep practicing until you can feel the independent control of each finger.** The best way to achieve this is to slow down gradually, as explained in the next paragraph.

Once you can play the (2-finger) four quads very rapidly, test the finger independence by continually slowing down to see if you have difficulties at some intermediate speed. If you encounter difficulties at slower speeds, there is something wrong. Initially, the cause is usually phase locking. You have not yet gained finger independence. It may also be an indication that you have some residual stress. Therefore, practice at different speeds.

Exercise #3. Larger parallel sets: e.g., 123 and its family, 234, etc. Repeat all of the procedures as in exercise #2. Then work with the 1234 group, and finally, the 12345 sets. With these large sets, you may have to slow down the quad repetition speed slightly. **The number of possible exercises for these larger sets is very large.** The beat can be on any note and you can start on any note. For example, 123 can be practiced as 231 and 312. When coming down, the 321 can be played 213 or 132; — all six are distinct because you will find that some are easy but some are very difficult. If you include the beat variations, there are 18 exercises for just three fingers on white keys.

Exercise #4. Expanded parallel sets: start with the 2-note sets 13, 24, etc. (the 3rds group). These sets also include the 14 (fourths), and 15 (fifth and octave), type groups. Then there are the 3-note expanded parallel sets: 125, 135, 145 (fifth and octave) groups. Here, you may have several choices for the middle note of the three.

Exercise #5. The compound parallel sets: 1.3, 2.4, where 1.3 represents a chord, i.e., CE played simultaneously. Then do the 1.4, 2.5 group. I have often found sets that are easy going up but difficult coming down, or vice versa. For example, 1.3, 2.4 is easier for me than 2.4, 1.3. **These compound sets will require quite a bit of skill.** Unless you have had at least several years of lessons, do not expect to be able to play these with any proficiency.

This is the end of the repetitive quad exercises based on exercise #1. In principle, Exercises #1 to #5 are the only exercises you need because they can be used to construct the parallel sets we discuss below. Exercises #6 and #7 are too complex to be repeated in rapid quads.

Exercise #6. Complex parallel sets: these are best practiced individually instead of as rapid quads. In most cases, they should be broken up into simpler parallel sets that can be practiced as quads; at least, initially. “Alternating sets” are of the type 1324, and “mixed sets” are of the type 1342, 13452, etc., mixtures of alternating and normal sets. Clearly, there is a large number of these. **Most of the complex parallel sets that are technically important can be found in Bach’s lesson pieces, especially his 2-part Inventions.** This is why Bach’s lesson pieces (by contrast to Hanon) are some of the best practice pieces for acquiring technique

Exercise #7. Now practice **connected parallel sets**; e.g., 1212, that contain one or more conjunctions. This can be either a trill (CDCD) or a run (CDEF, where you must use thumb-over). The 1212 trill is different from exercise #2 because in that exercise, the 12 interval must be played as fast as possible, but the subsequent 21 interval can be slower. Here, the intervals between notes must always be the same. Now these sets cannot be played infinitely fast because the speed is limited by your ability to connect the parallel sets. The objective here is still speed — how fast you can play them accurately and relaxed, and how many of them you can string together. This is an exercise for learning how to play conjunctions. Play as many notes as possible during one motion of the hand. For example, practice playing 1212 in one down motion of the hand. Then practice playing two of them in one down motion, etc., until you can do 4 in succession in one motion.

For fast play, the first two notes are the most important; they must start at the correct speed. It might help to phase lock just the first two notes to make sure that they start correctly. Once the first two notes are started at a fast speed, the rest tends to follow more easily.

For sets containing the thumb, use the thumb-over method for connecting them except for special situations when the thumb-under is needed (very few). Explore various connection motions to see which ones work best. A small flick of the wrist is one useful motion. For connecting sets not involving the thumb you almost always cross over, not under. However, many of these non-thumb crossovers are of questionable value because you seldom need them.

Connected parallel sets are the main practice elements in Bach's 2-part Inventions Therefore, look into these Inventions for some of the most inventive and technically important connected parallel sets. As explained in section 1.3.19.3, it is often impossible for many students to memorize certain Bach compositions and to play them beyond a certain speed. This has limited the popularity of playing Bach, and limited the use of this most valuable resource for acquiring technique. However, when analyzed in terms of parallel sets and practiced according to the methods of this book, such compositions usually become quite simple to learn. Therefore, this book should greatly increase the popularity of playing Bach. See section 1.3.19.3 for more explanations on how to practice Bach.

The nearly infinite number of parallel set exercises needed demonstrates how woefully inadequate the older exercises are (e.g., Hanon — I will use Hanon as a generic representative of what is considered the "wrong" type of exercise here). There is one advantage of the Hanon type exercises, however, which is that they start with the most commonly encountered fingerings and the easiest exercises; i.e., they are nicely prioritized. However, chances are nearly 100% that they will be of little help when you hit a difficult passage in an arbitrary piece of music. The parallel set concept allows us to identify the simplest possible series of exercises that form a more complete set that will apply to practically anything that you might encounter. As soon as these exercises become slightly complex, their number becomes unmanageably large. By the time you get to the complexity of even the simplest Hanon exercise, the number of possible parallel set exercises becomes intractably large. Even Hanon recognized this inadequacy and suggested variations such as practicing the exercises in all possible transpositions. This certainly helps, but still lacks whole categories such as Exercise #1 and #2 (the most fundamental and useful ones), or the incredible speeds we can readily achieve with parallel set exercises. **Note that exercises #1 to #4 form a complete set of purely parallel (without conjunction) exercises. Nothing is missing.** Intervals larger than what one can reach as a chord are missing from the list of parallel sets described here because they cannot be played infinitely fast and must be classified as jumps. Methods for practicing jumps are discussed in section 1.3.7.6 below.

It is easy to bring Hanon up to ridiculous speeds by using the methods of this book. You might try that just for the fun of it, but you will quickly find yourself asking, "What am I doing this for?" Even those ridiculous speeds cannot approach what you can readily achieve with parallel sets because every Hanon exercise contains at least one conjunction and therefore cannot be played infinitely fast. **This is clearly the biggest advantage of parallel set exercises: there is no speed limit in theory as well as in practice, and therefore allows you to explore speed in its entire range without any limitations and without any stress.** As noted earlier, the Hanon series is arranged in increasing order of difficulty, and this increase is created mainly by the inclusion of more conjunctions and more difficult parallel sets. In the parallel set exercises, these individual "difficulty elements" are explicitly separated out so that you can practice them individually.

As one illustration of the usefulness of these exercises, suppose that you want to practice a four-finger compound trill based on exercise #5 (e.g., C.E, D.F, C.E, D.F, ...). By following the exercises in order from #1 to #7, you now have a step-by-step recipe for diagnosing your difficulties and acquiring this skill. First, make sure that your

2-note chords are even by applying exercises #1 and #2. Then try 1.3, 2 and then 1.3, 4. When these are satisfactory, try 1.3, 2.4. Then work on the reverse: 2.4, 1 and 2.4, 3, and finally 2.4, 1.3. The rest should be obvious if you have read this far. These can be rough workouts, so remember to change hands frequently, before fatigue sets in.

It is re-emphasized here that there is no place in the methods of this book for mindless repetitive exercises. Such exercises have another insidious disadvantage. Many pianists use them to "limber up" and get into great playing condition. This can give the wrong impression that the wonderful playing condition was a consequence of the mindless exercises. It is not; the limbered up playing condition is the same regardless of how you got there. Therefore, you can avoid the pitfalls of mindless exercises by using more beneficial ways of limbering up. Sales are useful for loosening the fingers and arpeggios are useful for loosening the wrists.

1.3.7.3 How To Use The Parallel Set Exercises

Parallel set exercises are not intended to replace the Hanon, Czerny, etc., or any type of exercises. The philosophy of this book is that time can be better spent practicing "real" music than "exercise" music. The parallel set exercises were introduced because there is no known faster way to acquire technique. Thus, technical pieces like Liszt's and Chopin's etudes or Bach's Inventions are not "exercise music" in this sense. **The parallel set exercises are to be used in the following way:**

1. **For diagnostic purposes:** by going through these exercises systematically, you can find many of your strengths and weaknesses. More importantly, when you arrive at a passage you cannot play, they provide a method for finding out exactly why you can't play it. In hindsight, it seems obvious that if you are trying to improve some technical aspect you will need a good diagnostic tool. Otherwise it will be like going to a hospital for an operation without knowing what malady you have. According to this medical analogy, practicing Hanon is somewhat analogous to going to the hospital to get the same simple, routine checkups every day. The diagnostic capability of parallel sets is most useful when practicing a difficult passage. It helps you to pinpoint which fingers are weak, slow, uncoordinated, etc.

2. **For acquiring technique:** the weaknesses found in (1) can now be corrected using precisely the same exercises used to diagnose them. You simply work on the exercises that revealed the problems. In principle, these exercises never end, because the upper limit of speed is open ended. However, in all practicality, they end at speeds of around one quad per second because few, if any, music requires higher speeds. In most cases, you can't use these high speeds once you add even one conjunction. This demonstrates the beauty of these exercises in allowing you to practice speeds that are faster than what you will need, thus giving you that extra margin of safety and control. You should be using these exercises most during HS practice, as you bring the speed up beyond final speed.

Procedures (1) and (2) are all you need to solve most problems in playing difficult material. Once you have successfully applied them to several previously "impossible" situations, you will gain the confidence that nothing is unconquerable, within reason.

As an example, consider one of the most difficult passages of the third movement of Beethoven's Appassionata, bar 63, the LH accompaniment to the climactic RH run, and similar, ensuing passages. If you listen to recordings carefully, you will find that even the most famous pianists have difficulty with this LH and tend to start it slowly and then accelerate it, or even simplify the score. This accompaniment consists of the compound parallel sets 2.3, 1.5 and 1.5, 2.3, where 1.5 is an octave. Acquiring the required technique simply boils down to perfecting these parallel sets and then joining them. For most people, one of the above two parallel sets will be difficult, and that is the one you need to conquer. Trying to learn this by just playing it slowly and accelerating it HT would take much longer to learn. In fact, simple repetition brings no guarantee that you will ever succeed, because it becomes a race between success and building a speed wall, if you try to speed it up. You must practice HS and change hands frequently to avoid stress and fatigue. You also need to practice it softly in the beginning in order to learn to relax. Without parallel sets, there is a high probability that you will develop stressful habits and create a speed wall. Once the speed wall is erected, you can practice all your life without improvement.

Another cause of the speed wall is "forced playing". It is easy to bring most of the rest of this movement up to speed, so there is the tendency to play it at speed and then try to "force your way" through this difficult passage without the required technique. The resulting stressed playing creates a speed wall. This example shows how important it is to start practicing the difficult parts first. In this situation, a person who knows how to practice will slow down so that s/he will not have to play beyond her/is ability.

In summary, the parallel set exercises comprise one of the main pillars of the methods of this book. They are one of the reasons for the claim that nothing is too difficult to play if you know how to practice. They serve both as diagnostic tools and as technique development tools. Practically all technique should be acquired using parallel sets during HS practice to bring up the speed, to learn to relax, and to gain control. They form a complete set so that you know that you have all the necessary tools. Unlike Hanon, etc., they can be immediately summoned to help when you hit *any* difficult passage and they allow practice at any speed, including speeds higher than anything you will ever need. They are ideal for practicing to play without stress and with tone control. In particular it is important to get into the habits of sliding the fingers over the keys and feeling the keys before playing them. Sliding the fingers provides tone control and feeling the keys improves accuracy. Without breaking up a difficult passage into simple parallel sets, it is impossible to incorporate these extra refinements into your playing. We now move on to several other useful exercises.

1.3.7.4 Scales, Arpeggios, Finger Independence and Finger Lifting Exercises

Scales and arpeggios must be practiced diligently. They are not in the class of mindless repetitive exercises because of the numerous necessary techniques that are most quickly acquired using them (such as thumb over, flat finger positions, feeling the keys, velocity, parallel sets, glissando motion, tone/color, how to reverse directions, supple wrist, etc.). Scales and arpeggios must be practiced HS; practicing them HT all the time will place them in the same category as Hanon. Two exceptions to this "no HT rule" are: (A) when you are using them for warm-ups (before recitals, etc.), and (B) when practicing to make sure that the two hands can be synchronized accurately. Learning to play them well is very difficult and you will certainly need parallel sets, see sections 1.3.4.2 and 1.3.5 for more details.

The finger independence and lifting (see below) exercises are performed by first pressing all five fingers down, e.g., from C to G using the RH. Then play each finger three to five times: CCCCDDDDEEEEFFFFGGGG. While one finger is playing, the others must be kept down. Do not press down firmly as this is a form of stress, and will cause fatigue very quickly. All the depressed keys must be completely down, but the fingers are just resting on them with only enough downward force to keep the keys down. The gravitational weight of your hand should be enough. Beginners may find this exercise difficult in the beginning because the non-playing fingers tend to collapse from their optimum positions or lift involuntarily, especially if they begin to tire. If they tend to collapse, just try a few times and switch hands or quit; do not keep practicing in the collapsed position. Then try again after a rest. One variation of this exercise is to spread out the notes over an octave. This type of exercise was already in use during F. Liszt's time (Moscheles). They should be done using the curled as well as all the flat finger positions.

For the finger independence exercise, try to increase the speed. Note the similarity to exercise #1, section 1.3.7.2; however, for general technique development, exercise #1 is superior to this one. The main objective of exercise #1 was speed; the emphasis here is different — it is for finger independence. Some piano teachers recommend doing this exercise once during every practice session, once you can play it satisfactorily. Until you can play it satisfactorily, you may want to practice it several times at every practice session. Practicing it many times at once and then neglecting it in subsequent sessions will not work. Advanced players generally do not need this exercise.

All the practice methods and exercises discussed in this book deal mostly with the muscles used to press the key down (flexors). It is possible for those muscles to become far more developed than the ones used to lift the fingers (extensors), especially for those who practice loud all the time and never develop the art of playing fast, thus causing control problems. As you grow older, the flexors can end up overpowering the extensors. Therefore, it is a good idea to exercise the relevant extensors by performing lifting exercises. The flat finger positions are valuable for exercising the extensors for lifting the fingers and, at the same time, relaxing the extensors at the fingertips. These two extensors use different muscles.

For finger lifting exercises, repeat the above exercise, but lift each finger as high as you can, for two seconds each, only one lift for each finger. Again, keep all the other fingers down with minimal pressure. This is a form of isometric exercise for strengthening specific muscles. Therefore, you must give each lift your maximum effort, but without causing pain. As usual, it is important to reduce stress in the fingers that are not being lifted. This needs to be performed a maximum of three times a day. Because they are isometric, large numbers of repetitions are not needed each day.

There has not been any systematic research on whether all these exercises work and whether some of them might even be harmful. They are listed here because they have been used by many piano teachers in the past, and there is some logical expectation of why they might be beneficial. Clearly, this is a potential topic for future research.

Everyone has problems with lifting the 4th finger. There is a mistaken belief by many that we must be able to lift the 4th finger as high as all the others and therefore they expend an inordinate amount of effort trying to achieve this. Such efforts have been proven to be futile and counterproductive. This is because the anatomy of the

4th finger does not allow it to be lifted beyond a certain point. The only thing the 4th finger must not do is to depress a key inadvertently, which requires much less lift. Therefore you can play at all times with the 4th finger just barely off the keys or even touching them. Practicing difficult passages with inordinate effort at lifting this finger higher can cause stress in fingers 3 and 5. It is more productive to learn to play with less stress as long as the 4th finger is not interfering in any way. Therefore, you mainly need to lift the 4th finger independently of the others. The exercise for lifting the 4th finger independently is performed as follows. Press all fingers down, CDEFG, as before. Then play 1, 4, 1, 4, 1, 4, etc., with the accent on 1 and lifting 4 as quickly and as high as you can. Finger 1 should stay as close to the key as possible. Then repeat with 2, 4, 2, 4, 2, 4, etc. Then with finger 3, then 5 against 4. This is not an isometric exercise and can be repeated any number of times and maximum effort is not needed because you are practicing for control. You can also do this exercise with 4 on a black key.

Both the finger independence and lifting exercises can be performed without a piano, on any flat surface. This is the best time to practice relaxing the extensor muscles of the last two phalanges (the nail phalange and middle phalange) of fingers 2 to 5; see section 1.3.4.2 for more details. During the entire exercise, those two phalanges for all the fingers should be completely relaxed, even for the finger being lifted.

1.3.7.5 Playing (Wide) Chords, Palm Stretching Exercises

We first deal with the problem of playing accurate chords in which all notes must be played as simultaneously as possible. Then we address the problem of playing wide chords.

We saw in section 1.2.10 that the gravity drop can be used to improve your chord accuracy. However, if there is still unevenness after using the gravity drop, then there is a fundamental problem that must be diagnosed and treated using the parallel set exercises. Chords become uneven when the control over individual fingers is uneven. Which fingers are weak or slow, etc., can be diagnosed and corrected using the parallel set exercises. Let's take an example. Suppose that you are playing a C.E chord against a G (in the LH) in octave 3. The C3.E3 and G3 are played with the fingers 5.3 and 1. You are playing a series of 5.3, 1, 5.3, 1, 5.3, 1, etc., like a tremolo. Let's further assume that there is a chord problem with the 5.3. These two fingers do not land simultaneously, ruining the tremolo. The way to diagnose this problem is to try the 5, 3 parallel set, to see if you can play it. Now test the reverse set, 3, 5. If you have a problem with the chord, chances are that you have more of a problem with one of these two parallel sets than the other, or you have problems with both parallel sets. Typically, 3, 5 is more difficult than 5, 3. Work on the problematic parallel set(s). Once you can play both parallel sets well, the chord should come out much better. There is a smaller possibility that your problem lies in the 5, 1 or 3, 1 parallel sets, so if the 5, 3 did not work, try these.

The hand has two sets of muscles that stretch the palm to reach wide chords. One set mainly opens the palm and the other mainly spreads the fingers apart. When stretching the hand to play wide chords, use mainly the set of muscles that open the palm. The feeling is that of stretching the palm but with free fingers; i.e., spread the knuckles apart instead of the fingertips. The second set of muscles simply spread the fingers apart. This spreading helps to widen the palm but it interferes with the finger movement because it tends to lock the fingers to the palm. Cultivate the habit of using the palm muscles separately from the finger muscles. This will reduce both stress and fatigue when playing chords, and provide more control.

In order to test whether the palms are fully stretched, open your palm to its maximum and stretch the fingers for maximum reach — if the pinky and thumb form an almost straight line, then you will not be able to stretch much more. If they form a "V", then you may be able to reach more by performing stretching exercises. Another way to test this alignment is to place your palm on a table top at the edge of the table with the thumb and pinky down the edge, so that only fingers 2, 3, and 4 are resting on the table top. If the thumb and pinky form a triangle with the edge of the table, you may be able to stretch more. You can perform a stretching exercise by pushing the hand towards the table so as to spread the thumb and pinky apart. Although the thumb-pinky alignment is a good indication of maximum reach, the main objective in stretching is to widen the separation between the bones in the palm. Most people have a slightly larger left hand than right hand, and some can reach more by using fingers 1.4 than 1.5.

Another way to stretch is to place the right palm over the back of the left palm, right arm pointing left and left arm pointing right, with the palms just in front of the chest. In this position, thumb meets thumb and pinky meets pinky. Then push the hands towards each other so that thumbs and pinkies push each other back, thus stretching the palm. In order to stretch the palms without bending the fingers, lock the fingers at the first finger bone at the knuckle (proximal phalange), not the fingertips. Then repeat the same procedure with the left palm over the right palm. Regular stretching when young can make a considerable difference in the reach when you get older.

You can save a lot of time by stretching one hand using the top edge of the piano while practicing HS with the other hand.

When playing wide chords, the thumb should be curved slightly inwards, not fully stretched out. It is counter-intuitive that, by pulling the thumb in, you can reach further; this happens because of the particular curvature of the thumb's fingertip. Some of the difficulties in playing chords accurately originate from positioning of the hand rather than stretch or finger control. Especially for small hands, the orientation of the palm is critical. **When playing chords, you generally have to move the hand, and this motion must be very accurate; this is the "jump" motion discussed below. You will need to develop proper jump motions as well as a habit of feeling the keys.** You can't just raise your hand high above the keys, position all your fingers in the right position, smash it down, and expect to hit all the correct notes exactly at the same instant. Great pianists often appear to be doing that, but as we shall see below, they are not. Therefore, until you have perfected the jump movement and are able to feel the keys, any problems with playing chords (missing and wrong notes) may not be caused by lack of reach or finger control. If you have difficulty hitting chords, *and* have no confidence in your jumps, this is a sure sign that you have to learn jumps before you can think of hitting chords.

1.3.7.6 Practicing Jumps

Many students watch famous pianists make these quick, wide jumps and wonder why they can't do jumps themselves, no matter how hard they practice. These great pianists appear to jump effortlessly, playing notes or chords smoothly from position to position no matter where they are. In reality, the pianists are making several motions that are too fast and subtle for the eye to see unless you know what to look for.

Jumps consist of two principal motions: (1) a horizontal translation of the hand to the correct position and (2) the actual downward motion to play. In addition, there are two optional motions, feeling the keys and the take-off motion; these will be explained below. The combined motion should look more like an inverted "U" than an inverted "V".

Students with no jump training tend to move the hand along an inverted V motion. With this type of motion (no horizontal acceleration), it is awfully difficult to hit a note accurately because you are coming down at some arbitrary angle. Note that this angle is never the same (even for the same passage played at different times) because it depends on the distance of jump, your tempo, how high you lift your hand, etc. Practicing coming down straight is hard enough; no wonder some students consider jumps impossible if they have to practice all these angles. Thus it is important to come straight down (or feel the keys just before playing them) at the end of the jump.

Students with no jump training also do not generally realize that the horizontal motion can be greatly accelerated; therefore, **the first skill to practice is to make the horizontal motion as quickly as possible so as to reserve enough time to locate the keys after you get there.** Locate the keys by feeling them before the actual playing. **Feeling the keys is the 3rd component of a jump**, This 3rd component is optional because it is not always necessary and sometimes, there is not enough time for it. When this combination of motions is perfected, it looks as if it is done in one motion. This is because you only need to get there a split second before playing the note. If you don't practice accelerating the horizontal motion, you tend to get there a split second later than you need to. This almost imperceptible difference makes all the difference between 100% accuracy and poor accuracy. Make sure that you practice rapid horizontal motions even for slow jumps.

Although feeling the keys before playing is optional, you will be surprised at how quickly you can do this. You will have time to do it a majority of the time. Therefore, it is a good policy to *always* feel the keys when practicing jumps slowly. When you learn all the skills listed here, there will be plenty of time to feel the keys even at the final speed. There are few instances in which there is no time to feel the keys, and those few can be played accurately if you had located most of the other jumps accurately by feeling them.

The fourth component of the jump is the take-off. Get into the habit of making quick takeoffs regardless of the speed of the jump. There is nothing wrong with getting there way ahead of time. Even when practicing slowly, you should practice quick takeoffs so that the skill will be there when you speed up. Start the take-off with a small downward and sideways kick of the wrist. Although it is necessary to come straight down for playing the notes, there is no need to go straight up for the take-off. Obviously, the entire jump procedure is designed for the hand to arrive at the destination quickly, accurately, and reproducibly so that there is plenty of time to play straight down and feel the keys.

The most important element to practice once you know the components of a jump is to accelerate the horizontal motion. You will be surprised at how fast the hand can move horizontally if you concentrate only on that motion. You will also be amazed at how much faster you can move it with just a few days of practice — something some students never achieve in a lifetime because they were never taught to practice it. This speed is what provides that extra time needed to ensure 100% accuracy and to effortlessly incorporate all the other components of the jump — especially, feeling the keys. Practice feeling the keys whenever possible so that it becomes second nature, and you don't have to look at your hands. Once it is smoothly incorporated into your play, most people watching you will not even notice that you are feeling the keys because you can do it in a small fraction of a second. Like an accomplished magician, you will be moving your hands faster than the eye can see. The flat finger positions are important for this because you can use the most sensitive part of the fingers for feeling the keys, and those positions increase the accuracy of hitting the keys, especially the black keys.

Now that you know the components of a jump, look for them when you watch concert pianists performing. You should now be able to identify each component, and you may be amazed at how often they feel the keys before striking them and how they can execute these components in the blink of an eye. These skills will also enable to play, and even make long jumps, without looking at the hands.

The best way to practice fast horizontal motions is to do it away from the piano. Sit down with your elbow straight down. **Quickly move the hand sideways by swinging the forearm around the elbow with the elbow stationary. Now point the forearm straight in front and shift it horizontally sideways (not in an upward arc), by pivoting the upper arm around the shoulder socket and simultaneously moving the shoulder down.** In an actual piano jump, these motions are combined in a complex way. Practice fast right and left motions, as fast as you can with each of the two types of motion, and with a combination of the two. *Do not* try to learn these motions in one day. It is possible to injure yourself, and most significant improvements will have to await post practice improvement.

As you learn to accelerate the horizontal motion, jumps will immediately become easier. **In order to reduce stress, relax all muscles as soon as the horizontal motion is over. The same applies to the subsequent downward motion — as soon as the notes are played, relax all muscles**, and let the weight of the hand rest on the piano (do not lift the hand/fingers off the keys). A good piece to practice this jump for the LH is the 4th variation in Mozart's famous Sonata in A, #16 (K.300). This variation has large jumps in which the LH crosses over the RH. One popular piece you can use to practice RH jumps is the 1st movement of Beethoven's "Pathétique" Sonata (opus 13), right after the LH octave tremolos, where the RH makes jumps crossing over the LH.

Practice accelerating the horizontal motion by playing at a slow tempo, but moving horizontally as quickly as you can and then stopping over the correct position and waiting before playing. You will now have time to practice feeling the notes before playing, in order to guarantee 100% accuracy. The idea here is to establish a habit of always getting to the position ahead of time. Once you are satisfied that you have a quick horizontal motion, speed up the tempo. All you have to do to speed up is to simply reduce the waiting time before playing the notes. As you become proficient, you will always "get there at least a split second ahead of time". Then gradually combine all four jump motions into one smooth motion. Now your motion looks just like that of those great pianists you envied! Better yet, jumps aren't that difficult or scary, after all.

1.3.7.7 Stretching and Other Exercises

Most stretching exercises for the large muscles of the body are helpful (see Bruser). One stretching exercise for the flexor muscles (for the fingers) can be performed as follows. With the palm of one hand, push the fingers of the other hand back towards the top of the forearm. People have very different flexibility and some will be able to push the fingers all the way back so that the fingernails will touch the arm (180 degrees from the straight forward position!), while others may be able to push back only about 90 degrees (fingers pointing up with the forearm horizontal). The ability of the flexor muscles to stretch decreases with age; therefore, it is a good idea to stretch them frequently throughout life in order to preserve their flexibility. For stretching the extensor muscles, press the back of the fingers towards the bottom of the forearm. You might perform these stretching exercises just before "playing cold".

There are numerous exercises in Sandor and Fink (see Reference). These are interesting because each exercise is chosen to demonstrate a particular hand motion. In addition, the motions are often illustrated using passages taken from classic compositions by famous composers.

1.3.7.8 Problems with Hanon Exercises

Since about 1900, Charles Louis Hanon's (1820–1900) exercises have been used by numerous pianists in the hopes of improving technique. There are now two schools of thought: those who think that the Hanon exercises are helpful and those who do not. Many teachers recommend Hanon while others think they are counterproductive. There is one "reason" many people give for using Hanon: that is to keep the hands in good playing condition from day to day. This reason is most frequently cited by the type of person who wants to warm up the fingers with the brain shut off. I suspect that this habit grew out of having learned Hanon early in the person's piano career, and that this same person would not be using Hanon if s/he were not so habituated.

I used Hanon exercises extensively in my youth but I am now firmly in the anti-Hanon school. Below, I list some reasons why. Czerny, Cramer-Bülow, and related lesson pieces share many of these disadvantages. **Hanon is possibly the prime example of how intuitive methods can suck entire populations of pianists into using methods that are essentially useless, or even harmful.**

1. **Hanon makes some surprising claims in his introduction with no rationale, explanation or experimental evidence. This is exemplified in his title, "The Virtuoso Pianist, in 60 Exercises".** Upon careful reading of his introduction, one realizes that he simply felt that these are useful exercises and so wrote them down. It is another prime example of the "intuitive approach". There is no experimental evidence or even any rational explanation for why these exercises might work as advertised. In fact, **most advanced teachers reading this introduction would conclude that this approach to acquiring technique is amateurish and would not work.** Hanon implies that the ability to play these exercises will ensure that you can play anything — this is not only totally false, but also reveals a surprising lack of understanding of what technique is. **Technique can only be acquired by learning many compositions from many composers.**

   There is no question that there are many accomplished pianists who use Hanon exercises. However, **all advanced pianists agree that Hanon is not for acquiring technique**, but might be useful for warming up or keeping the hands in good playing condition. I think there are many better pieces for warming up than Hanon, such as etudes, numerous Bach compositions, and other easy pieces. The skills needed to play any significant piece of music are incredibly diverse and numerous — almost infinite in number. **To think that technique**

can be reduced to 60 exercises reveals the naiveté of Hanon and any student who believes that is being misled.

2. **All 60 are almost entirely two-hand exercises**, in which the two hands play the same notes an octave apart, plus a few contrary motion exercises in which the hands move in opposite directions. **This locked HT motion is one of the greatest limitations of these exercises because the better hand cannot practice skills more advanced than the weaker hand.** At slow speed, neither hand gets much workout. At maximum speed, the slow hand is stressed while the better hand is playing relaxed. **Because technique is acquired mostly when playing relaxed, the weaker hand gets weaker and the stronger hand gets stronger.** The best way to strengthen the weaker hand is to practice that hand only, *not* play HT. In fact, the best way to learn Hanon is to separate the hands as recommended in this book, but Hanon never seems to have even considered that. To think that by playing HT, the weaker hand will catch up to the stronger hand, reveals a surprising ignorance for someone with so much teaching experience. This is part of what I meant by "amateurish" above; more examples below.

   Locking the two hands does help to learn how to coordinate the hands, but does nothing to teach independent control of each hand. In practically all music, the two hands play different parts. Hanon doesn't give us any chance to practice that. Bach's Inventions are much better, also teach independence of the two hands, and (if you practice HS) will really strengthen the weaker hand. Of course, the two hands will also become well coordinated. **The point here is that Hanon is very limited; it teaches only a small fraction of the total technique that you will need.**

3. **There is no provision for resting a fatigued hand. This generally leads to stress and injury.** A diligent student who fights the pain and fatigue in an effort to carry out Hanon's instructions will almost surely build up stress, acquire bad habits, and risk injury. **The concept of relaxation is never even mentioned.** Piano is an art for producing beauty; it is not a macho demonstration of how much punishment your hands, ears, and brain can take.

   Dedicated students often end up using Hanon as a way of performing intense exercises in the mistaken belief that piano is like weight lifting and that "no pain, no gain" applies to piano. Such exercises might be performed up to the limit of human endurance, even until some pain is felt. This reveals a lack of the proper education about what is needed to acquire technique. The actual number of students who irreversibly injure their hands playing Hanon is probably small. Besides, such students will likely use other pieces other than Hanon that can be even more injurious. The wasted resources due to such misconceptions can mean the difference between success and failure for a large number of students, even if they don't suffer injury. Of course, many students who routinely practice Hanon do succeed; in that case, they work so hard that they succeed *in spite* of Hanon.

4. **The simplified, schematic structure of these exercises takes all the music out of them so that students can (and too frequently do) end up practicing like robots, totally devoid of artistry.** It does not require a musical genius to compile a Hanon type series of exercises. The joy of piano comes

from the one-on-one conversations with the greatest geniuses that ever lived, when you play their compositions. It makes no sense to practice something devoid of music; remember, technique and music can never be separated. I do recommend one-hand scales, arpeggios and chromatic runs, followed by some two-hand play. Scales and arpeggios should provide more than enough "routine exercises" for everybody. For too many years, Hanon has taught the wrong message that technique and music can be learned separately. Bach excels in this respect; his music exercises both the hands and the mind. The Hanon exercises are actually a small subset of Bach's 2 part Inventions. **In fact, Hanon probably excerpted most his material from Bach's famous Toccata and Fugue, modified so that each unit is self cycling. The remainder was probably also taken from Bach's works, especially the Inventions and Sinfonias.**

One of the greatest harm that Hanon inflicts is that it robs you of the time needed to make music playing compositions that you have already learned and practicing the art of performance, or even just learning new pieces. The student often ends up with insufficient time to develop their repertoire. **Hanon can be harmful to technique and performance!**

5. **Many pianists use Hanon routinely as warm-up exercises. This conditions the hands so that you become unable to just sit down and play "cold", something any accomplished pianist must be able to do, within reasonable limits.** Since the hands are cold for at most 10 to 20 minutes, "warming up" robs the student of this precious, tiny, window of opportunity to practice playing cold. This habit of using Hanon for warm-ups is more insidious than many realize. Those who use Hanon for warm-ups can be misled into thinking that it is Hanon that is making their fingers fly, while in reality, after any good practice session, the fingers will be flying, with or without Hanon. It is insidious because the main consequence of this misunderstanding is that the person is less able to perform, whether the fingers are limbered up or not. It is truly unfortunate that the Hanon type of thinking has bred a large population of students who think that you have to be a Mozart to be able to just sit down and play, and that mere mortals are not supposed to perform such magical feats. If you want to be able to "play on demand", the best way to start is to quit practicing Hanon.

6. There is little question that some degree of technique is required to play these exercises, especially the final 10 or so. **The problem is that Hanon gives no instructions on how to acquire these techniques.** It is exactly analogous to telling a penniless person to go earn some money if he wants to become rich. It doesn't help. If a student used her/is "Hanon time" to practice a Beethoven sonata, the results will be better as far as acquiring technique is concerned. **Who wouldn't rather play Mozart, Bach, Chopin, etc., than Hanon exercises with similar, or almost certainly better, results and end up with a repertoire you can perform?**

   Even if you can play all the Hanon exercises well, if you get stuck at a difficult passage in another composition, Hanon will not help. Hanon does not provide any diagnostics for telling you why you can't play a given passage. The parallel set exercises are different. They provide both the diagnostics and the solutions for practically any situation, including ornaments, etc., that Hanon does not even consider.

7. **What little advice he does dispense, have *all* been shown to be wrong!** So let's look into them.

   (a) He recommends "lifting the fingers high", an obvious no-no for fast playing, since that will be the biggest source of stress. I have never seen a famous pianist in concert lift the fingers high to play a fast run; in fact, I have never seen *anyone* do that! This advice by Hanon has misled an enormous number of students into thinking that piano should be played by lifting the finger and plonking it down onto the key. It is one of the most non-musical and technically incorrect ways to play. It is true that the extensor muscles are often neglected, but there are exercises for treating this problem directly.

   (b) He recommends continuous practicing of both hands, as if piano technique is some kind of weight lifting exercise. Students must never practice with fatigued hands. This is why the HS method of this book works so well — it allows you to practice hard 100% of the time without fatigue, because one hand rests while the other works. Stamina is gained, not by practicing with fatigue and stress, but by proper conditioning. Besides, what most of us need most is mental stamina, not finger stamina. Furthermore, stamina is a minor issue; what we really need are technique and relaxation.

   (c) He recommends playing every day, regardless of skill level, all your life. But once you acquire a skill, you don't need to reacquire it over and over; you only need to work on technique that you don't already have. Thus once you can play all 60 pieces well, there is no need to play them anymore — what will we gain? Does he think that our hands will mysteriously deteriorate once we stop playing Hanon in spite of all the other lesson pieces?

   (d) He is apparently aware of only the thumb under method, whereas the thumb over method is more important.

   (e) In most of the exercises, he recommends fixed wrists which is only partially correct.

   (f) His recommendation reveals a lack of understanding of what "quiet hands" means.

   There is no way to practice a majority of the important hand motions, although there are a few wrist exercises for repetitions.

8. **The Hanon exercises do not allow for practicing at the kinds of speeds possible with the parallel set exercises described above.** Without the use of such speeds, certain fast speeds cannot be practiced, you cannot practice "over-technique" (having more technique than necessary to play that passage — a necessary safety margin for performances), and it takes unnecessarily long to acquire any technique.

9. The whole exercise is an exercise in waste. All the editions I have seen print out the entire runs, whereas all you need are at most 2 bars ascending and 2 bars

descending and the final ending bar. Although the number of trees cut down to print Hanon is negligible in the broader picture, this reveals the mentality behind these exercises of simply repeating the intuitively "obvious" without really understanding what you are doing, or even pointing out the important elements in each exercise. **"Repetition is more important than the underlying technical concepts" — this is probably the worst mentality that has hindered students most in the history of piano.** A person who has 2 hrs to practice every day, playing Hanon for 1 hr as recommended, would waste half of his piano lifetime! A person who has 8 hours to practice, on the other hand, doesn't *need* Hanon.

10. I have noticed that teachers can be classified into two schools according to whether they teach Hanon or not. Those who do not teach Hanon tend to be more knowledgeable because they know the real methods for acquiring technique and are busy teaching them — there is no time left for Hanon. Thus when you are looking for a piano teacher, choose from among those that do not teach Hanon, and you will increase the chances of finding a superior one.

1.3.7.9 Practicing for Speed

Speed is the second most difficult skill to acquire, after musicality. It is where too many students spend too much time with too little to show for it. The most common intuitive misunderstanding is that you need to practice playing fast in order to acquire speed. Experienced teachers know the futility of such a simplistic approach and have tried to devise methods for acquiring speed, generally without much success. What success was achieved, depended on the "talent" of the student. One common approach has been to discourage students from playing fast — this approach will at least prevent all kinds of potentially irreversible damages: psychological, physical, musical, technical, etc., but does not address the speed problem directly and can slow down the learning process unnecessarily.

The key in understanding how to practice for speed is to ask the question, "Why is speed an inadequate criterion for success?" The answer is that speed alone, without proper technique, will ruin the music. Therefore, we should use music as our criterion for acquiring speed. That is, in order to acquire speed, we must play musically. However, musicality is only a necessary condition; it is not a sufficient condition. Playing musically does not automatically guarantee speed. But, at least, we are half way there! We now know that we can play fast, but only up to speeds at which we can maintain musicality. After we succeed in playing musically, we must then add everything else we know about speed in order to reach the end goal as quickly as possible. These two concepts, musicality and knowledge, give us the framework for understanding how to practice for speed.

Let's use this framework to design a practice routine for speed. An easy solution is to play only compositions that are so easy that you can play them musically. This solution is impractical because the best students want to play challenging pieces, and are willing to work for it. But perhaps more importantly, challenging pieces can help you advance more rapidly. In that case, we must iterate: first, learn the piece at slower speed so that you can still play it musically, then use parallel sets, etc., to enable faster speeds and then practicing to play musically at these faster speeds, then iterate the entire procedure; that is, use the principle stated elsewhere of practicing at different speeds. In addition, you will need to know how to make the best use of post practice improvements. In order to execute this routine, we must know what musicality is and what those "parallel sets, etc.," are.

Musicality cannot be defined in a few short sentences. This is not surprising in view of the fact that even the concept of music is still not easily definable. The only thing we can do is to describe the implications of musicality when we are practicing and learning new pieces. We all have sufficient musicality in the sense that we can judge musical quality at very high levels — witness the frequent remarks we hear (even from non-pianists) about the inadequacy of some concert performances of accomplished pianists and even famous artists. But when it comes to making music ourselves, it is a different matter. Musicality won't come easily, especially if you don't have a good teacher. One of the best methods of developing musicality is to record or video tape your playing and listening/watching it critically, using this high level of judgmental musicality that we all posses. Taping should start from the very first year of lessons, regardless of age. Then, you must listen to professional recordings of pieces you are playing. Beginners may have difficulty finding recordings of their simple lesson pieces; in that case, ask the teacher to play them so that you can record them. Most pianists listen to an adequate mount of music but the critical point here is that you must listen to performances of pieces that you are playing. The most basic part of musicality is accuracy (time signature, etc.), and following the expression markings on the score. Errors in reading the music, especially the rhythm, can make it impossible to bring it up to speed.

Because we all have sufficient musicality to appreciate and judge music that we hear, "I am not a trained musician" is never a valid excuse for not knowing what musicality is. In addition, music is personal — it is not possible to define a universal musicality that applies in all cases. This lack of a definition actually opens up the musical world into a limitless vista of possibilities that is the basis for the variety and excitement of music.

You do not understand how to practice musically unless you understand the difference between practice and performing. Most people simply assume that when you practice, you are also practicing to perform. For the majority of people, this is absolutely false. The mental states for practicing and for performing are two entirely different states. For practicing, the mind wants simply to acquire technique and learn the piece. For performing, the mind's only task is to make music. It is extremely difficult to put your mind into the performing state when practicing, because the brain knows that there is no audience.

This is why video taping or recording is so important; in addition, you can see and hear your own strengths and weaknesses. Do not just make tapes for practice; tape for a permanent record of your accomplishments — an album of all your finished pieces. If the recordings are not for permanent archiving, they become just another practice recording, which is not much different from routine practice. All good piano teachers hold recitals of their students; these recitals teach them the performing state of mind. You will be amazed at how rapidly you progress when you must tape by a certain deadline, or play a recital. Most people ascribe this progress to the pressure of having to perform, which is only partly true. A large component of the progress is attributable to the necessity to play musically. This is proof that we all know what "playing musically" means. But we may lack the mental discipline or energy to do it; this energy is what I call mental stamina. Therefore, the road to success in acquiring technique is to duplicate the performing state of mind during routine practice — which is another way of saying, "play musically".

There are two extremes in the way people approach musicality. One is the "artist" approach in which a musical expression is created in the mind and the hands "simply execute" to produce the desired effect. Unfortunately, most people with normal intelligence can't do that — it is called "talent". The other extreme is the analytical approach in which the person learns every detailed anatomical motion to produce the final effect. Unfortunately, we don't have a complete list of all those necessary motions. We are all somewhere between these extremes. Although the great artists use mostly the "artist" approach, they are geniuses and can figure out the right hand motions, often in great analytical detail. In other words, successful pianists from both extremes will end up doing basically the same things in the end. These considerations again lead us to the same conclusion: that in order to acquire speed, we must learn to play musically (artist approach, a necessary condition), and then add as much analytical knowledge as possible to accelerate the process (to make it as sufficient as we can). We are approaching the point of finding the necessary and sufficient conditions for speed.

One way to summarize the above is, "The road to speed is music". When playing musically, you are doing everything right. For example, you must lift the fingers at the exact right moments. This exercises the extensor muscles and prevents the flexor muscles from over-developing. Having established the necessity to play musically, the rest of this section will be devoted to the analytical side of how to practice for speed.

Relaxation is obviously the most important ingredient for speed. However, relaxation is a complex thing. Most of us need to learn a lot before we can relax completely because total relaxation is not a natural state. Especially for something like playing the piano, in which we tend to repeat things many times, we can develop unnoticed stress to very high levels before we even notice it. Below are some suggestions for developing relaxation and adding speed.

Always practice softly, even loud sections. The mistaken notion that you must build piano muscles in order to play well or fast has led many to practice louder than they need to. Speed is skill, not strength. Thus you need to separate loudness from technique; for playing loud passages, acquire technique first, and then add loudness. Difficult passages tend to cause stress and fatigue during practice. Playing softly reduces both, thereby accelerating technique acquisition. If you play the piano for many years, you will get stronger every year, and can end up playing correspondingly louder without knowing it. The louder playing also makes it difficult to play musically. There is general agreement among pianists that it is difficult to play softly and fast. One of the reasons for this is that most people practice fast passages too loud.

Good tone is produced by "pressing deeply" into the piano. That is, you must accelerate during the entire keydrop and make sure to engage the backcheck securely. However, you must relax immediately thereafter. There is no need to keep pushing down. This constant down pressure not only wastes energy (causing fatigue) but also prevents the fingers from moving rapidly. There is often a tendency to lean into the piano in order to "play deeply" and after many years of doing so, you can end up pressing down with a tremendous force (see item 6 in the Testimonials section) without realizing it. Even students of the arm weight method, which teaches the correct arm pressure, sometimes end up with inappropriate down pressure. This is why arm weight teachers will always check your down pressure by checking your arm relaxation. In spite of the "arm weight" terminology, the weight of the arm is not always the correct down pressure — in fact, it usually is not. The requirement of the arm weight method is that you should be sufficiently relaxed so that you can feel the weight of the arm. The optimum down pressure depends on many factors (speed, loudness, staccato-legato, etc.); therefore, you must learn to use the precisely correct down pressure, and no more. One way to test the proper down pressure is to decrease it until you start to miss some notes. Now add enough down pressure so that you do not miss any — this should be the correct value at which you practice for technique. In almost all instances, you will find that your original pressure was too high.

Practicing too loud and too much down pressure are two of the most undiagnosed or misdiagnosed problems in playing fast. Once you find the correct values, you will find that you can play faster. The trills and ornaments will also become faster and clearer. Your piano and pianissimo will improve. Reducing the down pressure does not mean play like staccato — the finger must stay down for the duration of the note even when playing fast. This is what is meant by accuracy and technique. The "weak 4th finger" will be less of a problem because of the reduction in stress and because the 4th finger does not have to constantly compete with the stronger fingers. Proper lifting of the fingers, staccato, legato, etc., are all affected when you change the loudness and down pressure.

Rhythm is extremely important. Not only the rhythm of the music as played by the fingertips, but also the entire body, so that one part does not move against another. Other problems are unnecessary motions and motions not compatible with the rhythm. A required motion in one hand can cause an involuntary motion elsewhere in the body. Many of these will be visible if you video tape yourself. Of course, you must have the correct rhythm in mind to start with; don't let the piano dictate the rhythm because it is as much a part of the music as the melody; you must consciously control it. Rhythm is not only the timing, but also the control of tone and loudness.

Balance is another important factor. Not only the balance of your body on the bench, but also the center of gravity of each playing hand and of the two hands. When practicing HS, watch to see where the center of gravity of the hand is (where you apply your downward force). Try to place that center along the line straight out from the arm. This is important only when playing very fast, because during slow play, all momenta are negligible and the center of gravity is right at the finger performing the keydrop so that you can't move it around.

Depending on circumstances, you will need all the other physical methods discussed elsewhere, such as TO, cartwheel method, flat finger playing, outlining, etc. In order to be able to pay attention to all these factors, you will need to practice at moderate or slow speeds frequently.

In conclusion, you cannot acquire speed by forcing the fingers to play faster than they can at their technical level because you will lose relaxation, develop bad habits and erect speed walls. The best way to make sure that you stay within your technical limitation is to play musically. You can briefly use parallel sets, cycling, etc., to quickly increase speed with little regard to musicality, but you should make that an exception, not the rule. Therefore, if you find the need to cycle for long periods, that should be practiced musically. Next, you must incorporate all the analytical methods for increasing speed, such as relaxation, the different hand/finger positions, TO, correct down pressure, etc. In the final analysis, practicing speed for speed's sake becomes counter-productive; when playing the piano, you must make music. This frees you from the speed demon and leads you into that magical realm of the wonderful sound of music.

1.3.8 Outlining (Beethoven's Sonata #1)

Updated: October 6, 2003

Outlining is a method for accelerating the learning process by simplifying the music. It is a simplifying process just like HS practice or practicing in short segments. Its main characteristic is that it allows you to maintain the musical flow or rhythm, and to do this at the final speed almost immediately, with a minimum of practice. This enables you to practice the musical content of the piece long before that segment can be played satisfactorily or at speed. It also helps you to acquire difficult technique quickly by teaching the larger playing members (arms, shoulders) how to move correctly; when this is accomplished, the smaller members often fall into place more easily. It also eliminates many pitfalls for timing and musical interpretation errors. The simplifications are accomplished by using various devices, such as deleting "less important notes" or combining a series of notes into a chord. You then get back to the original music gradually by progressively restoring the simplified notes. Whiteside has a good description of outlining on p. 141 of the first book, and pp. 54–61, 105–107, and 191–196 of the second book, where several examples are analyzed; see the Reference section.

For a given passage, there are usually many ways to simply the score or to restore notes, and a person using outlining for the first time will need some practice before s/he can take full advantage of the method. It is obviously easiest to learn outlining under the guidance of a teacher. Suffice it to say here that how you delete notes (or add them back in) depends on the specific composition and what you are trying to achieve; i.e., whether you are trying to acquire technique or whether you are trying to make sure that the musical content is correct. Note that struggling with technique can quickly destroy your sense of the music. The idea behind outlining is that, by getting to the music first, the technique will follow more quickly because music and technique are inseparable. In practice, it requires a lot of work before outlining can become useful. Unlike HS practice, etc., it cannot be learned so easily. My suggestion is for you to use it initially only when absolutely necessary (where other methods have failed), and to gradually increase its use as you become better at it. It can be especially helpful when you find it difficult to play HT after completing your HS work. Even after you have partly learned a piece, outlining can be used to increase the precision and improve the memorizing.

I will demonstrate two very simple examples to illustrate outlining. Common methods of simplification are (1) deleting notes, (2) converting runs, etc., into chords, and (3) converting complex passages into simpler ones. An important rule is that, although the music is simplified, you generally should retain the same fingering that was required before the simplification.

Chopin's music often employs tempo rubato and other devices that require exquisite control and coordination of the two hands. In his Fantaisie Impromptu (op. 66), the six notes of each LH arpeggio (e.g., C♯3G♯3C♯4E4C♯4G♯3) can be simplified to two notes (C♯3E4, played with 51). There should be no need to simplify the RH. This is a good way to make sure that all notes from the two hands that fall on the same beat are played accurately together. Also, for students having difficulty with the 3–4 timing, this simplification will allow play at any speed with the difficulty removed. By first increasing the speed in this way, it may be easier to pick up the 3–4 timing, especially if you cycle just half a bar.

The second application is to Beethoven's Sonata #1 (op. 2, no. 1). I noted in the Reference that Gieseking was remiss in dismissing the 4th movement as "presenting no new problems" in spite of the difficult LH arpeggio which is very fast. Let's try to complete the wonderful job Gieseking did in getting us started on this Sonata by making sure that we can play this exciting final movement.

The initial 4 triplets of the LH can be learned by using parallel set exercises applied to each triplet and then cycling. The first triplet in the 3rd bar can be practiced in the same way, with the 524524 fingering. Here, I have inserted a false conjunction to permit easy, continuous cycling, in order to be able to work on the weak 4th finger. When the 4th finger is strong and under control, you can add the real conjunction, 5241. Here, TO is absolutely required. Then you can practice the descending arpeggio, 5241235. You can practice the ensuing ascending arpeggio using the same methods, but be careful not to use TU in the ascending arpeggio, since this is very easy to do. Remember the need for supple wrists for all arpeggios. For the RH, you can use the rules for practicing chords and jumps (sections 1.3.7.5 and 1.3.7.6 above). So far, everything is HS work.

In order to play HT, use outlining. Simplify the LH so that you play only the beat notes (starting with the 2nd bar): F3F3F3F3F2E2F2F3, with fingering 55515551, which can be continually cycled. These are just the first notes of each triplet. Once this is mastered HS, you can start HT. The result should be much easier than if you had to play the full triplets. Once this becomes comfortable, adding the triplets will be easier than before, and you can do it with much less chance of incorporating mistakes. Since these arpeggios are the most challenging parts of this movement, by outlining them, you can now practice the entire movement at any speed.

In the RH, the first 3 chords are soft, and the second 3 are forte. In the beginning, practice mainly accuracy and speed, so practice all 6 chords softly until this section is mastered. Then add the forte. To avoid hitting wrong notes, get into the habit of feeling the notes of the chords before depressing them. For the RH octave melody of bars 33–35, be sure not to play with any crescendo, especially the last G. And the entire Sonata, of course, is played with no pedal. In order to eliminate any chance of a disastrous ending, be sure to play the last 4 notes of this movement with the LH, bringing it into position well before it is needed.

For technique acquisition, the other methods of this book are usually more effective than outlining which, even when it works, can be time consuming. However, as in the Sonata example above, a simple outlining can enable you to practice an entire movement at speed, and including most of the musical considerations. In the meantime, you can use the other methods of this book to acquire the technique needed to "fill in" the outlining.

1.3.9 Polishing a Piece — Eliminating Flubs

Updated: October 6, 2003

Is there a general principle that enables play without audible mistakes? Yes! It is the principle of increasing accuracy, which states that, in order to avoid a certain error, you must be able to control the next less serious level of error. First classify all errors according to their level of seriousness, or skill level required. This hierarchy may be different for each person. Typically, the worse mistake might be a complete blackout. Next might be stuttering and wrong notes. Then pauses and missing notes. Then a whole slew of errors related to accuracy, timing, evenness, expression, loudness, etc. Finally comes matters of color, each composer's characteristics, special properties of a particular composition, etc. Obviously, if you are having blackouts, the finer points of expression are out of the question. But this argument also works in reverse: if you know the piece so well that you can concentrate on the highest levels of music, then blackouts are the least of your worries.

Concentrating on correct expression, i.e., knowing all the fine details of the composition, trying to bring out the color and other musical attributes, are the most important components of the highest skill level. The best way to ensure correct expression is to go back to the music and review every expression mark, every staccato and every rest. The notes that are held down, the lifting of the finger or the pedal, etc., are just as important as the keydrop. Listening to recordings, in this respect, will greatly help your performance if you follow it up with proper practice.

Not only the hierarchy but also the weaknesses of each individual are different, and are usually not known to that individual. A person whose timing is off usually cannot hear the incorrect timing. **This is where a teacher plays a key role in detecting these weaknesses, and why, without a teacher, a student can try very hard for years and not succeed in becoming a good performer.** No amount of practice will eliminate performance flubs if the fundamental problems are not solved. All flubs originate in the brain. It might seem that it is possible to practice an incorrect timing so much that it can be played without stopping or pressing wrong notes, but that is not so. Incorrect timing (or other basic errors) will make the piece so difficult to play that it leads to flubs (in addition to the loss of music).

Of course, experience is the final teacher — without experience you cannot find out your specific weaknesses. This is the reason behind the statement that you can't really perform anything unless it had been performed at least three times. **For those who have not had sufficient experience or for a new piece you had never performed before, snippet playing (playing parts of a composition) is the easiest way to get started.** With snippet performance, you can stop at a mistake, skip a section that you are not confident with, etc., and nobody will know whether you blacked out or just stopped. Have all kinds of stories ready to tell at such pauses in the playing, and you can easily execute a satisfactory snippet performance. Every student should make it a policy to make snippet performances at every opportunity. Whenever there is a group, wherever there is a piano, just sit down and play for others. The real world is irrational and people often act diametrically opposite to what they should be doing — most piano students will refuse to play informally even after some coaxing. What opportunities they are missing!

If you examine the circumstances of the average amateur, you will quickly conclude that flawless performances are virtually impossible. At the same time, this exercise will teach us how to overcome those problems by explicitly identifying them. Most of the amateur's problems originate from a lack of time to properly execute all the necessary preparations. So let's examine the major problems and their solutions.

The most common mistake is that amateurs try to perform at practice speed. There should be a practice speed (actually a range of practice speeds) and a performance speed. Clearly, the performance speed is slower than the typical final practice speed. Therefore, the amateur must have a clear idea of what these speeds are before going into the performance. If there is no consideration of a slower performance speed, the person will naturally have insufficient practice at this speed, and is in the illogical situation in which the performance speed is the one that was practiced the least! Another way of restating this simply is that **it is not a good policy to always practice too fast because you may end up unable to perform.** This is why slow play is so important, so that you practice slowing down from the faster practice speeds. Remember that the audience has not heard this piece hundreds of times like you have during practice, and your final speed is usually too fast for them.

Most pianists have a practice speed they use for preparing for performances. This is a moderate speed that is slightly slower than the performance speed. This speed allows for accurate practice without picking up unexpected bad habits and for creating a clear picture of the music in the mind. It also conditions the hand for playing with control at the faster performance speed and improves technique.

Another common problem is that a student is always learning new pieces with little time to review "finished" pieces. **It is well known that learning a new piece is the best way to forget or become confused about finished pieces.** This happens because learning a new piece involves growing new nerve connections and this can alter previously established connections. Thus, just after learning a new piece, trying to play a previously finished piece error free is a risky game. Many students are perpetually learning new pieces, and are never in any shape to perform. Therefore, if you have been working hard learning new pieces, don't expect to perform a previously finished piece well unless you have performed it many times before. This is why it is so important to play old, finished pieces "cold" at the beginning of every practice session. This is also a good time to practice snippet performances.

We must also keep all the fundamentals of technique in mind; they are designed to build that margin of safety for eliminating flubs. Some important fundamentals are: (1) feeling the keys before playing them, (2) getting into position (jumps, chords, etc.) ahead of time, (3) practicing softly and with control, and (4) relaxing and feeling the arm weight.

Finally, no amateur can be expected to perform well without a performance preparation routine, which is discussed in section 1.3.14 below. Key elements of that routine are: (1) play the piece slowly (at least medium speed) after practicing it or playing it at speed, (2) make sure that you can still play it HS, (3) play very slowly (half speed or slower) if you want to make sure that it is well memorized, (4) you should be able to play it in your mind, away from the piano, (5) you should be able to begin play from anywhere in the piece, and (6) don't play it more than once at speed on the day of the performance.

It is clear from the above discussions that the inability to perform is not the fault of the student. The fault lies in the way the student was taught. Thus if the student is taught or concentrates on performing without audible errors from the first year of lessons, it will become just another routine matter. Notice that we started this section by discussing playing without flubs and ended up discussing performing. There is just no way to really separate the two.

1.3.10 Cold Hands, Illness, Hand Injury, Ear Damage

1.3.10.1 Cold Hands

Updated: January 26, 2004

Cold, stiff, hands, on a cold day, is a common affliction caused mainly by the body's natural reaction to cold. A few people certainly have pathological problems that may need medical attention. But the majority of cases are natural body reactions to hypothermia. In that case, the body withdraws blood, mostly from the extremities, towards the center of the body in order to conserve heat. The fingers are most susceptible to this cooling, followed by the hands and feet.

For such cases, the solution is, in principle, simple. You just need to raise the body temperature. In practice, it is often not that easy. In a cold room, even raising the body temperature so high (with extra clothing) that you feel too warm does not always eliminate the problem. Clearly, any method of conserving heat should help, though it may not completely solve the problem. Of course, it is best if you can raise the room temperature. If not, common aids are: (1) soaking the hands in warm water, (2) use of a room heater, such as a portable radiant heater (about 1 KW) that you can aim directly at the body, (3) thick socks, sweaters, or thermal underwear, and (4) gloves without fingers (so you can play the piano with the gloves on). If you just want to keep the hands warm before playing, mittens are probably better than gloves. Most hair dryers do not have sufficient power, are not designed to be used for more than about 10 minutes without overheating dangerously, and are too noisy for this purpose.

It is not clear whether it is better to stay warm all the time or just when practicing piano. If you keep warm all the time (such as by wearing thermal clothing), the body may not detect hypothermia and therefore will maintain blood flow. On the other hand, the body may become more sensitive to cold and eventually start to react even when the body is warm, if the room is cold. For example, if you wear the gloves without fingers all the time, the hands may become accustomed to this warmth and feel very cold when you take them off. And the warming effect of these gloves may wear off once the hands get accustomed to them. Therefore, it is probably best to wear them only when practicing or just before practicing. The counter argument is that wearing them all the time will allow you to play piano at any time, without warm-ups or having to soak the hands in warm water. Clearly, you will have to experiment to see what works best for your specific circumstances.

Cold fingers of this type are clearly the body's reactions to cool temperature. Many people have found that soaking the hands in warm water helps. It might be of interest to experiment and soak the hands several times a day in very *cold* water to acclimate the hands to cold temperatures. Then they may not react to cold at all. This might provide a permanent solution. For example, you might cool them this way right after practice so that it does not interfere with the practice. The objective of the cooling is to get the skin acclimated to cold temperatures. Therefore, you should dip in cold water for no more than 5 to 10 seconds. You should not cool the entire hand down to the bone. In fact what you might do is to first warm the hands in warm water, and then cool just the skin in ice cold water. Such a treatment should feel good, without any cold shock or pain. In fact, this is exactly the principle behind the Nordic practice of jumping into an opening in a frozen lake after a hot sauna. This seemingly masochistic practice is in fact completely painless and has practical consequences, such as acclimating the skin to cold temperatures and stopping perspiration that would otherwise cause your clothes to become soggy.

1.3.10.2 Illness

Some people might think that a harmless illness, such as a cold, might still allow them to practice piano. That is usually not the case. It is particularly important for parents to understand that playing the piano involves significant exertion, especially of the brain, and not treat piano as a relaxing pastime when illness strikes. Thus youngsters with even mild colds should not be made to practice piano, unless the child is willing to do so on her/is own. If the person is running a fever and then plays the piano, there may be some risk to brain damage. Fortunately, most people lose the urge to practice the piano even when only mildly sick.

Whether one can play piano when sick is an individual matter. Whether to play or not is quite clear to the pianist; most people will feel the stress of piano playing even before the symptoms of the illness become clear. Thus it is probably safe to leave the decision to play or not to play to the pianist. It is useful to know that, if you feel sudden fatigue or other symptoms that make it difficult to play, it might be an indication that you are coming down with some illness.

The problem with not playing during an illness is that if the illness lasts for more than a week, then the hands will lose a considerable amount of technique. Perhaps exercises that do not strain the brain, such as scales, arpeggios, and Hanon type exercises, might be appropriate in such a situation.

1.3.10.3 Most Injury

Hand injury is generally not a major issue for students up to about the intermediate level. For advanced pianists, it is a major issue because the human hand was not made to withstand such extreme use. Injury problems with professional pianists are similar to those of professionals in sports, such as tennis, golf, or football. **Therefore, the limitations from possible injury may be the second most important limitation after availability of time to practice.** It might appear that, because relaxation is an essential component of piano technique, injury should not occur. Unfortunately, the physical requirements of playing at advanced levels are such that (as in sports) injury is likely to occur in spite of well known precautions and other measures that professionals take. Injury tends to occur while practicing to acquire difficult technique. Students who use the methods of this book must be particularly aware of the possibility of injury because they will quickly start practicing material that require high technical skills. Thus is it important to know the common types of injuries and how to avoid them.

Most hand injury is of the repetitive stress injury (RSI) type. Carpal tunnel syndrome and tendonitis are common ailments. Anecdotal accounts suggest that surgery can do more harm than good and often does not solve the problem. In addition, surgery is generally irreversible. Stress reduction methods of piano practice, such as Taubman, Alexander, and Feldenkrais methods, can be effective both for preventing injury, and even for recovering from injury. In general, it is best to keep the playing finger (except the thumb) in line with the forearm as much as possible in order to avoid injury. Of course, the best preventive measure is not to over-practice with stress. The HS method is especially beneficial because stress is minimized and each hand gets to rest before damage can occur. The "no pain, no gain" approach is extremely harmful. Piano playing can require tremendous exertion and energy, but it must never be painful. See the Reference section for some informative web sites on hand injury for pianists.

Every injury has a cause. Although there are numerous documented accounts of injury and success/failure of cures, definitive information on causes and cures has been elusive. The only cures mentioned are rest and a gradual return to playing using stress-free methods. In my case, I injured the finger tendons in my left palm by using golf clubs with worn, hard grips. My hand doctor immediately diagnosed the cause of my pain (a notch in my tendon), but could not tell me how I injured my hand, so he could not really tell me how to cure it. The pressure of the grip had created notches in my tendons, and these notches moved up and down in my hand during piano playing. The doctor showed me how to feel these notches move by pressing on the tendon and moving my finger. The resulting friction caused inflammation and pain after long piano practice sessions. Now I replace the grips on my clubs frequently and have added pads in my golf glove (cut out from Dr. Scholl's self-stick foot-pads), and my problem has been eliminated.

Fingertips can be injured by playing too hard (loud). This condition can be somewhat alleviated with proper bandaging. You can accidentally sprain certain muscles or tendons. The best approach here is caution — pianists must be extra cautious and avoid such injuries because they can take years to heal. Stop practicing if you feel any pain. A few days of rest will not harm your technique and may prevent serious injury. Of course, it is best to see a hand doctor; however, many hand doctors are not familiar with piano injuries.

The curled finger position can cause bruising of the fingertips because there is minimum padding between the bone and skin at the tip. In the curled position, you can also peel the flesh off from under the fingernail if you cut the fingernail too short. You can avoid both of these types of injury by using the flat finger position (section 1.3.4.2).

1.3.10.4 Ear Damage

Ear damage generally occurs, as a function of age; hearing loss can start as early as age 40 and by age 70, most people have lost some hearing. Hearing loss can occur from over-exposure to loud sounds and can also be caused by infections and other pathological causes. The person may lose hearing in the low frequency or high frequency range. This is often accompanied by tinnitus (ringing sound in the ear). Those who lose hearing in the low frequency range tend to hear a low, roaring or throbbing tinnitus, and those who lose hearing in the high frequency range tend to hear a high pitched whine. Tinnitus may be caused by uncontrollable firing of the hearing nerves in the damaged section of the ear; however, there may be many other causes. See the Reference section for information on the internet on hearing damage.

Although hearing loss is easily diagnosed by an audiologist, its cause and damage prevention are not well understood. For tests and treatments you need to see an ENT specialist (Ear Nose Throat). For non-pathological cases, damage is generally attributed to exposure to loud sounds. Yet many people exposed to very loud sounds, such as pianists who play every day for hours on concert grands, piano tuners who routinely use “pounding” during tuning, or members of rock bands, may not suffer hearing loss. On the other hand, some, who are exposed to less sound, can lose their hearing, especially with age. Therefore, there is a wide difference in susceptibility to hearing loss. However, there certainly is a tendency for those exposed to louder sounds to suffer more hearing loss. Clearly, a definitive study on hearing loss would be useful for identifying the mechanisms of ear damage and susceptible persons, and for finding ways to prevent hearing loss. **It is quite likely that hearing loss by pianists and piano tuners (as well as rock bands members, etc., and people who routinely listen to very loud music) is much more widespread than is generally known because most of them go unreported.** One of the reasons for the under-reporting is that there are few known cures, so that documentation does not serve any useful purpose.

Tinnitus is present in essentially 100% of people 100% of the time, but is so soft in normal people that it cannot be heard unless the person is in a soundproofed room. It is most frequently caused by spontaneous firing of the hearing nerves in the absence of sufficient stimulus. That is, the human hearing mechanism automatically “turns up the amplification” when there is no sound. Totally damaged regions produce no sound because the damage is so severe that they cannot function. Partially damaged regions apparently produce tinnitus because they are sufficiently damaged to detect no ambient sound which causes them to turn up the amplification and fire the detectors. These detectors are piezo-electric material at the base of hairs inside the cochlea. Thus tinnitus may be analogous to the speaker squeak you hear when you turn up the microphone amplification too high. Of course, there are many other causes of tinnitus. Tinnitus is almost always an indication of the onset of hearing loss.

For those who do not have audible tinnitus, there is probably no need to avoid loud music, within reasonable limits. Thus practicing the piano at any loudness should be harmless up to about age 25. Those who already have tinnitus should avoid exposure to loud piano. However, **tinnitus usually "sneaks up" on you, so that the onset of tinnitus often goes unnoticed until it is too late. Therefore, it is probably a good idea to wear ear protection after age 40 during piano practice. Ear protection is an abhorrent idea to most pianists but when you consider the consequences (see below), it is probably worthwhile.** Before wearing protection, do everything possible to reduce sound intensity, such as soundproofing the room (adding carpets to hard floors, etc.), closing the lids of grands, and generally practicing softly (even loud passages — which is a good idea even without possibility of ear damage).

Ear protectors are readily available from hardware stores because many workers using construction or yard equipment need such protection. For pianists, an inexpensive unit will suffice because you need to hear some music. You can also use most of the larger headphones associated with audio systems. Commercial protectors completely surround the ear and provide a better sound barrier. Since protectors available today are not designed for pianists, they don't have a flat frequency response; that is, the sound of the piano is completely altered. However, the human ear is very good at adapting to different types of sound and you can get used to the new sound very quickly. The piano sound will also be quite different when you take the protection off (as you will need to do once in a while to see what the REAL sound is like). These different sounds can be quite educational for teaching us how much the brain influences what sounds you hear or don't hear and how different persons will interpret the same sounds. It is worthwhile to try ear protection so that you can experience these different sounds. For example, you will realize that the piano makes many strange sounds you never heard before! The differences in sound are so startling that they cannot be expressed in words.

The brain automatically processes any incoming data, whether you want it to or not. This is, of course, part of what music is — it is the brain's interpretation of incoming sounds, and most of our reaction to music is automatic. Thus when you wear ear protection, most of this stimulus disappears, and a large amount of the brain's processing power is freed to do other jobs. In particular, you now have more resources to apply to your HS practice. After all, that is why you practice HS, and not HT — so that you can concentrate more energy on the difficult task of playing with the one hand. Thus you may find that you progress faster HS when wearing ear protection! This is the same principle behind why many pianists close their eyes when they want to play something with high emotional content — they need all the resources available to produce the high level of emotion. When you close the eyes, you eliminate a tremendous amount of information coming into the brain because vision is a two-dimensional, multi-color, moving source of high bandwidth information that must be immediately and automatically interpreted in many complex ways. Therefore, although most audiences admire that a pianist can play with the eyes closed, it is actually easier with the eyes closed when you must concentrate on every detail of expression. Thus, in the near future, most piano students will probably wear ear protection, just as cyclers use helmets and construction workers use ear protection today. It doesn't make any sense for any of us to spend the last 10, 30, or more years of our lives, without hearing.

How does piano sound damage the ear? Clearly, loud sound with many notes should be most damaging. Thus it is probably not an accident that Beethoven became prematurely deaf. This also cautions us to practice his music carefully. The specific type of piano is also important. Most uprights that do not produce sufficient sound are probably least damaging. Large grands that transfer energy efficiently into the strings with long sustain probably do not cause as much damage as medium quality pianos in which a large amount of energy is imparted into the initial, instantaneous bang associated with the hammer striking the strings. Although much of this damaging sound energy may not be in the audible range of the ear, we can detect it as an unpleasant or harsh sound. Thus the medium size grands (6 to 7 ft) may be most damaging. In this regard, the condition of the hammer is important, since a worn hammer can produce a much louder instantaneous sound than a properly voiced hammer. This is why worn hammers cause more string breakage than new or well voiced hammers. With hardened hammers, probably most pianos can cause ear damage. Thus the proper, periodic voicing of the hammer may be much more important than many people realize, both from the points of view of being able to practice playing softly and with expression as well as for protecting the ear. If you have to close the lid of a grand in order to play softly, or to reduce the sound to a pleasant level, the hammers probably need voicing.

Some of the loudest sounds are produced by those small ear phones used to listen to music. Parents should warn their youngsters not to keep turning up the volume, especially if they subscribe to the culture that plays very loud music. Some youngsters will fall asleep with their ear phones blasting; this might be very damaging because the duration of exposure to loudness is also important. It is a bad idea to give gadgets with these ear phones to youngsters — postpone it as long as possible. However, sooner or later, they will end up with one; in that case, warn them *before* they suffer ear damage.

Except for some special cases of tinnitus (especially those cases in which you can alter the sound by moving your jaws, etc.), there is no cure yet. Large doses of aspirin can cause tinnitus; in that case, stopping its use can sometimes reverse the process. Small amounts of aspirin taken for cardiac purposes (81mg) apparently do not cause tinnitus, and there are some claims in the literature that these small amounts may delay the onset of tinnitus. Loud tinnitus can be extremely debilitating because it cannot be changed and is present all the time, and it only increases with time. Many sufferers have been driven to thoughts of suicide. Although there is no cure, there are remedies, and all indications are that eventually, we should be able to find a cure. There are hearing aids that reduce our perception of tinnitus, for example, by supplying sufficient sound so that the tinnitus is either masked or the amplification in the damaged area is reduced. Thus for tinnitus suffers, absolute quietness may be damaging.

One of the most annoying traits of hearing loss is not that the ear has lost its sensitivity (frequently, sensitivity tests reveal very little deterioration), but the inability of the person to properly process the sound so as to understand speech. People with normal hearing can understand speech mixed with a large amount of extraneous sound. Understanding speech is the first ability that is lost with onset of hearing loss. Modern hearing aids can be quite helpful, both by amplifying only those frequencies needed to understand speech and for suppressing sounds that are loud enough to cause damage. Another approach to tinnitus is to train the brain to ignore the tinnitus. The brain is amazingly trainable, and part of the reason why tinnitus causes suffering is the inappropriate brain response of the person. The brain can choose to either concentrate on the sound, thereby driving you crazy, or to ignore it, in which case you won't hear it unless you are reminded of it. The best example of this is the metronome. Most pianists do not know that if they practice with the metronome too long, the brain will play tricks so that you either do not hear the click at all, or hear it at the wrong time, especially if the metronome click is sharp and loud. This is one reason why modern metronomes have flashing lights; in addition to enabling you to time yourself without the sound, it allows you to check to see if what you hear matches the light flashes. Thus modern treatments of tinnitus start with teaching the patient that others have succeeded in living with it with minimal discomfort. Then the patient receives ear training in such a way as to be able to ignore the tinnitus. Fortunately, the brain is especially adept at learning to ignore a constant sound that is always there.

If you read enough stories about tinnitus suffers, you will probably follow the advice to wear ear protection after age 40, at least when practicing loud passages for long periods of time. At the first hint of tinnitus, it is imperative that you start ear protection procedures because once the tinnitus starts, ear deterioration can proceed rapidly with exposure to sound, with significant deterioration every year. Look for an ENT specialist immediately, especially one experienced in tinnitus treatments. Ear protection applies to other members of the household; therefore, if at all possible, isolate the piano room acoustically from the rest of the house. Most quality (glass) doors will be sufficient. There are a few herbs and "natural" medications that claim effectiveness against tinnitus. Most of these do not work, and the ones that seem to benefit some people have dangerous side effects. Although it is true that there are precious few specialists treating tinnitus, the situation is rapidly improving and there are now many sites on the internet with information on tinnitus. Therefore, although specialists may be few, the internet will enable to you find them. The American Tinnitus Association also has a web site.

1.3.11 Sight Reading

Updated: April 15, 2002

It is useful to classify sight reading into three levels so that we know what we are talking about. At the novice sight reading level, we are talking about playing compositions that we have not memorized, and which we play by looking at the score. We may already be familiar with the melodies in the composition, and have played it before. **At the intermediate level, we can sight read music we have never seen or heard before and can sight sing it, although we are not trained in music theory. This level is what is generally considered to be sight reading, and this type of sight reading is the topic of this section.** At the advanced level, we are able to apply basic music theory to the sight reading and we are reading music at a much higher level of understanding. How pianists at each of these levels approach sight reading is obviously different. Below, we discuss sight reading rules that are fairly generally applicable.

1. **Keep the eyes on the music; do not look at the keyboard/fingers.** You may glance at the hands when it is absolutely necessary for large jumps. You can also develop a peripheral vision towards the keyboard so that you have some idea of where the hands are while still looking at the score. Peripheral vision has the advantage that you can keep track of both hands simultaneously. **It**

is particularly beneficial to develop a habit of feeling the keys before playing them. Although this rule applies whether you are sight reading or not, it becomes critical in sight reading. It also helps to "get there ahead of time" for jumps, see section 1.3.7.5 and 1.3.7.6 above; therefore, you should practice the jump maneuvers in conjunction with the sight reading practice.

2. **Play through mistakes and make them as inaudible as possible.** The best way to do this is to make it sound as if you had modified the music — then the audience does not know whether you made a mistake or changed it. This is why students with basic music theory training have such an advantage in sight reading. Three ways to make mistakes less audible are (i) keep the rhythm intact, (ii) maintain a continuous melody (if you can't read everything, carry the melody and omit the accompaniment), and (iii) practice simplifying those parts that are too complicated to sight read. The first thing that must be done is to eliminate the habits of stopping and backtracking, or stuttering, at every mistake, if you already have those habits. **The best time to develop the skill of not stopping at every mistake is when you begin your first piano lessons.** Once the stuttering habit is ingrained, it will take a lot of work to eliminate it. For those with a stuttering habit, the best thing to do is to decide that you will never backtrack again and try your best at every mistake — it will slowly start to go away. Learning to anticipate flubs is a great help, and this will be discussed below. The most powerful tool, however, is the ability to simplify the music. Eliminate ornamentals, fish out the melody from fast runs, etc.

3. **Learn all the common musical constructs: major and minor scales and their fingerings as well as their corresponding arpeggios, common chords and chord transitions, common trills, ornaments, etc.** When sight reading, you should recognize the constructs and not read the individual notes. Memorize the locations of those very high and very low notes as they appear on the score so that you can find them instantly. Start by memorizing all the octave C's, then fill in the others.

4. **Look ahead of where you are playing; at least one bar ahead, but even more, as you develop the skill at reading the music structure.** Try to read one structure ahead. By looking ahead, you can not only prepare ahead of time but also anticipate flubs before they occur. You can also anticipate fingering problems and can avoid painting yourself into impossible situations. Although fingering suggestions on the music are generally helpful, they are often useless because, although they may be the best fingerings, you may not be able to use them without some practice. Therefore, you should develop your own set of fingerings.

5. "Practice, practice, practice". **Although sight reading is relatively easy to learn, it must be practiced every day in order to improve. It will take most students from one to two years** of diligent practice to become good. Because sight reading depends so heavily on recognition of structures, it is closely related to memory. This means that you can lose the sight reading ability if you stop practicing. However, just as with memory, if you become a good sight reader when young, this ability will stay with you all your life.

Of course, you should keep adding to the "tricks of the trade" as you improve. You can acquire the art of scanning through a composition before sight reading it, in order to get some feel for how difficult it is. Then you can figure out ahead of time how to get around the “impossible” sections. You can even practice it quickly, using a condensed version of the learning tricks (HS, shorten difficult segments, etc.), just enough to make it sound passable. I have met sight readers who would talk to me about some sections of a new piece for a while, then play through it with no trouble. I later figured out that they were practicing those sections in the few seconds they had while they were distracting me with their “discussions”.

In order to practice sight reading, you will need to gather several books with many easy pieces and read through them. Because it is initially easier to practice “sight reading” with familiar pieces, you can use the same composition to practice sight reading several times, a week or more apart. However, you should also practice with pieces that you had never seen before in order to develop true sight reading skills. The most useful skill for help with true sight reading is sight singing, which we now cover.

1.3.12 Learning Relative Pitch and Perfect Pitch (Sight Singing)

Updated: December 5, 2002

Relative pitch is the ability to identify a note, given a reference. Perfect pitch (also called absolute pitch) is the ability to identify a note without being given a reference note. People with good perfect pitch will instantly identify 10 notes played simultaneously as a chord. How good you are is determined by how accurately you can reproduce a pitch, how quickly you can identify a note, and how many notes you can identify when they are played simultaneously. **Nobody is born with relative or perfect pitch; they are learned skills.** This is because the chromatic scale is a human invention — there is no physical relationship between the pitches of the chromatic scale and nature. The only physical relationship between the chromatic scale and the ear is that both operate on a logarithmic scale in order to accommodate a large frequency range. The effect of the logarithmic human hearing is that the ear hears a large difference in pitch between 40 and 42.4 Hz (a semitone or 100 cents), but hears almost no difference between 2000 Hz and 2002.4 Hz (about 2 cents), for the same difference of 2.4 Hz. The human ear responds to all frequencies within its range and is not calibrated on an absolute scale at birth. This is in contrast to the eye, which responds to color on an absolute scale (everyone sees red as red) because color detection is achieved using chemical reactions that respond to specific wavelengths of light. Some people who can identify certain pitches with specific colors can acquire perfect pitch by the color that the sound evokes. They are effectively calibrating the ear to an absolute reference.

Perfect and relative pitch are best learned in very early youth. Babies who cannot understand a single word will respond appropriately to a soothing voice or a lullaby or an angry sound, which demonstrates their readiness for musical training. **The best way to acquire perfect pitch is to be exposed almost daily to well tuned pianos from birth.** Therefore, every parent who has a piano should keep it tuned and play it for the baby from birth. Then they should test the child from time to time for perfect pitch. This test can be performed by playing a note (when the child is not looking) and then asking her/im to find that note on the piano. If the child can find it after several tries, s/he has relative pitch; if s/he can find it the first time every time, s/he has perfect pitch. The particular temperament to which the piano is tuned (equal, Well temperament, Pythagorean, etc.) is not important; in fact most people with perfect pitch know nothing about temperaments and when notes on pianos tuned to different temperaments are played, they have no trouble in identifying the notes. Perfect pitch and relative pitch can be acquired later in life but becomes difficult after age 20 to 30. In fact, **even those with perfect pitch will slowly lose it starting around age 20, if it is not maintained.** Many piano schools routinely teach perfect pitch to all their students. Although the success rate is not 100%, a vast majority of the students generally succeed. The problem with teaching a group of older students is that there is always a certain percentage of "pitch deprived" students who had never been trained in pitch and who will have difficulty learning even relative pitch.

Babies can hear right after birth. Many hospitals routinely screen babies immediately after birth in order to identify hearing impaired babies who will need special treatments immediately. If the hearing impaired babies do not receive the sound stimuli, their brain development will slow down; this is another evidence that music can help brain development. For babies, the memory of external sound in the brain is nearly empty. Thus any sound heard at that stage is special, and all subsequent sounds are referenced to those initial sounds. In addition, babies (of most species, not only humans) use sound to identify and bond to the parents (usually the mother). Of all the sound characteristics that the baby uses for this identification, absolute pitch is probably a major characteristic. These considerations explain why they pick up absolute pitch so readily, and why practically all babies should be able to do so. Some parents expose babies to music before birth to accelerate the babies' development, but I wonder if this will help perfect pitch, because the sound velocity in amniotic fluid is different from that in air with a resultant change in apparent frequency. Therefore, this practice might confuse the perfect pitch.

Having perfect pitch is clearly an advantage. It is a great help for memorizing, sight reading, and recovering from blackouts, and for composing music. You can be the pitch pipe for your choir, and easily tune a violin or wind instrument. It is a lot of fun because you can tell how fast a car is going by just listening to the tires whine, you can tell the differences between different car horns and locomotive whistles, especially by noting whether they use thirds or fifths. You can remember telephone numbers easily by their tones. However, there are disadvantages. Music played off tune does not sound right. Since so much music is played off tune, this can present quite a problem. The person can sometimes react strongly to such music; physical reactions such as teary eyes or clammy skin can occur. Transposed music is OK because every note is still correct. Out-of-tune pianos become difficult to play. **Perfect pitch is definitely a mixed blessing.**

Start learning pitch identification by learning relative pitch first because it is easier and is needed for learning perfect pitch. Begin by learning the scales and chords. First learn the C major scale. Given C, can you sing all the other notes in the octave in sequence? Given any note, can you sing another note, one full tone or a semitone up or down? Next, learn the chromatic scale. Then learn the chords. Given C, can you sing a third, fourth, fifth, or octave? Learning relative pitch is fairly easy for most piano students because they have heard the scales and chords so many times.

You can now graduate to sight singing actual music. You might start with music you already know, to make it easier to start. Then gradually practice on music you never played before. Congratulations (after a year or so of practice)! You have just acquired a skill that is not only useful in its own right, but will also be helpful in sight reading.

If you do not have perfect pitch, you should consider learning perfect pitch as a long term project of a year or more. One way to start is by memorizing one note. You might pick A440 because you hear it every time you go to a concert and can perhaps recall it most easily. However, A is not a useful note for getting to the various chords of the C major scale, which is the most useful scale to memorize. Therefore, pick C, E, or G, whichever you tend to remember best. Your accuracy may be atrocious in the beginning; you might be easily off by 3 or 4 semitones, but it should improve with time. Devise ways of checking yourself. One way is to identify the highest and lowest notes you can hum; for me, they are F3 and F5. In that case, F4 may be the best note to memorize. By trying to sing one octave up or down, you can find out if your F4 is too high or too low.

Another way is to remember a favorite composition, such as a Bach Invention that you can play. It is memorized, so you should be playing it in your mind from time to time (keyboard memory). Try singing it in absolute pitch, and check with the piano. Memorizing a short piece of music at absolute pitch has the advantage that you memorize many notes at once, and it does not require that much more work than memorizing one note. As with sight reading, you must practice every day; otherwise, there may be little progress. For learning the absolute pitches of C, D, E, F, G, you might use the beginning of Bach's Invention #1, and #8 will provide F, A, B, and C, to complete the octave.

For example, I learned perfect pitch by using Bach's Invention #1. I first memorized C4. I could test it by humming down to F3, which is the lowest note that I can hum. I then tested my C4 using C5 (obtained from C4 using relative pitch) by humming up to F5, which is the highest note that I can hum. When I first started practicing perfect pitch, I was frequently off by 3 semitones for several months (I was not practicing seriously, and did not practice every day). After a few months, I was generally within one semitone. Then I tested all the other notes, randomly across the piano. If I practiced diligently for a while, every note took on an individual characteristic so that I could identify it without using relative pitch from the C4. This came as quite a pleasant surprise. I identify the notes of the octave using the "do re mi" system instead of C D E, and when I press any C, it seems to say "do" to me. However, if I stop practicing for a while, this ability disappears, and I need to start all over again, even when my C4 is still pretty close.

1.3.13 Videotaping and Recording Your Own Playing

Updated: December 5, 2001

One of the best ways to improve your musical playing and to practice for recitals is to videotape/record it and watch/listen to it. You will be surprised at how good and how bad the different parts of your playing are. They are often very different from what you imagine yourself to be doing. Do you have a good touch? Do you have rhythm? What are you doing, that is breaking up the rhythm? Is your tempo accurate and constant? What are your strengths and weaknesses? Do you clearly bring out the melodic lines? Is one hand too loud/soft? Are the arm/hands/fingers in their optimum positions? Are you using the whole body — i.e., is the body in synch with the hands or are they fighting each other? All these and much more become immediately obvious. The same music sounds quite different when you are playing it or listening to its recording. You hear much more when you are listening to a recording than when playing it. Video taping is the best way to prepare for recitals and can sometimes eliminate nervousness almost completely.

Until recently, most pianists tried mainly to make audio recordings, thinking that the musical output was the most important; in addition, the older camcorders could not adequately record music. Audio recording has the disadvantage that proper recording of the piano sound is more difficult than most people realize and such attempts usually result in failure and abandonment of the effort. Camcorders have become so affordable and versatile that videotaping is now unquestionably the better method. Although the resulting sound may not be CD quality (don't believe the claims of digital video camera manufacturers), you do not need such quality to achieve all the useful pedagogical objectives. Only when you have a properly voiced, high quality grand piano (Steinway B or better) and you become an advanced player, do you need the necessary equipment for satisfactory audio recording. Even then, you will get better results more cost effectively by seeking out a recording studio.

Initially, start by making a one-to-one map between what you *think* you are playing and the actual output. That way, you can modify your general playing tendencies so that the output will come out right. For example, if you are playing faster than you think in easy sections and slower in difficult sections, you can make the proper adjustments. Are your pauses long enough? Are the endings convincing? The recording is also helpful in deciding whether you want or need a better piano; your inability to perform satisfactorily may in fact be caused by the piano, not you. With old, worn hammers, you can't play pianissimo. Once you become a good enough pianist, factors such as the quality of the piano and proper voicing of the hammers will show up more obviously in the recordings.

There is no question that you must record your playing if you want to progress beyond just playing for yourself. The recording session will test how you might react in an actual performance, for example, if you make a mistake or have a blackout. Watching yourself react to mistakes will give you an opportunity to see what types of reactions are "proper" and what types are "improper". Also, during a performance, you tend to get blackouts, etc., at unexpected places where you generally had no trouble during practice. Recording sessions will bring out most of these problem spots.

In general, your pieces are not "finished" unless you can record them satisfactorily; that is, to the degree of perfection that you desire. Videotaping turns out to be a very good simulation of playing in recitals. Thus, if you can play satisfactorily during videotaping, you will have little trouble playing that piece in a recital. You will also find that you are not nervous performing pieces that you can record with acceptable results; we will discuss this in more detail in the section on nervousness (stage fright). Thus videotaping is one of the best tools for polishing a piece and getting it ready for performing.

What are the disadvantages? The main disadvantage is that it will take a lot of time, because you must watch or listen to the recordings. You might be able to save some time by listening while you are doing some other chore. The recording session itself takes little extra time because that counts as part of practice time. However, every time you correct a section, you must re-record and listen again. Thus there is no escaping the fact that watching/listening to yourself is going to be a time consuming operation. However, it is something that every piano student must do. Another disadvantage is that, without a really super recording system, you may need to use more pedal than you would like because the percussive component of the piano sound is picked up more efficiently by the audio system than by the human ear.

I describe some methods for audio and video recording below.

1.3.13.1 Audio Recording

Audio recording piano music is one of the most demanding of recording tasks. Things like portable cassette recorders for recording voice will not do, because the volume and frequency ranges of the piano exceed the capabilities of most inexpensive recording systems under about $1000.00. Modern equipment is sufficient to pick up most of the frequency range, and what small distortions are introduced, are not generally bothersome. However, the frequency response is not sufficiently flat, the highest and lowest frequencies are missed, and the dynamic range is insufficient. There is a surprising amount of audio power in ambient noise that the human ear/brain excludes (for example, the ears are shaped in such a way as to act as a noise filter), which microphones will pick up. Therefore, you will have to put up with some hiss for the softest playing and/or distortion for the loudest sounds, and all background noise (such as someone walking around or washing dishes) must be minimized. And unless you purchase very good mikes and/or put a lot of effort into their proper placement, etc., the piano sound will not be faithfully reproduced.

The following is an audio recording system that I have set up for myself. The components are:

1. Sony MiniDisc ($150).
2. Small mixer ($150 to $250).
3. Boundary or PZM (Pressure Zone Microphone) mike ($50 to $300 each). You will need one for mono recording and two for stereo.
4. Connecting cables.

I am assuming that you have a HiFi system into which you can plug the output; if not, use your TV (via the mixer). The Sony MD is readily available at electronics stores. In the US, Sam Ash may be the best place to buy a mixer, cables and mike, or you can get them at Radio Shack.

The MD is convenient because it is easy to edit, label, erase, and to quickly locate different recordings, is portable (fits in a small pocket), operates on its own rechargeable battery and comes with headphones. You can record 74 minutes on one disk, which can be rewritten any number of times. It also has many features such as optical and analog input/output, and most of the important functions (volume [both for record and playback], recording modes [mono/stereo], etc.), are programmable. **The greatest disadvantage of the MD (I don't know if this has been corrected with the newer models) is that, although it is a digital device, it has no digital output.** Within its dynamic range, the sound quality is almost as good as a CD so that the sound quality will be limited by the mike. Make sure to bring all the components with you when shopping around for the cables.

If you have a versatile HiFi system, you may not need the mixer. However, because the mixer allows you to try many more options and to optimize the system, I highly recommend it. You might first set up the system without the mixer and then buy it if necessary. The mixer has many built-in functions and just about any type of connector you might have, allowing you to connect practically any device to any other device and perform some signal processing. It contains pre-amps, signal attenuators, equalizers, balancers, etc. It has inputs for mono and stereo so that you can put in a mono signal and distribute it to both inputs of your stereo system. This is useful if you have only one mike. However, stereo recording gives audibly better results. For example, one mike placed towards the treble will not pick up sufficient bass sound; however, you can correct for this using the mixer. Most mixers will even supply power to your mike. Since the MD has both a line-in and mike inputs, you can record either with or without the mixer; however, you will usually sacrifice quite a bit of dynamic range, resulting in distortion or excessive noise. For playback, the same mixer will allow you to plug the output into any HiFi system. For many HiFi systems, the MD output may not have sufficient power.

1.3.13.2 Camcorders

Digital camcorders are better than the older analog types because you can make copies without degradation, they provide more options for editing, etc., and you can copy them directly to CDs or DVDs. Once you start taping, you may want to send the tapes to other people! However, analog camcorders are more affordable and are quite adequate. The biggest problem with camcorders is that they all have motors that make noise which is picked up by the built-in mike. Find a model with either an attachable mike of good quality, or a mike input and buy a separate quality mike. This will produce better results than the built-in mike. Also, make sure that the AGC (automatic gain control) can be turned off. Especially with classical music, you want to record the entire dynamic range of your playing. Some AGCs in high end camcorders do such a good job that you barely notice them, but you should make every effort to turn them off because the dynamic range is such an important characteristic of the piano. Most camcorders have plugs for connecting to a TV, which makes viewing simple. You will also need a fairly sturdy tripod; a light one might shake if you really pound away at the piano.

1.3.14 Preparing for Performances and Recitals

1.3.14.1 Why Do Some Pianists Never Perform?

Updated: January 11, 2001

Many amateur pianists never perform. Even more surprisingly, many piano teachers never hold recitals of their students. Why does this happen so frequently, when piano is a performing art? Clearly, there is something wrong in the learning/teaching procedures when the main objective of the art is not attained. The obvious reason for non-performance is that the performance tends to be a disaster. If your playing is terrific, you will be playing to audiences every chance you have. First of all, there shouldn't be a reason why performances must turn disastrous because no matter what your level, there are always pieces that are easy for you to play. Secondly, many students do not realize that disasters don't just happen, they are *caused*. You have to do something wrong to cause a disaster. When anything happens, there is always a reason. Let me explain. Practicing to play a piece of music and practicing to perform can be two entirely different things. Many students make the mistake of thinking that being able to play automatically qualifies them to perform. Many teachers know only how to teach to play, but not to perform. Moreover, just as the intuitive method of piano practice is one of the worst methods you can use, so the intuitive methods of preparation for recitals are the reasons why performances end up as disasters. We devote the rest of this section to learning how to perform, and how to avoid common pitfalls.

Of course, there are plenty of valid excuses for not being able to perform. Knowing these excuses is one of the prerequisites for learning how to perform. Perhaps the most important excuse is that you are always learning new pieces so that there is insufficient time to really finish a piece or maintain the finished pieces in playable condition. We saw that learning a new piece is the best way to forget old pieces. For those who have never performed, the second most important reason is that they probably never really finished anything. There is always that one difficult section you can't quite manage in every "interesting" piece worth performing. If you haven't performed the piece, you have no idea whether it is finished or not. Another excuse is that pieces that are easy for you are somehow always uninteresting. Note that the learning methods of this book are designed to counter every one of these excuses, mainly by accelerating the learning process and by encouraging memorization. The section on "Maintenance" in the memory section is obviously important. If you make it a point to always practice musically, then no piece is ever uninteresting, whether it is played slowly or fast. There are many other aspects of performance that we must now learn.

1.3.14.2 Benefits and Pitfalls of Performances/Recitals

Knowledge of the benefits and pitfalls is important because this knowledge determines how we design our daily piano learning program. For the amateur pianist, the benefits of performances, even casual ones, are immeasurable. The most important benefit is that technique is never really demonstrated until you can demonstrate it in a performance. That is, music and technique are inseparable, so that if you perform successfully, it means that you practiced correctly. This works both ways: if you practice correctly, performing shouldn't be a problem. This point draws a clear line between practicing musically, relaxed, on the one hand and, on the other, repeating mindlessly just to be able to play a difficult passage, working like a dog, mistaking piano for some type of calisthenics.

For young students, the benefits are even more fundamental. They learn what it means to complete a real task, and they learn what "making music" means. Most youngsters in protected environments don't learn these skills until they go to college; piano students must learn them at their *first recital,* regardless of age. Students are never as self-motivated as when preparing for a recital. Teachers who have held recitals know the enormou benefits. Their students become focused, self-motivated, and results oriented; they listen intently to the teacher and really try to understand the meaning of the teachers' instructions. The students become deadly serious about eliminating all errors and learning everything correctly — it is capitalism at its best, because it is *their* recital. Teachers without recitals often end up with students who practice maybe a few times just before lesson day — the difference is like night and day.

Because the psychology and sociology of piano playing is not well developed, there are pitfalls that we must seriously consider. The most important one is nervousness and its impact on the mind, especially for the young. Nervousness can make recitals a frightful experience that requires careful attention in order to avoid not only unhappy experiences but also lasting psychological damage. At the very least, reducing nervousness will alleviate stress and fright. There is not enough attention paid to making recitals a pleasant experience and reducing the tension and stress, especially for piano competitions. This whole subject will be treated more completely in the section on nervousness. The point here is that any treatment on performing must include a discussion of stage fright. Even great artists have stopped performing for long periods of time for one reason or another. Therefore, although good piano teachers always hold recitals of their students and enter them into competitions, it is the job of the parents to look out for the social and psychological welfare of their children, since piano teachers are not necessarily good sociologists or psychologists. It is important for any person guiding youngsters through recitals and competitions to learn the fundamentals of what causes nervousness, how to deal with it, and its psychological consequences. Therefore, the following section (section 1.3.15) on nervousness is a necessary companion to this section.

There are numerous other psychological and sociological implications of recitals and competitions. The judging systems in music competitions are notoriously unfair, and judging is a difficult and thankless job. Thus students entered into competition must be informed of these shortcomings of the "system" so that they do not suffer mental damage from perceived unfairness and disappointment. It is difficult, but possible, for students to understand that the most important element of competitions is that they participate, not that they win. There is too much emphasis on technical difficulty and not enough on musicality. The system does not encourage communication among teachers to improve teaching methods. It is no wonder that there is a school of thought that favors eliminating competitions. There is no question that recitals and competitions are necessary; but the present situation can certainly be improved.

1.3.14.3 Preparing for Performances/Recitals

Even casual performances require preparation and practice. Recitals generally require a strict preparation routine. We shall start with discussions of casual performances and then describe the procedures for recitals, as the way you approach casual and formal performances can be quite different. There are at least two stages to the process of learning how to perform. The first is the initiation stage at which you get over the initial difficulties of performing a given piece of music for the first time. In the second stage, in which you are now familiar with what is involved in the preparations, you can concentrate on working on the details of the procedures.

In general, don't expect to perform anything well, casual or otherwise, unless you have performed the piece at least several times, and some claim, at least 5 times. Sections that you thought were simple may turn out to be difficult to perform, and vice versa. Thus the first order of business is to lower your expectations and start planning on how you are going to play this piece, especially when unexpected things happen. It is certainly not going to be like the best run you made during practice.

A few mistakes or missed notes goes unnoticed in practice, and your assessment of how they sound during practice is probably much more optimistic than your own assessment if you had played exactly the same way for an audience. After a practice, you tend to remember only the good parts, and after a performance, you tend to remember only the mistakes. Usually, you are your worst performance critic; every slip sounds far worse to you than to the audience. Most audiences will miss half of the mistakes and forget most of what they do catch after a short period of time.

Most students do not listen to themselves sufficiently during practice; they often practice as if on auto-pilot. This does not mean that you can put yourself on auto-pilot for a performance in the hopes that you can perform like you did during practice. You can't just run with a piece of music and expect the audience to follow you; if you did, you will lose them because they will sense that the music is not communicating. The correct way is to listen to your own music (always) and to let your music lead you — that is the only way it is going to attract the audience's attention.

During a performance, your music will always lead you, whether you let it or not; this is why students who make mistakes become so depressed and this makes it so much harder to play well. On the other hand, if you get a good start, the audience will be drawn in, and the music will feed on itself and the performance becomes much easier.

This change from casual listening during practice to critical listening during a performance can change your playing environment sufficiently to interfere with your memory and playing. That is why you must always listen to yourself critically while practicing. This is the type of experience you need to go through for the first few times you perform in order to know how to change your practice methods and to know to what extent these factors will affect your playing. Lowering your expectations generally means playing a little slower than your practice speeds and paying more attention to every note. As we saw earlier, playing slowly is not necessarily easier, and this illustrates the importance of slower practice. Remember that the audience hasn't heard this piece hundreds of times like you have and so are not as familiar with every detail; chances are, it will sound much faster to them than to you. And you will need to spoon feed every note to them or they won't hear it. During practice you will probably even hear notes that you missed, as if you had played it correctly, because you know that it is supposed to be there. Clearly, the science of performing is complex and experienced performers can give you plenty of useful advice. But let's not get too far ahead of ourselves and restart this discussion from the very beginning — how do you prepare for performances during practice?

1.3.14.4 Practicing for Performances and Playing Musically

Although the ideas of this paragraph apply to all practice sessions, this is the most appropriate place to bring up this subject. **This is the subject of how musically you practice and how loud you practice, especially the more exciting loud, passages. Many students hate to practice when others are around to listen. Others are of the opinion that piano practice is necessarily unpleasant and punishing to the ear. These are symptoms of a common misconception.** If you are using the correct practice methods and making terrific progress, and quickly transitioning to making music, there is nothing unpleasant about such practice sessions.

A common mistake is to practice loud passages loud all the time when learning a new composition. There is no need to play a loud passage loud until you can play it satisfactorily; loudness is added later. By separating the loudness from the technique, you acquire technique with less fatigue and learn to reduce stress faster. Once the technique is attained with full relaxation, you can add much more power than you could before, without picking up bad habits. Students who have not completely eliminated stress often practice everything too loud. Thus practicing too loud is frequently an indication of some underlying problem. Of course, there are students who never play sufficiently firmly to produce a solid, clear, tone, and these have the opposite problem of having to firm up their playing. Both problems, either playing too loudly or too softly, can be helped by practicing the gravity drop. **The best criterion that you are practicing correctly is the reaction of others — if your practice sounds good to them, or at least it doesn't bother them, then you are probably doing it right.**

Since technique is inseparable from music (even scales and arpeggios should be practiced musically, not mechanically) everything you practice and play must be musical. This type of practice will be of great help when it comes time to perform.

Looking at this another way, practicing without regard to musicality will certainly make switching to "performance mode" an impossible task. But of course, this matter is much more fundamental; it is a matter of what is the right and wrong way to acquire technique for difficult passages.

What does it mean to play musically? This question can only be answered definitively by application of the myriad micro-rules that apply to specific passages of specific compositions. If you have incorporated all of the musical notations and markings into your music, this should follow automatically. However, there are a few very useful macro-rules, without which most performances would come out flat. Basically, during a performance, you have to be able to play with confidence and authority. In order to achieve this, it is useful to keep the following rules in mind:

1. carefully and consciously connect each bar to the preceding bar (or measure, or phrase). These bars/measures do not stand alone; one logically flows into the other and they all support each other. They are connected rhythmically as well as conceptually. You might think that this point is trivially obvious; however, when you do this consciously, you might be surprised by a significant improvement in your music.

2. there must always be a conversation between the RH and LH. They don't play independently. And they won't talk to each other automatically just because you timed them perfectly. You must consciously create a conversation between the two hands, or voices, in the music.

3. "cresc." means that most of the passage should be played softly; only the last few notes are loud, which means that it is important to start softly. Similarly, for other indications of this nature (rit., accel., dim., etc); make sure that you have reserved space for the action to take place and don't start the action immediately, wait until the last moment.

4. strive more for accuracy than expressive rubato; rubato is often too easy, incorrect, and not in tune with the audience. This is the time to use the metronome to check your timing and rhythm!

5. when in doubt, start and end each musical phrase softly, with the louder notes near the middle. It is usually incorrect to have loud notes at the ends.

Musical playing feeds on itself. Thus a good performance begets a better performance. This also applies to practicing. Musicality also has no limit — you can improve no matter where you are on the scale of musicality. The terrifying part of this is the flip side. If you do not pay attention, you can develop non-musical playing habits that can keep on destroying your musicality. This is why it is so important to focus on musicality and not only on technique; it can make the difference between whether you can perform or not. The above points (1 to 5) are not trivial. If you focus on them, several things will automatically happen. Firstly, you will be so preoccupied by trying to get them all to come out right that you will have less opportunity to make non-musical mistakes. Secondly, they will set your playing on a sound basis from which to improve. As you hear the music coming out correctly, it will become much easier to further enhance the music than if you had started it wrong.

1.3.14.5 Casual Performances

Now let's talk about casual performances. Common types of casual performances are playing pieces for testing pianos in stores or playing for friends at parties, etc. These are different from formal recitals because of their greater freedom. There is usually no set program, you just pick anything you think appropriate for the moment, and it may in fact be full of changes and interruptions midway through the playing. Nervousness is not even an issue. Even with the alleviating factors, this is not easy in the beginning. One thing you can do to get an easy start is to play little snippets (short segments from a composition) from various pieces you know. You can start with easy ones. You can pick out just the best sounding sections. If it doesn't work out too well, start on another one. Same, if you get stuck. You can start and quit at any time. This is a great way to experiment and find out how you perform and which snippets work. Do you tend to play too fast? It is better to start too slow and speed up than the other way round. Can you adjust to a different piano? Can you keep track of the audience reaction? Can you make the audience react to your playing? Can you pick the right types of snippets for the occasion? Can you put yourself in the right frame of mind to play? What is your level of nervousness, can you control it? Can you play and talk at the same time? Can you gloss over mistakes without being bothered by them?

Playing snippets has one interesting advantage which is that most audiences are very impressed by your ability to stop and start anywhere in the middle of a piece. Most people assume that all amateur pianists learn pieces by finger memory from beginning to end, and that somehow, the ability to play snippets requires special talent. Since the methods of this book are based on practicing segments, this should be an easy thing to do. Start with short snippets, and then gradually try longer ones. Once you have done this type of casual snippet performance on 4 and 5 different occasions, you should be ready to perform longer sections.

There are few special rules for preparing for snippet performances. Don't perform a piece you had just learned. Let it stew for at least 6 months; preferably one year. If you had just spent 2 weeks learning a difficult new piece, don't expect to be able to play snippets you had not played at all in those 2 weeks — be prepared for all kinds of surprises, such as blackouts. In that case, try out the snippets at home before attempting to perform them. On the other hand, if you had been polishing old pieces for the last 2 weeks, you can play any snippet you want; even ones you hadn't played at all for months. They will tend to come out fine. Don't practice the snippets fast on the day on which you might be performing them. Practicing them very slowly will help. It is a good idea to double check that you can still play them HS. You can break a lot of these rules for very short snippets. You should experiment to see which rules you need to follow for snippet performances.

Because casual performances are much more relaxed, it provides an avenue for easing your way gradually into performing, in preparation for recitals. This is because recitals are often high pressure affairs with the attendant nervousness. Students suddenly thrust into formal recitals often end up becoming nervous at *any* performance. Nervousness is a purely mental thing and is a feedback mechanism that feeds on itself. Therefore it is quite possible that it can be mostly avoided depending on the person's history. For example, by going through enough casual performances without developing any nervousness, a person can get to perform at recitals with much less nervousness than if s/he were suddenly thrust into formal recitals. Thus one thing you should work on, is to learn how to suppress nervousness during casual performances. Learning to enjoy the occasion, to use it as a way to demonstrate how you can express yourself, etc., will reduce nervousness, whereas fear of performing, making mistakes, etc., will increase it.

Clearly, it is a mistake for a teacher to take a student and enter her/im into a recital without any preparation. Students must be gradually introduced to performing through a well planned program. They should be taught the art of snippet playing at informal occasions. They should practice performing by videotaping. Students need to take a course on nervousness. They should play very simple pieces for the first few recitals. Students and their parents must know the details of the recital preparation routines (see below). In summary, even if we know the art of making music, we can't perform without training in the art of performing.

1.3.14.6 Preparation Practice Routines

As noted above, there are good reasons why all successful piano teachers hold recitals of their students. Therefore, attending these recitals is a good way to find good teachers and to learn about how they teach. There is a direct correlation between how good the teacher is and how many recitals s/he schedules. Obviously, the better teachers hold more recitals, some as many as six or more a year. See the section on "Teaching" for how you can schedule so many recitals a year. Have you noticed that student recitals tend to be either terrific or terrible? This happens because some teachers know how to prepare their students for recitals while others do not. This explanation is supported by the observation that, when the recital is good, all the students play well, and vice versa.

Even if a student can play perfectly during practice, s/he can make all kinds of mistakes during a recital if the preparation is incorrect. Most students intuitively practice hard and at full speed during the week preceding the recital, and especially on the day of the recital. In order to simulate the recital, they imagine an audience listening nearby and play their hearts out, playing the entire piece from beginning to end, many times. This practice method is the single biggest cause of mistakes and poor performance. The most telling remark I hear so often is, "Strange, I played so well all morning but during the recital, I made mistakes that I don't made during practice!" To an experienced teacher, this is a student practicing out of control without any guidance about right and wrong methods of recital preparation.

Teachers who hold those recitals in which the students perform wonderfully keep a tight leash on their students and control their practice routines closely. Why all this fuss? Because during a recital, the most stressed element is the brain, not the playing mechanism. And this stress cannot be replicated in any kind of simulated performance. Thus the brain must be rested and fully charged for a one-time performance; it cannot be drained by playing your heart out. All mistakes originate in the brain. All the necessary information must be stored in an orderly manner in the brain, with no confusion. This is why improperly prepared students always play worse in a recital than during practice. When you practice at full speed, a large amount of confusion is introduced into the memory. It is analogous to a computer that has been used for a long time without defragmenting the main disk and deleting duplicate and useless files. In addition, the environment of the recital is different from that of the practice piano. Therefore, you must have a simple, mistake-free memory of the piece that can be retrieved in spite of all the added distractions. This is why it is extremely difficult to perform the same piece twice on the same day, or even on successive days. The second performance is invariably worse than the first, although intuitively, you would expect the second performance to be better because you had one extra experience performing it. As elsewhere in this section, these types of remarks apply only to students. Professional musicians should be able to perform anything any number of times at any time; this skill comes from continuous exposure to performing, and honing the proper rules of preparation.

Through trial and error, experienced teachers have found practice routines that work for students. The most important rule is to limit the amount of practice on recital day, so as to keep the mind fresh. The brain is totally unreceptive on recital day. It can only become confused. Only a small minority of talented students have sufficiently "strong" musical brains to assimilate something new on recital day. By the way, this also applies to tests and exams. Most of the time, you will score better in an exam by going to a movie the night before the exam than by cramming. A typical recommended practice routine is to play nearly full speed once, then medium speed once and finally once slowly. That's it! No more practice! Never play faster than recital speed. Notice how counter intuitive this is. Since parents and friends will always use intuitive methods, it is important for the teacher to make sure that any person associated with the student also know these rules, especially for the younger students. Otherwise, in spite of anything the teacher says, the students will come to the recital having practiced all day at full speed, because their parents made them do it.

Of course, this is just the starting point. It can be altered to fit the circumstances. This routine is for the typical student and is not for professional performers who will have much more detailed routines that depend not only on the type of music being played, but also on the particular composer or particular piece to be played. Clearly, for this routine to work, the piece will have had to be ready for performance way ahead of time. However, even if the piece has not been perfected and can be improved with more practice, this is still the best routine for the recital day. If you make a mistake that you know is stubborn and which you are almost certain that it will occur during the recital, fish out just the few bars containing the mistake and practice those at the appropriate speeds (always ending with slow play), staying away from fast playing as much as possible. If you are not sure that the piece is completely memorized, you can play it very slowly several times.

Since you are allowed only one practice at speed (or close to it), what do you do if you make a mistake? Play right through! Don't stop to correct it or even hesitate. Unfortunately, any mistake you make at this time has a high probability of reappearing during the recital. Therefore, after you have finished the piece, go back and fish out the phrase containing the mistake and play it slowly several times. That is all that can be done. The rest of the procedure for avoiding this mistake must be conducted during the recital, see below.

Also, avoid extreme exertion, such as playing a football game or lifting or pushing something heavy. This can suddenly change the response of your muscles to a signal from the brain and you can end up making totally unexpected mistakes when you play at the recital. Of course, mild exercise, stretching, calisthenics, Tai Chi, Yoga, etc., can be very beneficial.

For the week preceding the recital, always play medium speed, then slow speed, before quitting practice. You can substitute medium speed for slow speed if you are short of time, the piece is particularly easy, or if you are a more experienced performer. Actually, this rule applies to any practice session, but is particularly critical before a recital. The slow play erases any bad habits that you might have picked up, and re-establishes relaxed playing. Therefore, during these medium/slow plays, concentrate on relaxation. Sometimes, relaxation becomes difficult at slow play, which is another valid reason for substituting it with medium speed. There is no fixed number such as half speed, etc., to define medium and slow, although medium is generally about 3/4 speed, and slow is about half speed. More generally, medium speed is the speed at which you can play comfortably, relaxed, and with plenty of time to spare. Slow is the speed at which you need to pay attention to each note separately. If you make any mistake while practicing, always play through them; do not stop and restart. Of course you should do this all the time, but it is especially critical before a recital. After you have played the entire piece, go back and check to see if the mistake is a habitual one. If so, practice just the segment containing the mistake. The best time to learn to play through mistakes is from day one when you start your first piano lessons. Then playing through becomes second nature and is not difficult at all. Once you get the habit of "stuttering" at every mistake, it becomes almost impossible to correct, and you wonder how anyone can play through mistakes.

Blackouts are different from mistakes and must be dealt with differently. Never try to restart from where you blacked out unless you know exactly how to restart. Always restart from a preceding section or a following section that you know well (preferably a following section because mistakes cannot be corrected during the recital).

Up to the last day before the recital, you can work on improving the piece. But within the last week, adding new material or making changes in the piece (such as fingering) is not recommended, although you might try it as a training experiment to see how far you can push yourself. Being able to add something new during the last week is a sign that you may be a strong performer. For working on the piece, avoid playing the entire composition many times. It is best to chop it into short segments and practice the segments. Practicing HS is also an excellent idea. Although playing too fast is not recommended in the last week, you can practice at any speed HS. Avoid learning new pieces during this last week. That does not mean that you are limited to the recital pieces; you can still practice any piece that you have previously learned. New pieces are unpredictable and will often cause you to learn new skills that affect or alter how you play the recital piece. In general, you will not be aware that this happened until you play the recital piece and wonder how some new mistakes crept in.

Make a habit of playing your recital pieces "cold" (without any warming up) when you start any practice session. The hands will warm up after one or two pieces, so you may have to rotate the recital pieces with each practice session, if you are playing many pieces. Of course, "playing cold" has to be done within reason. If the fingers are totally sluggish from inaction, you cannot, and should not try to, play difficult material at full speed; it will lead to stress and even injury. Some pieces can only be played after the hands are completely limbered up. It is part of your job to play cold and to find out which ones you can play cold at full speed, and which ones you should not.

Students should record or videotape their playing and listen to these recordings (see section 1.3.13 above). They will be surprised at how different the recordings sound from what they intended to play. Frequently, they will catch a slew of mistakes of which they were not aware. Recording is also a good way to practice playing before an audience. Videotaping is far better than just audio recording and can produce some nearly magical effects. It is by far the best way to simulate a performance; the only better way is to recruit a bunch of people to listen to you. Videotaping has the advantage that you can alternate practicing with taping so that you can immediately correct any mistakes you find. The magic of videotaping works in two ways. First, it is such a good simulation of the actual recital that, if you can play satisfactorily during videotaping, you will have no trouble during the recital — you will gain the confidence to perform. The second magic is that, if you gain sufficient confidence, the nervousness can be almost completely eliminated. Of course, in order to eliminate nervousness, you must also follow all the other points discussed in this book, starting with the attitude that you are a performing pianist and therefore is *expected* to perform. See the following section (section 1.3.15) for more information on controlling nervousness using videotaping.

1.3.14.7 During the Recital

Nervousness is generally worst just before you start to play. Once you start, you will be so busy with the execution that the nervousness will usually be forgotten, and from then on, things will get better. This knowledge can be quite reassuring, so there is nothing wrong with starting play as soon as you sit down at the piano for the recital. Some people will delay starting by adjusting the bench or some clothing item in order to have time to double check that the starting tempo, etc., are correct; this procedure is also acceptable, as it reassures the audience that you are not too nervous and is in no hurry to start. It is a good idea to practice starting, from several days prior to the recital. Whenever you have time, just pretend that it is recital time, and play the first few bars. In particular, practice the first few lines more than anything else. Most people become more nervous than they should be, because the level of nervousness just before playing can be so high that they fear that if it gets any higher, they won't be able to perform. The knowledge that nervousness will subside as soon as you begin play will prevent this from happening.

You can't assume that you won't make any mistakes because that assumption can only get you into more trouble. Be ready to react correctly with each mistake, or more importantly an impending mistake that you can avoid. It is amazing how often you can feel an impending mistake before it hits. This happens because, chances are, you have made this mistake many times before. The worst thing that most students do when they make a mistake or when they anticipate one is to get scared and start playing more slowly and softly. This can *lead* to disaster. At this point in the recital, you can use help from anywhere you can get it. Although finger memory is not something you want to depend on, this is one time you can take advantage of it. Finger memory depends on habit and stimuli — the habit of having practiced many times, and the stimuli of previous notes leading to succeeding notes. Therefore, in order to enhance finger memory, you must play slightly faster and louder, exactly the opposite of what an anxious person would do during a recital (another counter-intuitive situation!). The faster play makes better use of the playing habit, and leaves less time for moving some wrong muscle that might derail you from the habit. The firmer play increases the stimuli for the finger memory. Now playing faster and louder are scary things to do during a recital, so you should practice this at home just as you practice anything else. Learn to anticipate mistakes and to avoid them by using these avoidance methods. The important lesson here is that one trick for "playing through mistakes" is to play it slightly faster and louder. Another method is to make sure that the melodic line is not broken, even at the cost of missing some "accompaniment" notes. With practice, you will find that this is easier than it sounds; the best time to practice this is when you are sight reading. Another is to at least keep the rhythm. The trick of playing faster works particularly well with blackouts. For mistakes that occur because the passage is difficult, slowing down might be a better approach.

1.3.14.8 That Unfamiliar Piano

Some students fret that the recital piano is a huge grand whereas they practice on a small upright. Fortunately, the larger pianos are easier to play than the smaller ones. Therefore the issue of a different piano is usually not something to worry about for the typical student recital. Larger pianos generally have better action, and both louder and softer sounds are easier to produce on them. In particular, grands are easier to play than uprights, especially for fast, difficult passages. Thus the only time you may have to be concerned about the piano is when the recital piano is decidedly inferior to your practice piano. The worst situation is the one in which your practice piano is a quality grand, but you must play a low quality upright. In that case, technically difficult pieces will be very difficult to play on the inferior piano and you may need to take that into account, for example, by playing at a slower tempo, or shortening or slowing down the trill, etc. The actions of grands can be slightly heavier than those of uprights, which may give some beginners problems, so it is advisable to practice on the grand before the recital. On average, the key weight feel of grands and uprights is about the same because, although most grands have heavier action, they produce more sound, and the two effects tend to cancel each other out. Of course, it is impossible to generalize about pianos because there is so much variation from piano to piano, even within the same model piano from the same manufacturer. Therefore, you should always try to practice on the recital piano. For advanced students, the particular piano can be of paramount importance.

Another important factor is the tuning of the piano. Pianos in good tune are significantly easier to play than one out of tune. Therefore, it is a good idea to tune the recital piano just before the recital. Conversely, it is not a good idea to tune the practice piano just before the recital. In that case you might end up with the situation in which the practice piano is in better tune than the recital piano, and you end up playing the recital on an inferior piano — a difficult feat. An out of tune piano tends to cause flubs and blackouts. Therefore, if the recital piano is out of tune, it may be best to play slightly faster and louder than you intended. Because of the tendency of out of tune pianos to cause flubs and blackouts, the practice piano should always be in reasonable tune. Otherwise, the students may develop a habit of stuttering or lose their confidence in their ability to memorize.

Proper voicing of the hammers (see 2.7.1) is more critical than most people realize. The importance of practicing musically, and especially of being able to play softly, is mentioned repeatedly in this book. You can't do any of that without properly voiced hammers. Hammer voicing is too often neglected in practice pianos with the result that musical playing becomes nearly impossible. How can you practice performing on a piano with which it is impossible to perform? There are many students who think that they cannot perform, simply because their pianos were not properly maintained. The folklore that a great pianist can produce great music using any piano is not true. Please read the section on voicing.

1.3.14.9 After the Recital

Review the recital results and evaluate your strengths and weaknesses so that you can improve your recital preparation routine. In addition to your own evaluation, you need feedback from your teacher, the audience, etc. Everybody must develop a "recital preparation routine", because that is the secret for a good performance. A few students will be able to play consistently without audible mistakes. Most of the others will make several mistakes every time they play. Some will tend to bang on the piano while others may be too timid. There is a cure for every problem. Those who make mistakes probably have not yet learned to play sufficiently musically. Give them easier pieces to perform, not because they are technically easier, but because that will allow them to work on musical playing and to get out of the tendency to flub. Of course, they will still need to learn difficult pieces, in addition to the easier recital pieces, for technical development.

As noted elsewhere, playing several recitals in succession is the hardest thing to do. But if you must, then you will need to recondition the recital pieces immediately following the recital. Play them with little or no expression, medium speed, then slow. If certain sections or pieces did not come out satisfactorily during the recital, you can work on them, but only in small segments. If you want to work on the expression at full speed, do this also in small segments. Experienced teachers know the difficulty of playing consecutively and will purposely use this to strengthen the students' performance ability by scheduling recitals on consecutive days. However, it is my personal opinion that it is more important to train the student to enjoy performing than to give them too many difficult tasks. The joy of performance should not emphasize "showing off" the technical skills of playing difficult pieces but should instead concentrate on making music.

1.3.15 Origin and Control of Nervousness

Updated: November 6, 2004

Nervousness is a natural human emotion just as happiness, fear, sadness, etc., are emotions. Happiness arises as a physical response to a mental perception of something good; fear arises from a perception of danger, etc. Nervousness arises from a mental perception of a situation in which performance is critical. **Therefore, nervousness, like all emotions, is a performance enhancing reaction to perceived critical situations.** Happiness feels good, so we try to create happy situations, which helps us; fear helps us to escape danger, and sadness makes us avoid sad situations which tends to improve our chances of survival. Nervousness makes us concentrate all our energies towards the critical task at hand and is therefore another beneficial survival tool of evolution. Most people dislike nervousness because it is too often accompanied, or is caused, by fear of failure. However, it is important to realize that nervousness is a natural response to critical situations and can be beneficial.

Emotions are basic, primitive, animal reactions, somewhat like instinct, and are not totally rational. Under normal circumstances, emotions guide our daily actions nicely. However, **under extreme conditions, emotions can get out of control, and it can then become a liability.** Clearly, emotions were designed to work only under normal circumstances. For example, fear makes the frog escape long before a predator can catch it. However, when cornered, the frog freezes in fear and this makes it an easier meal for the snake than if the overwhelming fear hadn't paralyzed it. Likewise, **nervousness normally is mild and helps us to perform a critical task better than if we were lackadaisical.** However, under extreme conditions, it can spin out of control and hinder our performance. The requirement to perform a difficult piano solo flawlessly in front of a large audience eminently qualifies as an extreme condition. It is no surprise that nervousness can grow out of control, unless our name is Wolfie or Franz (Freddy apparently didn't qualify, as he was a nervous wreck and disliked public performances). Thus, although violinists do get nervous, it does not spin out of control when they are playing in an orchestra because the conditions are not as extreme as for solo performances. Youngsters, who are too frightened to perform solo, almost always enjoy performing in a group. This shows the over-riding importance of the mental perception of the situation.

Clearly, the way to control nervousness is to first study its cause and nature and to develop methods for controlling it based on this knowledge. Since it is an emotion, any method for controlling emotions will work. Some have claimed that, under a doctor's supervision, medications such as Inderal and Atenolol, or even Zantac will work to calm nerves. Conversely, you can make it worse by drinking coffee or tea, not getting enough sleep, or taking certain cold medications. Emotions can also be controlled by use of psychology, training, or conditioning. Knowledge is the most effective means of control. For example, experienced snake handlers do not suffer any of the emotions most of us would experience when we come close to a poisonous snake because of their knowledge of snakes.

By the time nervousness becomes a problem, it is usually a compound emotion spinning out of control. In addition to nervousness, other emotions such as fear and worry, join in. A lack of understanding of nervousness also creates fear because of the fear of the unknown. As the symptoms worsen, you worry that the extreme nervousness will interfere with the performance. Thus just the simple knowledge of what stage fright is, can be a calming factor by reducing the fear of the unknown.

How does nervousness grow out of control, and are there ways to prevent it? One way to approach this question is to visit some principles of fundamental science. **Practically anything in our universe grows by a process known as the Nucleation-Growth (NG) mechanism. The NG theory states that an object forms in two stages, nucleation and growth.** This theory became popular and useful because it is in fact the way in which the majority of objects in our universe form, from raindrops to cities to stars. It is amazing that this theory, which has many intricate parts, describes the formation of so many things so accurately. **Two key elements of NG theory are: (1) nucleation — nuclei are always forming and disappearing. However, there is a thing called a critical nucleus which, when formed, becomes stable — it does not disappear. In general, the critical nucleus does not form unless there is a supersaturation of the material that aggregate to form it, and (2) growth — for the object to grow to its final size, the critical nucleus needs a growth mechanism by which to increase its size. One of the most interesting aspects of nucleation is that there is almost always a barrier to nucleation — otherwise, everything would have nucleated a long time ago. Growth is a two-way street: it can be positive or negative.**

Let's examine one example: rain. Rain occurs when water droplets form critical nuclei in air that is supersaturated with water vapor (relative humidity greater than 100%). The oft misquoted "scientific truth" that relative humidity never exceeds 100% is routinely violated by Nature because that "truth" is valid only under equilibrium conditions, when all forces have been allowed to equilibrate. Nature is almost always dynamic, and it can be far from equilibrium. This happens, for example, when the air cools rapidly and becomes supersaturated with water vapor. Even without supersaturation, water vapor is constantly forming water droplets, but these evaporate before they can form critical nuclei. With supersaturation, critical nuclei can suddenly form, especially if there are hydrophilic dust particles in the air or a compressive disturbance such as a thunderclap that brings the molecules closer together. The air filled with critical nuclei is what we call a cloud or fog. If the formation of the cloud reduces the supersaturation to near zero, a stable cloud is created; if not, the nuclei will grow by several new mechanisms. This is the second stage of the NG process. The nuclei can bump into each other and aggregate, or start to fall and hit other water molecules and nuclei, until rain drops form.

Let's apply NG theory to nervousness. In everyday life, your sense of nervousness comes and goes, without becoming anything serious. However, in an unusual situation such as just before a performance, there is a supersaturation of factors that cause nervousness: you must perform flawlessly, you didn't have enough time to practice the piece, there is a big audience out there, etc. However, this still may not cause any problem because there are natural barriers to nucleating nervousness, such as a flow of adrenalin, a sense of accomplishment, or even just a lack of the realization that there is nervousness. But then, a fellow performer says, "Hey, I got butterflies in my stomach," and you suddenly feel a lump in your throat and realize that you are nervous — the critical nucleus has formed! This may still not be that bad, until you start to worry that perhaps your piece is not yet ready to perform or the nervousness might start to interfere with the playing — these worries cause the nervousness to grow. These are exactly the processes described by NG theory. The nice thing about any scientific theory is that it not only describes the process in detail, but also provides solutions. So how does NG theory help us?

First of all we can attack nervousness at the nucleation stage; if we can prevent nucleation, it will never form a critical nucleus. Just merely delaying the nucleation will be helpful because that will reduce the time available for it to grow. Playing easier pieces will reduce the supersaturation of worry. Mock recitals will give you more experience and confidence; both will reduce the fear of the unknown. Generally, you need to perform a piece 3 or more times before you know whether you can perform it successfully or not; thus playing pieces that had been performed several times will also help. **Nervousness is generally worst before a performance; once you start playing, you are so busy with the task at hand that there is no time to dwell on nervousness, thus reducing the growth factor.** This knowledge helps because it alleviates the fear that things might get worse during the performance. Not dwelling on nervousness is another way of delaying the nucleation as well as slowing the growth stage. Thus it is a good idea to keep yourself occupied while waiting for the recital to begin. Keyboard memory is useful because you can check your memory and keep yourself occupied at the same time by playing the piece in your mind. See the following section on Teaching for suggestions on how teachers can provide performance training.

For an important recital, avoiding nucleation is probably not possible. Therefore we should also consider ways to discourage growth. Since nervousness generally decreases after the performance starts, this knowledge can be used to reduce the worry and therefore the nervousness. This can feed on itself, and as you feel more assured, nervousness can often dissipate entirely, if you can reduce it below the critical nucleus. Another important factor is mental attitude and preparation. A performance is always an interactive process, with yourself, and with the audience. When the music comes out well, it is easier to perform well; conversely, if you make a mistake, it can feed back psychologically and further degrade the performance. Thus it is important to be mentally prepared so as not to be adversely affected by mistakes or perceived poor performance. Instead of grimacing at a mistake, you might put on a smile. Remember that you are your worst critic and even casual playing sounds terrific to the audience. They generally hear less than half of the mistakes and remember even less, whereas the performer remembers every mistake. Inexperienced performers often try to play too fast which is almost always counterproductive. Playing musically, of course, is always the answer — when you can involve your entire brain in the business of creating music, there is very little brain resources left to worry about nervousness. These are all measures for reducing the growth of nervousness.

It is not a good idea to pretend that nervousness does not exist, especially with youngsters who can more easily suffer long term psychological damage. Kids are smart and they can easily see through the pretense, and the need to play along with the pretense can only increase the stress. This is why performance training, in which nervousness is discussed openly, is so important. For the case of young students, their parents and friends attending the recital need to be educated also. Statements like "I hope you aren't nervous!" or "How can you perform without getting nervous?" are almost certain to cause nucleation and growth. On the other hand, to completely ignore nervousness and send kids out to perform with no performance training is also irresponsible and can even cause irreparable psychological damage.

There is no substitute for the proper mental attitude for controlling stage fright. If you can get into the frame of mind that performing is a wonderful experience of making music for others and develop proper reactions when you do make mistakes, nervousness will not be problematic. There is this huge difference between, for example, creating humor out of a mistake or recovering nicely from it and letting that mistake look like a disaster that mars the entire performance. Here again, we must know what not to do. That is why it is so important, early in a student's career, to play very easy pieces that can be performed without nervousness; even just one such experience can provide the existence proof that performing without nervousness is possible. That single experience can influence your performance attitude for the rest of your life.

In summary, stage fright is a form of nervousness that has spiraled out of control. A certain amount of nervousness is normal and beneficial. You can minimize nervousness by delaying its nucleation by keeping busy and reducing its growth by playing musically. Thus it doesn't make sense to ask "do you get nervous when you perform?" Everyone does, and should. We only need to contain it so that it does not grow beyond our control. **Thus realizing that a certain amount of nervousness is normal is the best starting point for learning how to control it.** See the preceding section on preparing for recitals on how to practice performing. Gaining confidence in your ability to perform can sometimes completely eliminate nervousness. Of course, nervousness is a very individual behavior and there is a wide range of reactions from those who don't get nervous, to those who suffer terribly from stage fright. The best policy for nervousness is honesty — we must acknowledge its effect on each individual and treat it accordingly.

1.3.16 Teaching

1.3.16.1 Types of Teachers

Teaching piano is a difficult profession because practically everything you try to do contradicts something else that should be done. If you teach reading, the student may end up unable to memorize. If you teach slow, accurate play, the student may not acquire sufficient technique in any reasonable amount of time. If you push them too fast, they may forget all about relaxation. If you concentrate on technique, the student might lose track of musical playing. You need to devise a system that successfully navigates through all these types of contradictory requirements and still satisfies the individual wishes and needs of each student. **Teaching piano is a Herculean task that is not for the faint of heart.**

Teachers generally fall into at least three categories, depending on whom they teach. There are teachers for beginners, intermediate students, and advanced students. This makes it difficult for any one teacher to teach successfully, independently of other teachers. The most successful approach involves a group of teachers composed of all three categories; the teachers are coordinated in such a way that their teachings are mutually compatible, and the appropriate students are directed to the appropriate teachers. This assembly of different teachers into a group is necessary today because teaching methods are not standardized. Thus many teachers of advanced students refuse to take students from certain teachers because the latter "do not teach the proper fundamentals". This should not happen if the fundamentals are standardized.

The three categories of teachers are needed because it is a waste of resources for teachers capable of teaching intermediate students to be teaching beginners. In addition, advanced teachers are usually not good teachers of beginners. However, **all teachers must be coordinated in the sense that they must all teach the same methods, philosophies, etc., so that when a beginner student graduates and is passed on to the intermediate teacher, this transition goes smoothly.** The last thing an advanced teacher wants is a student who was initially taught all the "wrong" methods. Another reason for the need for the three levels of teachers is that the talents and objectives of the students are diverse, so that some will advance rapidly while others will stay at a low level. Thus some students who had taken lessons for years may still be inappropriate for a higher level teacher.

1.3.16.2 Teaching Youngsters

The first lessons for beginners, especially young children 4 or 5 years old, should be brief, 10 to 15 minutes at most. Increase the lesson time only as their attention time span and stamina increase. If more time is necessary, divide the lesson into sessions with breaks in between ("cookie time", etc.). The same rules apply to practice times at home.

General comment: although specific methods are frequently cited for youngsters in this section on teaching, the methods also apply to adults, except where noted.

It is important for youngsters to listen to recordings. Even if they can't truly interpret Chopin until they demonstrate some maturity, they can listen to Chopin at any age. They should also listen to recordings of their own playing; otherwise, they may not understand why you are criticizing their mistakes. Do not feed them music just because it is classical or it was written by Bach. Play only what you and the youngsters enjoy.

Youngsters should learn counting by counting out loud — without hearing their counting, the teacher may have no idea whether the child understands the concept. Youngsters develop in spurts, and they can only learn what they are mature enough to learn. In other words, you can't teach them something until they are ready for it. Therefore, part of the teaching must consist of a constant testing of their level of maturity. On the other hand, most youngsters are ready for many more things than most adults realize and once they are ready, the sky is the limit. Therefore, it is also a mistake to assume that all kids are kids. They can be surprisingly advanced in many respects and treating them as kids (for example, letting them listen only to "kiddie music") only holds them back, and deprives them of the opportunity to fulfill their full potential.

For at least the first five years of lessons, especially for youngsters, teachers must insist that the parents participate in the teaching/learning process. The parents' first job is to understand the methods that the teacher is teaching. **Since so many practice methods and recital preparation procedures are counter-intuitive, the parents must be familiar with them so that they can not only help to guide the students, but also avoid negating the teacher's instructions.** The parents must participate in deciding how long the students practice each day, since they are most familiar with all the time demands of the students. The parents also know the students' ultimate objectives best — are the lessons just for casual playing, or for advancing to much higher levels? What types of music do the students eventually want to play? Beginning students always need help at home in working out the optimum routine for daily practice as well as keeping track of weekly assignments. Once the lessons start, it is surprising how often the teachers need the parents' help — where and how to buy sheet music, how often to tune the piano, or when to upgrade to a better piano, etc. The teachers and parents need to agree on how fast the students are expected to learn and to work towards attaining that learning rate. The parents need to be informed of the students' strengths and weaknesses so as to be able to match their expectations and plans with what is or is not achievable. **Most importantly, it is the parents' job to evaluate the teacher and to make proper decisions on switching teachers at the appropriate time.**

Students need a lot of help from their parents, and the kinds of help change with age. When young, the students need constant help with daily practice routines, whether they are practicing correctly and following the teacher's instructions. It is most important at this stage to establish correct practice habits. **The parents must make sure that during practice, the students make it a habit to play through mistakes instead of backtracking, which will create a stuttering habit and makes the student mistake-prone during performances.** Most youngsters will not understand the teacher's instructions given hurriedly during their lessons; the parents can more readily understand those instructions. As the students advance, they need feedback on whether they are playing musically, whether their tempo and rhythm are accurate or if they need to use the metronome, and whether they should stop practicing and start listening to recordings.

Parental involvement should go much farther than just helping the teacher. **Piano or music education can start at home as soon as the child is born. Listening to the "right" kind of music, and listening to the sound of well tuned pianos, can have the most profound effects on the child's brain and its development. In addition to supplying the musical stimuli, it is also the parents' job to keep testing the child for when s/he becomes receptive to the different stages of musical development.** Is the child ready to start pressing piano keys? Can the child sing or hum a tune? Is the child ready to start (music) reading lessons? Note that music notation is much simpler than the alphabet. Does the child have rhythm? Does the child have perfect pitch? What kind of music or instrument does the child like? You never know until you test them. It is generally counterproductive to try to push children into something for which they are not yet ready or do not show interest. You cannot just push children in some direction; the only thing you can do is to arrange the environment so that they will develop an interest in that direction. Familiarity, good, pleasant experiences, and success are factors that can lead a child in certain directions. Before they are ready, the only thing you can do is to provide these environments and to test them; but if they are ready, watch out! They can progress far faster than you ever dreamed.

Mental development is the main reason for letting youngsters listen to classics — the “Mozart Effect”. The reasoning goes something like this. Assume that the average parent has average intelligence; then there is a 50% chance that the child is smarter than the parents. That is, the parents cannot compete on the same intellectual level as their baby! Mozart (or any other genius composer) is different — few babies will be able to challenge those intellectual levels. In addition, music is a universal language; unlike the crazy adult languages that we speak, music is inborn, so babies can communicate in music long before they can say “dada”. Therefore, classical music can stimulate a baby’s brain long before the parents can communicate with the baby even on the most basic levels. And these communications are conducted at the levels of the genius composers, something few parents can hope to do!

1.3.16.3 Memorizing, Reading, Theory

The teacher must choose, at an early stage, whether the student should be taught to play from memory or learn to read music. This choice is necessitated by the fact that the details of the teaching program and how the teacher interacts with the students depend on it. **The Suzuki violin method emphasizes playing from memory at the expense of reading, especially for youngsters, and this is the best approach for piano also.** It is easier to practice reading *after* you can play reasonably well. The reason for this order of learning is simple; it is also the way children learn language: they first learn to speak, then to read. The abilities to speak and to make music are natural evolutionary traits that we all have; reading is something that was added later as a consequence of our civilization. Learning to speak is simply a process of memorizing all the sounds and logical constructs of each language. Therefore, reading is more “advanced” and less “natural”, and therefore cannot logical precede memory. For example, there are many concepts in memory that can never be written down, such as color, playing with authority and confidence, etc. A single “crescendo” indication can be played in a large number of ways.

However, reading should not be totally neglected in the beginning. It is only a matter of priority. Since music notation is simpler than any alphabet, young children should be able to learn to read music even before they can learn to read books. Thus reading should be taught from the very beginning, but only enough to read music for practicing a piece and memorizing it. **Reading should be encouraged as long as it does not interfere with playing from memory.** This means that, once a piece is memorized, the music should not be used for daily practice. However, the teacher must make sure that this lack of emphasis on reading does not result in a poor reader who automatically memorizes everything but can’t read. There is a tendency in most beginners to become either good readers (and poor memorizers) or vice versa, because when you become good at one, you need less of the other. Thus the best outcome is a student who is both a good memorizer and a good reader. By monitoring the student carefully, a teacher can prevent the student from becoming a poor reader or a poor memorizer. Because becoming a poor reader or memorizer happens over a long period of time, usually many years, there is ample time to detect the trend and correct it. A negligible number of people are born good or bad readers or memorizers. The vast majority became good memorizers or good readers because of the way they learned throughout their life.

Reading is an indispensable teaching tool for teachers; the teacher's job can be made easier if the student can be taught to read. Teachers who emphasize reading are certainly justified because of the enormous amount of information that is contained in even the simplest printed music, and practically every beginning student will miss a large fraction of that information. Even advanced pianists often return to the music score to make sure that they haven't missed anything. Very often, you have to improve your skill to a certain level before you can fully execute all the markings on the score so that, in the beginning, some of the markings may be effectively meaningless; thus you need the score at every stage of development. Therefore, there is no question that reading is essential. In addition, learning to read is not a simple task; not only do you have to learn the complex language of the music score, but you also have to learn to recognize and execute the instructions in real time. This is why reading must be taught from the very beginning. However, too many teachers depend too much on reading, which causes confusion among the students because the students are more interested in learning piano than simplifying the teacher's task. Asking a student to read the score is not the most efficient way to correct mistakes. All these conflicting factors cause great confusion and controversy in piano pedagogy about whether is it better to teach memory or reading. Clearly, the best program is one based on memory, but with enough reading training so that the student does not become a poor reader.

How much reading training is enough? The normal amount of reading needed to learn your new pieces is generally sufficient. Especially for beginners, it does not pay to embark upon a reading program just to be able to read (because your fingers can't play them anyway), although the initial slow reading speed can be awfully frustrating. A major learning trick in piano pedagogy is to learn several skills simultaneously, especially because many of them take a long time to learn. Thus memorizing, reading, theory, etc., can all be learned simultaneously, saving you a lot of time in the long run. When you first start a new piece, try to read without looking at the hands as much as possible. However, there is nothing wrong with looking at the hands for large jumps, complex fingerings, etc. As you memorize more, you will be looking at the music less and looking more at your hands. Once memorized, you should practice practically all the time without the music score.

As students advance, a distinction should be made between compositions that they "sight read" and those that they memorize. "Sight reading" is used here in a loose terminology to mean playing music by looking at the score, without memorizing it. All significant lesson pieces should be memorized. These are pieces that the students can be expected to perform for an audience. **As the students advance, therefore, they will acquire two types of repertoire; those they memorize and those they sight read, such as easy pieces and accompaniments.** In later stages, the student may decide to learn true sight reading (section 1.3.11 above), which is the ability to play music, that they had never heard before, by reading a music score that they had not previously seen.

You can never teach too much music theory (solfege), notation, dictation, etc. Learning theory helps the students to acquire technique, memorize, understand the structure of the composition, and perform it correctly. It will also help with improvisation and composition. It should be noted that, statistically, the majority of successful piano students will end up composing music. Modern music (pop, jazz, etc.) nowadays uses very advanced musical concepts and the underlying theory is helpful for understanding chord progressions, music structure and improvisation. Therefore, **there are advantages to learning both classical and modern music. Modern**

music provides contemporary theory and helps develop rhythm, and also appeals to a wider audience.

1.3.16.4 Some Elements of Piano Lessons

The piano lesson should not be a routine in which the student plays the lesson piece and the teacher assigns a new piece. **It is the teacher's job, when starting a new piece, to go through it in segments, examining the fingerings, analyzing the music, and basically bringing the student up to speed during the lesson, at least HS or in segments.** After a few lessons of this type, the job shifts into playing it musically — examining the musical content, bringing out the expression, the attributes of the composer (Mozart is different from Chopin, etc.), the color, etc. A good teacher can save the students a tremendous amount of time by demonstrating all the necessary elements of technique. It should not be left to the student to try to find these out by trial and error. Because of these requirements, lessons beyond beginner level can become quite intense and time consuming. **Scales should be taught thumb-under for beginners but, within a year, they should be taught thumb-over also.** Although most exercises such as Hanon are now considered unhelpful, it is very important to be able to play scales and arpeggios (in all transpositions) well; this will require many years of hard work.

Practicing 30 minutes every 2 or 3 days is the absolute minimum necessary to make any progress. Half an hour every day is adequate for significant progress for youngsters. As they get older, they will need progressively more time. These are minimum practice times; more time will be needed for faster progress.

The best way to motivate students to practice, and the best way to teach the art of making music, is to hold recitals. When the students must perform, all the teacher's instructions, the necessary practice time, etc., take on an entirely new meaning and urgency. **The students will become self-motivated.** These points were discussed in detail in section 1.3.14 above. It is a mistake to teach piano without any program of performance. There are numerous possibilities for such programs and experienced teachers will be able to design an appropriate one for each student at every level. Formal recitals and music competitions are full of pitfalls and must be approached with care and a lot of planning. However, teachers can organize informal recitals using much less stressful formats, with tremendous benefits to the students.

Although recitals and competitions are important, it is even more important to avoid their pitfalls. The main pitfall is that recitals can be self-defeating because the stress, nervousness, extra effort and time, and sense of failure after even small mistakes, can do more harm than good in molding the performance capability/psychology of the student at any age. Therefore **teachers must have a clearly defined program or approach to teaching the art of performing in addition to the art of playing.** The preparatory methods for recitals discussed in section 1.3.14 above should be part of this program. Popular, or "fun" music is especially useful for performance training. Above all, the program must be designed to produce a rewarding atmosphere of accomplishment and not a competitive one where anything short of miraculous perfection, playing the most difficult pieces the student can manage, is a failure. In competitions, students must be taught early on that judging is never perfect or fair; that it is not the winning, but the participatory process, that is most important for its pedagogical value. Given the same piece of music to play, a relaxed and less nervous student will perform better, and develop a better attitude towards performing. Students must understand that it is the process, not the final winning, that is the final objective of having competitions. One of the most important components of this objective is to cultivate the ability to enjoy the experience instead of becoming nervous. One of the worst pitfalls of most competitions is the emphasis on the most difficult material that the student can play. The correct emphasis should be on the music, not the technique.

Of course we must aim to win competitions and play flawless recitals. But there are stressful and less stressful approaches to these objectives. **It is the teacher's job to teach stress control.** Unfortunately, the majority of teachers today totally ignore performance stress control or worse, parents and teachers frequently pretend that there is no such thing as nervousness even when they themselves are nervous. This can have the effect of creating a permanent problem with nervousness. See section 1.3.15 above for discussions on controlling nervousness.

It is important to first teach a student all about nervousness and stress and not to shove them out on a stage to perform with no preparation in the vain hope that they will somehow learn to perform on their own. Such action is quite analogous to throwing a person into the middle of a deep lake to teach them how to swim; that person can end up with a lifelong fear of water. Playing for the teacher at every lesson is a good start, but is woefully insufficient preparation. Thus the teacher should design a "performance training" routine in which the student is gradually introduced to performances. This training must start with the first piano lessons. Various skills, such as recovering from blackouts, preventing blackouts, covering mistakes, sensing mistakes before they occur, snippet playing, starting from arbitrary places in a piece, choice of pieces to perform, audience communication, etc., should be taught. In this regard, we saw that HS practice, slow play, and "playing cold" are the most important components of preparation. Most students do not know which "finished" pieces they can perform satisfactorily until they actually play them in recitals several times; therefore, even among finished pieces, every student will have a "performable" and a "questionable" repertoire. **One of the best ways to train for performances is to record the student's finished pieces and produce an album of finished repertoire that is periodically updated as the student advances** This should be done from the very beginning of lessons so as to cultivate the skill as early as possible. The first mistake most pianists make is to think that "I am still a beginner, so my playing is not worth recording". Once you buy that argument in the beginning, you will end up following it the rest of your life because it becomes a self-fulfilling prophesy. That argument is false because music is supreme — easy compositions, played musically, is as good as it gets; Horowitz cannot play "chopsticks" any better than a well-taught beginner.

Clearly, performance is a complex field and must be systematically taught before a student is asked to walk out on a stage and play. Without such training, even good performers will not perform to their best ability, and the majority of students will end up thinking that piano performance as a kind of hell that is associated with music or piano. Once that attitude is ingrained in youth, they will carry it into adulthood. The real truth should be the exact opposite. Performance should be the final goal, the final reward for all the hard work. It is the demonstration of the ability to sway an audience, the ability to convey the grandest designs of the greatest musical geniuses that every lived. Because of the need to control nervousness and student attitude, a teacher must become a psychologist in order to teach performance skills. Many otherwise good piano teachers are ill prepared for such a task and must work on correcting this deficiency. Some teachers completely ignore performance training while others simply hold as many recitals as possible in attempts to teach the art of performing. The only real solution is to teach a performance curriculum.

One way to introduce students to performing at recitals is to hold mock recitals among the students themselves and to have them discuss their fears, difficulties, weaknesses, and strengths to get them all acquainted with the main issues. They will understand the issues better when they can actually feel them and then discuss them openly with their peers. Any stress or nervousness they might feel becomes less scary when they realize that everyone experiences the same things, that nervousness is perfectly natural, and that there are various ways to combat them. In particular, once they go through the entire process from start to finish of a mock recital, the whole procedure becomes much less mysterious and frightening. **Students must be taught that learning to enjoy performing is part of the art of piano. That "art of performing" also requires study and practice, just like finger technique.** In a group of students, there is always one that is good at performing. The others can learn by watching and discussing how these good ones cope with each issue.

Another way to introduce students to performances and at the same time have some fun is to schedule an informal recital in which the students play a game of "who can play fastest". In this game, every student plays the same piece, but the amount of practice time is limited, say, to three weeks. Note that in this ruse, the hidden agenda is to teach the students how to enjoy giving recitals, not to teach them how to play fast. The students themselves vote for the winner. At first, the teacher gives no instructions; students must choose their own practice methods. After the first recital, the teacher holds a group lesson in which the winner describes her/is practice methods and the teacher adds any useful information. Note that HS practice and parallel sets are major concepts that help to play fast. Of course, clarity, accuracy, and music must be considered in choosing a winner. There will be wide differences in the practice methods and achievements of the various students and, in this way, they will learn from each other and will understand the basic teachings better. While the students are participating in a "contest", it is the teacher's job to ensure that it is a fun experience, a way to experience the joy of performing, a way to completely forget about nervousness. Mistakes evoke laughter, they are not to be frowned upon. And refreshments might be served afterwards. The teacher must not forget to intersperse instructions for learning to perform, together with the "contest" skills.

Once the students are taught the basics of performance, how should recitals be organized? They should be designed to strengthen performance capability. **One of the hardest things to do is to perform the same composition several times on the same day or on successive days.** Therefore, such repeat performances provide the best training for strengthening the performance capability. For teachers or schools with a sufficient number of students, the following is a good scheme to use. Group the students into beginner, intermediate, and advanced. On Friday, hold a recital of the beginners, with their parents and friends as audience. Beginners should participate in recitals from their first year of lessons, as early as 4 or 5 years of age. At the end of this recital, the advanced students also play, which makes it really worthwhile for the audience to attend. On Saturday, the intermediate students play, with their parents and friends as audience; again, the advanced students play at the end. On Sunday, the advanced students hold their recital, with their parents as the audience; some special guests might be invited. In this way, the advanced students get to perform the same piece three days in a row. The Sunday recital of the advanced students should be recorded and copied onto CD's, as they make great souvenirs. If this type of recital is held twice a year, each advanced student will have six recitals under their belt every year. If these students are also entered into competitions (typically involving an audition, a final, and, if they win, a winner's concert), they will have adequate performance training (at least 9 performances a year). Since most pieces are not "secure" until they are performed 3 times, this recital scheme will also serve to make the recital piece "secure" so that it can now be included in the "performable" repertoire, after just one weekend of recitals.

Teachers should be willing to communicate with other teachers, exchange ideas, and learn from each other. There is nothing as potentially damaging to a student as a teacher whose teaching methods are inflexible and frozen in time. In this information age, there is no such thing as secret methods of teaching piano, and the success of the teacher depends on open communications. An important topic of communication is the exchange of students. Most students can benefit greatly by having been taught by more than one teacher. Teachers of beginners should pass their students to higher level teachers as soon as they are ready. Of course, most teachers will try to keep their best students and to teach as many students as they can. One way to solve this problem is for teachers to form groups consisting of teachers with different specialties so that the group forms a complete school. This also helps the teachers because it will make it much easier for them to find students. For students looking for good teachers, it is clear from these considerations that it is best to look for groups of teachers rather than teachers who operate individually. Teachers can also benefit by banding together and sharing students and costs of facilities.

Starting teachers often have difficulty finding their first students. Joining a group of teachers is a good way to get started. Also many established teachers often have to turn away students because of a lack of time, especially if the teacher has a good reputation in that local area. Those teachers are good sources of students. One way to increase the pool of potential students is to offer to go to the students' homes to teach. For at least the first few years when a new teacher starts to teach, this might be a good approach for increasing the potential student pool.

1.3.16.5 Why the Greatest Pianists Could Not Teach

Very few of the greatest pianists were good teachers. This is eminently natural because artists train all their lives to be artists, not teachers. I experienced an analogous situation as a graduate physics student at Cornell University where I took courses taught by professors who specialized in teaching, and where I also attended weekly lectures by famous physicists including numerous Nobel Prize winners. Some of those renowned physicists could certainly present exciting lectures that attracted great interest, but I learned most of the skills needed to find a job as a physicist from the teaching professors, not the Nobel laureates. This difference in teaching ability between teaching and practicing scientists pales in comparison with the chasm that exists in the arts world because of the nature of the scientific discipline (see Chapter Three). Learning and teaching are an integral part of being a scientist. By contrast, the greatest pianists were either reluctantly, or by economic necessity, pushed into teaching for which they received no meaningful training. Thus there are plenty of reasons why the great performers may not have been good teachers.

Unfortunately, we have historically looked to the famous artists for guidance, under the rationale that if they can do it, they should be able to show us how. Typical historical accounts reveal that, if you were to ask a famous pianist how to play a certain passage, s/he will sit at the piano and play it out because the language of the pianist is spoken by the hands and the piano, not the mouth. That same great artist may have little idea about how the fingers are moving or how they are manipulating the piano keys. In order to move the hands in the proper way, you must learn to control thousands of muscles and nerves, and then train the hands to execute those motions. There are two extremes among the ways to acquire technique. One extreme is the analytical one, in which every motion, every muscle and every physiological information is analyzed. The other extreme is the artist's approach, in which the person simply imagines a certain musical output and the body responds in different ways until the desired result is obtained. This artist's approach can not only be a quick shortcut, but can also yield unexpected results that may exceed the original idea. It also has the advantage that a genius without analytical training can be successful. The disadvantage is that there is no assurance of success. Technique acquired in this way cannot be taught analytically, except by saying that "you must feel the music this way" in order to play it. Unfortunately, for those who do not know how to do it yet, this kind of instruction is of little help, except as a demonstration that it can be done. Also, even knowing the practice methods isn't enough. You need the correct explanation of why they work. This requirement is often outside the expertise of the artist or piano teacher. Thus there is a fundamental impediment to proper development of piano teaching tools: artists and piano teachers do not have the training to develop such tools; on the other hand, scientists and engineers who may have such training have insufficient piano experience to teach piano. One thing that only artists can teach us is how they achieve their objectives or "shortcuts". In many instances, in which the analytical solutions have not yet been found, that is the only way. In fact that may be the most important lesson we would like to learn — however, what we must not forget is that, especially for beginners, there is no faster way to learn than a well understood analytical approach.

The old masters were geniuses, of course, and had some remarkable insights and inventiveness as well as intuitive feel of mathematics and physics which they applied to their piano playing. Therefore, it is incorrect to conclude that they had no analytical approaches to technique; practically every analytical solution to piano practice that we know of today was re-invented many times by these geniuses or at least used by them. It is therefore unbelievable that no one ever thought of documenting these ideas in a systematic way. It is even more amazing that there does not seem to have been even a general realization by both teachers and students that practice methods were the key to acquiring technique. The main difficulty seems to have been the inability of the artist approach to identify the correct theoretical basis (explanation) for why these practice methods work. Without a sound theoretical explanation or basis, even a correct method can be misused, misunderstood, changed, or degraded by different teachers so that it may not always work and be viewed as unreliable or useless. These historical facts prevented any orderly development of piano teaching methods. Thus the understanding, or the explanation of why a method works, is at least as important as the method itself.

In addition, piano teachers tended to be poor communicators in the sense that they tended not to share teaching ideas. Only at large conservatories was there any significant mixing of ideas so that the quality of teaching at conservatories was better than elsewhere. However, the problems of the preceding paragraph prevented any truly systematic developments of teaching methods even at these organizations. An additional factor was the stratification of piano learning into beginners and advanced students. Conservatories generally accepted only advanced students; yet, without conservatory type teaching, few students attained the advanced levels necessary to be accepted. This gave piano learning a reputation as something far more difficult than it really was. The bottleneck created by a lack of good teaching methods was attributed to lack of "talent". When all these historical facts are assembled, it is easy to understand why the great masters could not teach, and why even dedicated piano teachers did not have all the tools they needed.

Although I started writing this book as just a compilation of some remarkably effective teaching tools, it has evolved into a project that deals directly with the historical deficiencies responsible for most of the difficulties of acquiring technique. Fate has suddenly turned the future of piano into a wide, open unknown with limitless possibilities. We are entering a brave, new, exciting era that can finally be enjoyed by everyone.

1.3.17 Upright, Grand & Electronic Pianos; Purchasing and Care

1.3.17.1 Grand, Upright, or Electronic?

Grands have certain advantages over uprights. However, these advantages are minor compared to the importance of the skill level of the pianist. **There are great pianists who became technically advanced practicing mostly on uprights. There is no evidence that you need a grand for initial technical development,** although a few piano teachers will insist that any serious student must practice on a grand. An argument can be made in favor of uprights, at least for beginners, because uprights require firmer playing and may be better for early finger development (you need to press harder in order to make louder sounds). They may be superior even for intermediate students because uprights are less forgiving and require greater technical skill to play. These arguments are controversial, but do illustrate the point that, for students up to intermediate level, any differences among uprights and grands are small compared to other factors such as student motivation, talent, quality of teachers, practice methods, and proper piano maintenance. Another factor is piano quality: good uprights are superior to low quality grands (which includes most grands under 5.2 feet). In general, students above intermediate level will need a grand piano.

Electronic (also called digital) pianos have capabilities that the acoustics (the mechanical uprights and grands) cannot provide and therefore fill a niche of their own, as explained below. They cost much less, are easier to purchase, maintain and transport, and make excellent starter or second pianos. The electronics have basically rendered the uprights obsolete. **Therefore, if you are buying your first piano, it is easiest if you start with a quality electronic and then purchase a grand later on, when you are certain that the piano is going to be a big part of your life.** Thus the rule concerning uprights is simple: if you already have one, there is no reason to get rid of it until you buy an electronic or a grand; if you don't have a piano, there is no compelling reason to buy an upright.

1.3.17.2 Electronic Pianos

Today's electronic pianos are still inferior to good grands for technical development but are improving rapidly. Even the best electronics are inadequate for advanced pianists; their mechanical response is poorer, the musical output and dynamic range are inferior, and fast, technically advanced material becomes difficult to execute. Most affordable speakers can not compete with the sound board of a grand. The electronic pianos do not allow the control of tone, color, pianissimo, staccato, and the special manipulations of the damper and soft pedals, that good grands provide. Thus there is no question that an advanced pianist will prefer a grand piano over an electronic. Most uprights do not provide sufficient advantage for technical development to warrant their use over quality electronics that are readily available.

The electronic pianos have some unique advantages, so we discuss them here. Because of these advantages, most serious pianists will own both an acoustic and an electronic.

1. For less than half the price of an average acoustic upright, you can buy a new electronic piano with all the features you need: headphone and volume control, touch control, organ, string, harpsichord, metronome, recording and midi/analog out, transposition, different tunings and canned accompaniments. Most electronics provide much more, but these are the minimum features you can expect. The argument that an acoustic piano is a better investment than an electronic is false because an acoustic piano is not a good investment, especially when the initial cost is so much higher. The electronic piano requires no maintenance, whereas the maintenance costs of acoustics are substantial, since they require tuning, voicing and regulation about twice a year, plus occasional repairs.

2. The electronics are always in perfect tune. Very young children exposed sufficiently to perfectly tuned pianos acquire perfect pitch automatically, although most parents never discover this because, if it is not discovered and maintained, it is lost during the teen years. The acoustic piano begins to go out of tune the minute the tuner leaves your house, and some notes will be out of tune most of the time (in fact, most of the notes will be out of tune most of the time). However, these small deviations from tuning will not affect the learning of perfect pitch unless the piano is allowed to go way out of tune. Because too many acoustic pianos are inadequately maintained, the fact that the electronics are always in tune can be a huge advantage. **The importance of a well tuned piano for musical and technical development cannot be overemphasized, because without the musical development, you will never learn how to perform.**

3. You can use headphones or adjust the volume so that you can practice without disturbing others. The ability to turn down the volume is also useful for reducing ear damage when practicing loud passages: an important factor for anyone over 60 years old, when many will start to suffer from hearing loss or tinnitus. If you are an advanced player, even an electronic will create considerable “playing noise” (with the volume turned off) that can be quite loud to anyone nearby and these vibrations can transmit through the floor to rooms under the piano. Therefore it is a mistake to think that the sound from an electronic (or an acoustic with “silent” feature) can be completely turned off.

4. They are more portable than acoustics. Although there are light keyboards with similar features, it is best for piano practice to use the heavier electronics so that they do not shift while playing loud, fast music. Even these heavier electronics can be easily moved by two persons, and will fit in many cars.

5. **Variable touch weight is more important than many people realize.** However, you have to know what "touch weight" means before you can use it to advantage; see the following paragraphs for details. In general, the touch weight of electronics is a little lighter than that of acoustics. This lighter weight was chosen for two reasons: to make it easier for keyboard players to play these electronics (keyboards are even lighter), and to make them easier to play compared to the acoustics. The disadvantage of the lighter weight is that you may find it slightly more difficult to play an acoustic after practicing on an electronic. The touch weight of acoustics needs to be heavier in order to produce a richer tone. One advantage of heavier weight is that you can feel the keys of an acoustic while playing, without inadvertently playing some wrong notes. However, this can also lead to careless playing with some inadvertent finger motions because you can lightly hit a key of an acoustic without making any sound. You can practice getting rid of these uncontrolled motions by using an electronic and choosing a light touch weight so that an inadvertent strike will produce a sound. Many people who practice only on acoustics don't even know that they have such uncontrolled motions until they try to play on an electronic. The light touch is also useful for acquiring difficult technique quickly. Then, if you need to play on an acoustic later on, you can practice with increased weight after you acquire the technique. This two-step process is usually faster than trying to acquire technique at heavy key weight.

6. Recording piano music is one of the most difficult things to do using conventional recording equipment. With an electronic piano, you can do it with the push of a button! You can easily build up an album of all the pieces you learned. Recording is one of the best ways not only to really finish and polish your pieces but also to learn how to perform for an audience. Everyone should cultivate a habit of recording every finished piece from the very beginning of their lessons. Of course, the initial performances will not be perfect, so you may want to go back and re-record them as you improve. Too many students never record their performances, which is the main reason for excessive nervousness and difficulties during performances.

7. Most pianists who follow good practice methods and become proficient when young will end up composing their own music. Electronic pianos are helpful for recording these compositions so that you don't need to write them down, and for playing them in different instruments, as appropriate for each composition. With some additional software or hardware, you can even compose entire symphonies and play every instrument yourself. There is even software that will transcribe (though imperfectly) your music onto sheet music.

8. If you can acquire technique rapidly, there is nothing stopping you from broadening your horizon beyond classical music and playing popular music, jazz, blues, etc. You will appeal to a wider audience if you can mix music genres and you will have more fun. The electronic piano can help by providing the accompaniments, drums, etc., for those types of music. Thus these extra capabilities of the electronic pianos can be very useful and should not be ignored.

9. Buying electronic pianos is very simple, especially when compared to buying acoustics (see below). All you need to know is your price range, the features you want, and the manufacturer. You don't need an experienced piano technician to help you evaluate the piano. There are no questions about whether

> the piano dealer made all the proper “prepping”, whether the dealer will honor the agreements to ensure that the piano functions after delivery, whether the piano was properly “stabilized” during the first year of ownership, or whether you got one with good or inferior tone and touch. Many established manufacturers, such as Yamaha, Roland, Korg, Technic, Kawai, and Kurzweil, produce electronics of excellent quality.

The touch weight of a piano is not a simple matter of adding or subtracting lead weights to the keys to change the force required to depress them. The touch weight is a combination of the down weight, the inertia of the keys and hammers, and the force required to produce a certain volume of sound. The down weight is the maximum weight that the key will support before it will start to move down. This is the weight that is adjusted using lead weights. The down weight of all pianos, including the “weighted key” electronics, is standardized at about 50 grams and varies little from piano to piano regardless of touch weight. When playing a piano, this 50 gram weight is a small fraction of the force required to play — most of the force is used to produce the sound. In acoustics, this is the force needed to impart velocity to the hammer. In electronics, it is the electronic reaction to the key motion and a fixed mechanical resistance. In both cases, you also have to overcome the inertia of the mechanism in addition to supplying the force for producing the sound. For example, when playing staccato, most of the force required is for overcoming the inertia whereas when playing legato, the inertial component is small. Electronics have a smaller inertial component because they have only the inertia of the keys whereas the acoustics have the additional inertia of the hammers; this makes the acoustics less sensitive to inadvertent hitting of the keys. Therefore, you will feel the most difference between acoustics and electronics when playing fast or staccato and little difference when playing legato. For the pianist, touch weight is simply the effort required to produce a certain volume of sound and has little to do with down weight. For acoustics, touch weight is determined mostly by hammer mass and voicing (hardness of the hammer). There is only a narrow range of hammer masses that is ideal because you want heavier hammers for larger sound but lighter ones for faster action. Thus a lot of the touch weight can be adjusted by the piano technician by hammer voicing, rather than by changing weights. For electronic pianos, touch weight is controlled in the software in the following way, in order to simulate what happens in a grand. For heavier touch weight, the sound is switched to that of a softer hammer, and vice versa. There is no mechanical change to the down weight of the keys or the inertial component. Thus if you switch to the heaviest key weight, you might feel that the sound is somewhat muffled and if you switch to the lightest weight, the sound might be too brilliant. In electronic pianos, it is easier to decrease the touch weight without adversely affecting the sound because there is no hammer to move. On the other hand, the maximum dynamic range of most electronic pianos is limited by the electronics and speakers, so that for the loudest sounds, the grand piano can have a lighter touch weight. In summary, touch weight is a subjective judgment by the pianist about how much effort is required to produce a certain volume of sound; it is not the fixed weight or resistance of the keys to the keydrop.

You can demonstrate this subjective judgment by turning the volume up or down using the electronic piano. Thus if you practice on an electronic for a long time with the volume turned down, and then play an acoustic, the acoustic can feel downright light. Unfortunately, things are a little more complicated because when you switch to a heavier touch weight with the electronic piano, it also gives you the sound of a softer hammer. In order to reproduce the sound of a properly voiced hammer, you need to strike harder. This adds to the perception of a heavier key weight, and this effect cannot be simulated by changing the volume control. From these discussions, we can draw the following conclusions: there are small differences in the touch weight between grands and electronics, with the grands tending to be heavier, but those differences are not sufficient to cause major problems when switching from one to the other.

1.3.17.3 Uprights

Acoustic uprights have their own advantages. They are less expensive than grands. They take up less space, and for small rooms, large grands may produce too much sound so that they cannot be played full blast with the lid fully open without hurting or even damaging the ears. Grands, with the lid open, are very sensitive to touch. Thus grands require hammer voicing more frequently than uprights; otherwise, they become too "brilliant" or "harsh", at which point most owners will end up playing the grand with the lid closed. Many homeowners ignore voicing entirely. The result is that such grands produce too much and too harsh sound, and are therefore played with the lid down. There is nothing technically wrong with playing a grand with the lid closed. However, some purists will express great dismay at such practice, and you are certainly throwing away something wonderful for which you made a significant investment. Performances at recitals almost always require the lid to be open. Therefore you should always practice with the lid open before a performance even if you normally practice with it closed. However, in a larger room, or in a recital hall, there is much less multiple reflection of the sound so that you do not hear the deafening roar that can result in a small room. A concert hall will absorb the sound from the piano so that, if you are accustomed to practicing in a small room, you will have difficulty hearing your own playing in a concert hall. Since uprights are essentially closed instruments, the neglect of voicing is less noticeable. Uprights also tend to be less expensive to maintain, mainly because expensive repairs are not worthwhile and are therefore not performed. Of course, there are quality uprights that are competitive with grands in feel and sound quality, but their number is small.

Among uprights, spinets are the smallest and generally the least expensive pianos; most do not produce satisfactory sound, even for students. The small height of spinets limits the string length, which is the main limitation on sound output. In theory, the treble should produce satisfactory sound (there is no limitation on string length even for spinets), but most spinets are weak in the treble because of poor quality of construction; therefore, be sure to test the higher notes if you are evaluating a spinet. Uprights larger than console size can be very good student pianos. Old uprights with poor sound are generally not salvageable, no matter what their size. At such an age, the value of the piano is less than the cost of restoring them; it is cheaper to buy a newer upright with satisfactory sound.

1.3.17.4 Grands

The advantages of most grands are: greater dynamic range (loud/soft), open structure allowing the sound to escape freely (which provides more control and expression), richer sound, faster repetition, smoother action (use of gravity instead of springs), a "true" soft pedal (see section 1.2.24), clearer sound (easier to tune accurately) and more impressive appearance. An exception is the class of "baby" grands (less than about 5' 2") whose sound output is usually unsatisfactory and should be considered mainly as decorative furniture. A few companies (Yamaha, Kawai) are beginning to produce baby grands with acceptable sound, so for these very new pianos, don't write them off without testing them. Larger grands can be classified into two main classes, the "student grands" (those below about 6 to 7 ft), and the concert grands. The concert grands provide more dynamic range, better sound quality, and more tonal control.

As an example of this "quality versus size" issue, consider the Steinway pianos. The baby model, model S (5' 2"), is essentially a decorative furniture and very few produce sufficient quality sound to be considered playable and are inferior to many uprights. The next larger size group consists of models M, O, and L (5' 7" to 5' 11"). These models are quite similar and are excellent student pianos. However, advanced pianists would not consider them to be true grands because of poorer sustain, too much percussive sound, and notes with too much harmonic content. The next model, A (6' 2"), is borderline, and (6' 10"), C (7' 5"), and D (9') are true grands. One problem with evaluating Steinways is that the quality within each model is extremely variable; however, on average, there is a significant improvement in sound quality and output with each increase in size.

One of the biggest advantages of grand pianos is the use of gravity as the return force of the hammer. In uprights the restoring force for the hammer is supplied by springs. Gravity is always constant and uniform across the entire keyboard whereas non-uniformities in the springs and friction can create non-uniformities in the feel of the keys of an upright. Uniformity of feel is one of the most important properties of well-regulated, quality pianos. Many students are intimidated by the appearance of huge grands at recitals and competitions, but these grands are actually easier to play than uprights. One fear that these students have concerning these grands is that their actions may be heavier. However, touch weight is something that is adjusted by the technician regulating the piano and can be adjusted to any number regardless of whether the piano is an upright or a grand. Advanced students will of course find it easier to play demanding pieces on grands than uprights, mainly because of the faster action and uniformity. Consequently, grands can save you a lot of time when you try to acquire advanced skills. The main reason for this is that it is easy to develop bad habits when struggling with difficult material on uprights. Challenging material is even more difficult on electronic pianos (and impossible on models without proper touch weight) because they do not have the robustness and response to touch that are required at high speeds.

Some people with small rooms agonize over whether a large grand would be too loud in such a space. Loudness is usually not the most important issue, and you always have the option of closing the lid to different degrees. The maximum loudness of the medium and large grands is not that different, and you can play softer with the larger grands. It is the multiple sound reflections that are most bothersome. Multiple reflections can be easily eliminated by a carpet on the floor and sound-insulation on one or two walls. Thus if the piano physically fits into a room with no obvious difficulties, then it may be acceptable from the sound point of view.

1.3.17.5 Purchasing an Acoustic Piano

Buying an acoustic piano can be a trying experience for the uninitiated, whether they buy new or used. If a reputable dealer can be found, it is certainly safer to buy new but even then the cost of the initial depreciation is large. Many piano stores will rent you the piano with an agreement that the rental will be applied to the purchase price in case you decide to keep it. In that case, make sure that you negotiate for the best purchase price *before* you even discuss rental; after you agree to a rental, you will have very little negotiating power. You will end up with a higher initial price so that, even after subtracting the rental, the final price is not a bargain. Even with expensive pianos, many dealers find it too costly to keep them prepped and in tune. At such dealers, it is difficult to test the piano by playing it. Thus buying a piano is usually a hit-or-miss proposition. For mass produced pianos such as Yamaha or Kawai, the quality of their new pianos tends to be uniform, so that you know pretty much what you will get. The sound quality of the more expensive "hand made" pianos can vary considerably so that buying these pianos is more difficult if you want to pick a good one.

Good used acoustic pianos are difficult to find in piano stores because playable pianos sell first and most stores are left with an excess inventory of unplayable ones. **Obviously, the best bargains are to be found among the private sales. For the uninitiated, you will need to hire a piano tuner/technician to evaluate the used pianos in the private market.** You will also need a lot of patience because good private sales are not always there when you need them. However, the wait can be worthwhile because the same piano will cost only half as much at a private sale compared to the store. There is a steady demand for good, reasonably priced pianos. This means that it is not easy to find bargains at widely accessible sites, such as the internet piano markets, because good pianos sell quickly. Conversely, such sites are excellent places to sell. The best place to find bargains is the classified section of newspapers, especially at large metropolitan areas. Most such advertisements are placed on Friday, Saturday, or Sunday.

Only a few name brand pianos "hold their value" when kept for many years. The rest quickly lose their value so that trying to sell them years after purchase is not a worthwhile alternative. "Hold value" means that their resale value will keep up with inflation; it does not mean that you can sell them for a profit. Thus if you bought a piano for $1,000 and sold it 30 years later for $10,000, you have made no profit if inflation is 10× during those 30 years. In addition, you will incur the cost of tuning and maintenance of at least $2,000 for this example. It is cheaper to buy a brand new 7 ft Yamaha grand every 50 years than to buy a new Steinway M and completely restore it every 50 years; therefore, the choice of which piano to buy does not depend on economics but on what type of piano you need. With very few exceptions, pianos are not good investments; you have to be an experienced piano technician in order to find bargains in the used piano market that can be resold for a profit. Even if you find such a bargain, selling pianos is a time consuming, labor-intensive task. For more details on how to buy a piano, consult Larry Fine's book. Even with the most famous brands, a newly purchased piano will immediately lose 20% to 30% of its purchase price upon delivery, and will in general depreciate to half of the price of an equivalent new piano in about 5 years. As a very rough "rule of thumb" a used piano will cost about half the price of the new one of the same model in a piano store and about 1/4 at a private sale.

The price of pianos can be roughly classified according to whether they are worth rebuilding. Those worth rebuilding tend to cost at least twice as much when new. Practically all uprights and all mass produced grands (Yamaha, Kawai, etc), are not rebuilt because the rebuilding cost is about as high as the price of a new piano of the same model. Rebuilding such pianos is often impossible because the rebuilding trade and necessary parts are non-existent. Pianos worth rebuilding are Steinway, Bosendorfer, Bechstein, Mason and Hamlin, some Knabe, and a few others. Roughly speaking, it costs about 1/4 of the price of a new piano to rebuild and the resale value is about 1/2 of new; this is why rebuilding such pianos can be cost effective, for both the rebuilder and the buyer.

1.3.17.6 Piano Care

All new pianos need at least a year of special care and tuning after purchase, in order for the strings to stop stretching and the action and hammers to equilibrate. Most piano dealers will try to minimize the cost of servicing the new pianos after delivery. This is assuming that the piano was properly prepped prior to delivery. Many dealers postpone a lot of the prep work until after delivery, and if the customer does not know about it, may omit some steps entirely. In this regard, among the less expensive models, Yamaha, Kawai, Petroff, and a few others may be easier to buy because most of the prep work is completed at the factory. A new piano will need at least 4 tunings the first year in order to stabilize the stretching of the strings.

All pianos require maintenance in addition to regular tuning. In general, the better the quality of the piano, the easier it is to notice the deterioration caused by normal wear and tear, and therefore the more maintenance it should require. That is, more expensive pianos are more expensive to maintain. Typical maintenance chores are: leveling the keys, reducing friction (such as polishing the capstans), eliminating extraneous sounds, re-shaping the hammers and voicing them (needling), checking the innumerable bushings, etc. Voicing the hammer is probably the most neglected maintenance procedure. Worn, hard, hammers can cause string breakage, loss of musical control (bad for technical development), and difficulty in playing softly. It also ruins the tonal quality of the piano, making it harsh and unpleasant to the ear. If the action is sufficiently worn, it may need a general regulation job, which means restoring all parts of the action to their original specifications.

For old pianos with visibly rusted strings, the sound can sometimes be improved significantly by replacing the strings. If the bass wire-wound strings are very rusted, this can deaden those notes. Replacing these strings can be quite worthwhile if those bass notes are weak and have no sustain. The upper, non-wound strings generally do not need replacing. However, for extremely old pianos, these strings can be so stretched out that they have lost all longitudinal elasticity. Such strings are prone to breakage and cannot vibrate properly, and should be replaced.

Pianists should familiarize themselves with some of the basic knowledge about tuning, such as the parts of a piano, temperaments, stability of tuning, and effects of temperature and humidity changes, in order to be able to communicate with the tuner and to understand what s/he needs to do. Too many piano owners are ignorant of these basics; consequently, they frustrate the tuner and in fact work against her/im, with the result that the piano is not properly maintained. Some owners get so accustomed to their deteriorated piano that, when the tuner does a good job of restoring it to its original glory, the owner is very unhappy about the strange new sound and feel of the piano. Worn hammers tend to produce overly bright and loud sounds; this has the unexpected effect of making the action feel light. Therefore, properly voiced hammers may initially give the impression that the action is now heavier and less responsive. Of course, the tuner did not change the force required to depress the keys. Once the owners become accustomed to the newly voiced hammers, they will find that they have much better control of expression and tone, and they can now play very softly. With worn hammers, it is very difficult to play evenly and softly.

Pianos need to be tuned at least once a year and preferably twice, during the fall and spring, when the temperature and humidity are midway between their yearly extremes. Many advanced pianists have them tuned even more frequently. In addition to the obvious advantages of being able to create better music and to sharpen your musicality, there are many compelling reasons for keeping the piano tuned. One of the most important is that it can affect your technical development. Compared to an out-of-tune piano, a well-tuned piano practically plays itself — you will find it surprisingly easier to play. Thus a tuned piano can actually accelerate technical development. An out-of-tune piano can lead to flubs and the stuttering habit of pausing at every mistake. Many important aspects of expression can be brought out only on well-tuned pianos. Since we must always pay attention to practicing musically, it does not make sense to practice on a piano that cannot produce proper music. This is one of the reasons why I prefer Well Temperaments (with their crystal clear chords) to the Equal Temperament, in which only the octaves are clear. See Chapter Two for more discussions on the merits of various temperaments. Higher quality pianos have a distinct edge because they not only hold the tuning better, but can also be tuned more accurately. Lower quality pianos often have extraneous beats and sounds that make accurate tuning impossible. In this respect, good grands are far superior to run-of-the-mill uprights.

Those who have perfect pitch are very much bothered by pianos that are out of tune. If you have perfect pitch, severely out of tune pianos can accelerate the gradual loss of perfect pitch with age. Babies and very young children can automatically acquire perfect pitch if they hear the piano sound sufficiently frequently, even if they have no idea what perfect pitch is. In order for them to acquire the correct perfect pitch, the piano must be in tune.

If you always practice on a tuned piano, you will have a difficult time playing on one that is out of tune. The music doesn't come out, you make unexpected mistakes, and have memory blackouts. This holds true even if you know nothing about tuning and can't even tell if a particular note is out of tune. Conversely, the best way to test the tuning is to play a piece of music. Good tuning is like magic to any pianist. By playing a piece of music, most pianists can readily hear the difference between a poor tuning and an excellent one, even if they cannot tell the difference by playing single notes or test chords (assuming they are not also piano tuners). Therefore, along with technical development, every pianist must learn to hear the benefits of good tuning. It may be a good idea to practice on an out-of-tune piano once in a while in order to know what to expect in case you are asked to play on one with questionable tuning. For recitals, it is a good idea to tune the recital piano just before the recital, so that the recital piano is in better tune than the practice piano. Try to avoid the reverse case in which the practice piano is in better tune than the recital piano. This is another reason why students who practice on inexpensive uprights have little problem with playing recitals on large, unfamiliar grands, as long as the grands are in tune.

In summary, grands are not necessary for technical development up to about the intermediate level, although they will be beneficial at any level. Above intermediate level, the arguments in favor of grands over uprights become compelling. Grands are better because their actions are faster, they can be tuned more accurately, have a larger dynamic range, have a true soft pedal, can enable more control over expression and tone (you can open the lid), and can be regulated to provide more uniformity from note to note (by use of gravity instead of springs). These advantages, however, are initially minor compared to the student's love for music, diligence, and correct practice methods. Grands become more desirable for advanced students because technically demanding material is easier to execute on a grand. For such advanced pianists, proper tuning, regulation, and hammer voicing become essential because if the piano maintenance is neglected, practically all of the advantages will be lost.

1.3.18 How to Start Learning Piano: Youngest Children to Old Adults

1.3.18.1 Do You Need a Teacher?

Updated: November 6, 2004

Many beginners would like to start learning piano on their own, and there are valid reasons for this. However, there is no question that, for the first 6 months (and probably much longer), there is no faster way to start than taking lessons from a teacher, even one who teaches the intuitive method. The only teachers to avoid completely are those who cannot teach what you want (you may want pop, jazz, and blues while the teacher teaches only classical), or those who teach strict, inflexible methods not appropriate for the student (one method might be designed for very young children but you may be an older beginner). Why are teachers so helpful in the beginning? Firstly, the most fundamental things that you do every time you play, such as hand position, sitting position, hand movements, etc., are difficult to explain in a textbook, whereas a teacher can show you instantly, what is right and what is wrong. You don't want to pick up these wrong habits and have to live with them all your life. Secondly, a beginner sitting down at the piano and playing for the first time is usually making at least 20 mistakes at the same time (left-right coordination, volume control, rhythm, arm and body movements, speed, timing, fingering, trying to learn the wrong things first, total neglect of musicality, etc., etc.). It is the teacher's job to identify all the mistakes and make a mental priority list of which ones must be corrected first, so that the worst offenders can be eliminated quickly. Most teachers also know which basic skills you need and teach them to you in the correct order. Teachers are also helpful in finding the appropriate teaching material for you. Teachers provide a structured learning environment, without which the student can end up doing the wrong things and not realizing that they are not making any progress. In short, teachers are definitely cost effective for beginners.

1.3.18.2 Starter Books and Keyboards

The first order of business when starting is to decide which lesson books to use. For those who want to start by learning general technique (not specialties such as jazz or gospel), you can use any of a number of beginner books such as Michael Aaron, Alfred, Bastien, Faber and Faber, Schaum, or Thompson. Of these, many people prefer Faber and Faber. Most of them have beginner books designed for young children or adults. There is an excellent piano site at:

`http://www.amsinternational.org/piano_pedagogy.htm`

which lists most of these teaching books and reviews many of them. Depending on your age and past musical education, you can skip through these books at your pace and optimize your learning rate.

These starter books will teach you the fundamentals: reading music, various common fingerings such as scales, arpeggios and accompaniments, etc. As soon as you are familiar with most of the fundamentals, you can start learning pieces that you want to play. Here again, teachers are invaluable because they know most of the pieces that you might want to play and can tell you whether they are at the level that you can handle. They can point out the difficult sections and show you how to overcome those difficulties. They can play the lesson pieces to demonstrate what you are trying to achieve; obviously, avoid teachers who cannot or refuse to play for you. After a few months to about a year of such study, you will be ready to continue by following the material of this book. In order to avoid the numerous pitfalls that await you, it is a good idea to read this book, at least quickly once through, before you begin your first lesson.

At the very beginning, perhaps up to a year, it is possible to start learning using keyboards, even the smaller ones with less than the 88 keys of the standard piano. If you plan to play electronic keyboards all your life, it is certainly permissible to practice only on keyboards. However, practically all keyboards have actions that are too light to truly simulate an acoustic piano. As soon as possible, you will want to transition to a 88-key digital piano with weighted keys, see section 1.3.17 above.

1.3.18.3 Beginners: Age 0 to 65+

A frequent concern of many parents is "At what age can our children start piano?", while the primary concerns of older beginners are "Am I too old to learn piano? How proficient can I expect to be? How long will it take?" So let's briefly survey what we might be able to expect if you started piano at different ages. Of course, there are significant differences in "talent" among individuals, so that you may not fit into any of the categories below. However, we are increasingly beginning to recognize that what we had attributed to "talent" was in reality a result of our history. In other words, "talent" was a way for us to hide our ignorance of what really happened. This relatively recent "discovery" is radically changing the landscape of piano pedagogy. The old, intuitive system followed the sequence typified by: Beyer, Hanon, Czerny, small pieces, classics, and finally major pieces. In our new system, we eliminate the first three; i.e., we are back to what Mozart, Beethoven, etc. did. Surprise! What they did was perfectly legitimate! They may be the norm, not the exception, if you know what you are doing. **Therefore, we can legitimately question whether talent is such an important factor in how quickly you can learn to play.** So then, what IS an important factor? Age is one, because learning piano is a process of developing nerve cells, especially in the brain. The process of nerve growth slows down with age. So let's examine categories of beginners according to their ages, and the consequences of slowing brain growth with age. In the classifications below, we assume that the practice methods of this book are available to these individuals. It is still difficult to predict the learning rate because the methods of this book have not been widely adopted until now, these methods allow students to learn practically anything they want, within reason, at any skill level, and these methods have solved many problems that were traditionally almost insurmountable.

Ages 0–6 Babies can hear as soon as they are born, and most maternity wards test babies for hearing right after birth in order to detect abnormalities as early as possible. Up to about age 6, they acquire new skills in stepwise fashion; that is, they suddenly acquire a new skill such as language and rapidly become good at it. But each individual acquires these skills at different times and in a different order. These skills will be discussed in the next section. The most important topic in this age range is listening to music. Most parents make the mistake of giving the baby only baby music. That might be appropriate for a very short time (a few months), but you should quickly transition to adult music. It is not a good idea to expose them immediately to loud blaring trumpets and thunderous drum rolls that can frighten the baby, but most babies can understand Bach, Chopin, etc. Music is an acquired taste; therefore, how the babies' brains develop musically will depend on the type of music they hear. Older classical music started with simpler chord structures and harmonies that are easily and naturally appreciated by the human brain. Then more complex chords and dissonances were added later on as we became accustomed to them over the ages. Therefore, the older classical music is more appropriate for babies because they are more compatible with the fundamental brain processes that produce music appreciation. The piano is particularly appropriate because it is like an entire orchestra that is nonetheless based on a single chromatic scale that can lead to perfect pitch, which babies can acquire without even trying.

Ages 3–12 Below age 3, most children's hands are too small to play the piano, the fingers cannot bend or move independently, and the brain and body (vocal chords, muscles, etc.) may not yet be sufficiently developed to deal with concepts in music. Above age 4, most children are able to receive some type of music education, especially if they have been exposed to music since birth; thus **they should be constantly tested for their sense of pitch (relative and perfect pitch; can they "carry a tune?"), rhythm, loud-soft, fast-slow, and reading music, which is easier than any alphabet.** This group can take full advantage of the enormous brain growth that takes place during this age interval; learning is effortless and limited more by the ability of the teacher to provide the appropriate material than by the student's ability to absorb it. One remarkable aspect of this age group (there are many!) is their "malleability"; their "talents" can be molded. Thus, even if they would not have naturally become musicians if left alone, they can be made into musicians by proper training. This is the ideal age group for starting piano.

Ages 13–19, the "teen" ages. This group still has an excellent chance of becoming concert level pianists. However, they may have lost the chance to become those super stars that the younger beginners can become. Although brain development has slowed down, the body is still growing rapidly until about age 15, and at a slower rate thereafter. The most important factors here are the love of music and the piano. This age group can achieve practically anything they want to, as long as they have an intense interest in music. However, they are not malleable any more; encouraging them to learn piano does not work if they are more interested in cello or saxophone, and the parents' role changes from giving direction to giving support for whatever the teens want to do. This is the age interval in which the teens learn what it means to take responsibility and what it means to become an adult — all lessons that can be learned from the piano experience. In order to influence them, you need to use more advanced methods, such as psychology. This age group should not be considered "too late to start" for becoming concert pianists; they still definitely have a good chance. They will probably never forget anything they memorized at these ages or younger. Above this age group, age classifications become difficult because there is so much variation among individuals depending on their history.

Ages 20–35 Some individuals in this age group still have a chance of becoming concert level pianists. They can use the experience they learned in life to acquire piano skills more efficiently than younger students. Those who decide to learn piano in this age group generally have greater motivation and a clearer understanding of what they want. But they will have to work very hard, because progress will come only after a sufficient amount of work. At this age group, nervousness can start to become a major problem for some. Although younger students can become nervous, nervousness seems to increase with age. This happens because severe nervousness arises from fear of failure, and fear arises from mental associations with memories of terrible events, whether imagined or real. These terrifying memories/ideas tend to accumulate with age. Therefore, if you want to perform, you should do some research into controlling nervousness, by becoming more confident, or by practicing public performance at every opportunity, etc. Nervousness can arise from both the conscious and subconscious brain; therefore, you will need to deal with both in order to learn to control it. For those who just want to become sufficiently technically proficient to enjoy playing major piano compositions, starting in this age group should not present any problems. Although some maintenance will be required, you can keep anything you memorized in this age group, for life.

Ages 35–45 This age group cannot develop into concert level pianists, but can still perform adequately for simpler material. They can acquire enough skill to play most famous compositions for personal enjoyment and informal performances. The most demanding material will probably be out of reach. Nervousness reaches a maximum somewhere between the ages of 40 and 60 and then often declines slowly. This might explain why many famous pianists stopped performing somewhere in this age interval. Memorizing starts to become a problem in the sense that, although it is possible to memorize practically anything, you will tend to forget it, almost completely, if not properly maintained. Reading the music can start to become a problem for some who require strong corrective lenses. This is because the distance from the eyes to the keyboard or music stand is intermediate between reading and distant vision. Thus you may want a set of eye glasses for intermediate vision. Progressive lenses might solve this problem, but some find them bothersome because of their small field of focus.

Ages 45–65 This is the age range in which, depending on the person, there will be increasing limitations on what you can learn to play. You can probably get up to the level of the Beethoven Sonatas, although the most difficult ones will be a huge challenge that will take many years to learn. Acquiring a sufficiently large repertoire will be difficult, and at any time, you will be able to perform only a few pieces. But for personal enjoyment, there is still a limitless number of compositions that you can play. Because there are more wonderful compositions to learn than you have time to learn them, you may not necessarily feel a limit to what you can play. There is still no major problems in learning new pieces, but they will require constant maintenance if you want to keep them in your repertoire. This will greatly limit your playable repertoire, because as you learn new pieces, you will completely forget the old ones, unless you had learned them at much younger ages. In addition, your learning rate will definitely start to slow down. By re-memorizing and re-forgetting several times, you can still memorize a significant amount of material.

Ages 65+ There is no reason why you can't start learning piano at any age. Those who start at these ages are realistic about what they can learn to play and generally do not have unattainable expectations. There are plenty of simple but wonderful music to play and the joy of playing remains just as high as at younger ages. As long as you are alive and not terribly handicapped, you can learn piano and make satisfactory progress at any age. Memorizing a composition you are practicing is not a problem for most. The greatest difficulty in memorizing will come from the fact that it will take you a long time to get up to speed for difficult material, and memorizing slow play is the most difficult memory work. Therefore, if you choose easy pieces that can be brought up to speed quickly, you will memorize those more quickly. Stretching the hands to reach wide chords or arpeggios, and fast runs will become more difficult, and relaxation will also be more difficult. If you concentrate on one composition at a time, you can always have one or two compositions that can be performed. There is no reason to modify your practice methods — they are the same as those used for the youngsters. And you may not feel as much nervousness as you might have in the middle ages. Learning piano, especially memory work, is one of the best exercises for the brain; therefore, serious efforts at learning piano should delay the aging process, just as proper physical exercise is necessary to maintain health.

1.3.19 The "Ideal" Practice Routine (Bach's Teachings and Invention #4)

Updated:
December 14, 2003

Is there an ideal, universal practice routine? No, because each person must design her/is own practice routine at each practice session. In other words, **this book is all about designing your own practice routines.** Some differences between a well designed routine and the intuitive routine of section 1.2.1 are discussed in the last paragraph of this section. A good piano teacher will discuss the appropriate practice routines for the lesson pieces during the lesson. Those who already know how to create practice routines might still find this section interesting, as we will discuss many useful points (such as Bach's teachings and specifics on how to practice his invention #4) in addition to practice routines.

Many students who learn the numerous useful ideas of this book for the first time feel lost and wonder if there are magical practice routines, like the magical practice methods described here. They would like some guidance on typical practice routines that use these methods. Therefore, I describe a few sample practice routines below. Practice routines depend on the skill level, what the person wants to accomplish, the composition being practiced, what the person was practicing the day before, etc. A practice session for preparing for performances is different from that for learning a new piece, which is different from that for polishing a piece that you have been practicing for some time.

A universal routine, such as "Practice Hanon for 30 minutes, then scales/arpeggios for 20 minutes, then Cramer-Bülow (or Czerny, etc.), followed by lesson pieces" does not make any practical sense; it is the epitome of the intuitive method and reveals a general ignorance of how to practice. **The question "What is a good practice routine?" is answered by "How do you design practice routines?" Instead of asking "What must I do?" you should ask "What do I want to accomplish?" You design a practice routine by (i) defining your objective and (ii) assembling the re-**

sources to accomplish it. In order to do this, you must first become familiar with all the practice methods. Since there is so much material in this book, you should not wait until you understand the last page before applying the methods. This book is written like a practice routine: you can pick a composition you want to play, and start practicing it by reading from the beginning of Chapter One and applying each principle in the order in which it is presented.

1.3.19.1 Learning the Rules

Therefore, the first "practice routine" you should use is to follow Chapter One, starting from the beginning and applying the concepts to a composition you want to play. The objective is to become familiar with all the available practice methods. You can choose a piece that you have never played before, but the best choice is probably a composition that you have already practiced a little so that you can concentrate more on learning the practice methods than learning the composition. Choose a piece that is not too long and not too difficult. Before you start on the piano, read the entire Chapter One (or the whole book) once quickly. Don't even try to learn anything the first time because this book contains so many ideas, and they are described so concisely, that most people need to read it several times. You will be surprised at how well the key ideas will register permanently in your brain when you read something without trying to memorize everything in it. Read it the first time as if you are reading a novel or some fun story and skip sections that you think have too much detail; after you pass all the major ideas through your brain once, it will become much easier to understand the beginning of the book even if you don't remember most of what you read previously. You will also have a good idea of the outline of the book and how it is organized: all the basics are presented in Chapter One, section 2, and the more advanced concepts are discussed in section 3.

There is no need to practice each method until you become good at it, before going on to the next one. The idea is to try each one several times and to understand the purposes of the methods and to get a rough idea of how the objectives are achieved. You will have plenty of time to practice them later on! Of course, you might have fun applying them and end up spending a lot of time on some particularly rewarding methods. There is nothing wrong with that!

Once you have some familiarity with most of the practice methods, we are ready to design practice routines. In order to design generally useful routines, we assume that you have had at least one year of serious piano practice. Our objective is to learn Bach's Invention #4.

1.3.19.2 Routine for Learning a New Piece (Invention #4)

In this book, "Learning a new piece" is synonymous with memorizing it. Therefore, without any warm-ups, etc., immediately start memorizing Bach's Invention #4, RH first, starting with segments of one to three bars that make up a distinct phrase, then the LH. Continue this process until you have memorized the entire piece, HS only. See section 1.3.6 for more details on memorizing. Those already good at using the methods of this book should be able to memorize the entire Invention (not perfectly), HS, on the first day, after one or two hours of practice (for an average person with an IQ of about 100). Concentrate only on memorizing, and don't worry about anything that you "cannot play satisfactorily" (such as the 1, 3 trill in the LH), and play at any speed that is comfortable for you. If you want to memorize this piece as quickly as possible, it is best to concentrate only on this piece and not play other pieces. Instead of one long session of 2 hrs, you might practice 1 hr, twice during the day.

Memorizing is easier at faster speed. Therefore, as you memorize in segments, accelerate it as much as you can, even if this makes the playing a little sloppy. However, play it slowly once before switching hands, making sure that you play each note accurately. Play each segment just a few times, then switch hands. From the first day, try to play HS in your mind, away from the piano; if you get stuck and have a complete blackout, don't worry, this is normal. You will re-memorize this part during the next practice session. Practice until you can play the entire composition, each hand separately.

Play Thumb Over everywhere except for the 21 in 212345 of bar 1, and other similar places, where Thumb Under is much easier. It is amazing how Bach found a way to make you practice Thumb Under in a fast passage; in practically all fast passages, you need to play Thumb Over. The choice of Thumb Under or Over will become very important later on, when we increase the velocity.

On the second day, start HT slowly, still in segments of a few bars, and then connecting them. Again, don't practice anything else; even playing finger exercises to warm up will cause you to forget some of what you just memorized. Note that from the first day, you had started technique acquisition, which is inseparable from memory. Technique acquisition/memory is almost a purely brain process (although many people call it "hand memory"), and is composed of short term memory that is stored in a specific part of the brain, and several forms of permanent memory that are permanent changes in the brain. Short term memory is almost instantaneous, but the first form of permanent memory takes about 5 minutes to complete (even for those who can "instantly" memorize many things), and after that, the memory is in your brain essentially forever. However, there is no guarantee that you can recall it later on. This process of writing from "volatile memory" to "non-volatile memory" is automatic, and you have no control over it. The difference between good memorizers and bad memorizers is that the bad memorizers cannot recall what is already in their brain. Therefore, when you practice memorizing, you must practice recalling information rather than inputting information into the brain. The second form of permanent memory is associated with post practice improvement and actually changes your ability to play that segment, in addition to storing it in memory — this is the technique acquisition part. Most of the permanent improvement in technique occurs during sleep, and this is one of the reasons why we need to sleep — so that the brain can make the necessary repairs and improvements to adapt to our changing environment. Our brain is more complicated than an automobile; therefore, it is not surprising that you cannot make repairs or modifications until you bring it into a garage and shut the engine off (sleep). A good night's sleep, including REM sleep, is necessary for making maximum progress for learning piano. REM (Rapid Eye Movement) sleep is an important stage of sleep in which the eyes move rapidly, although you are asleep. This is why sleep is so important for babies — because there is so much construction going on in their brains.

1.3.19.3 "Normal" Practice Routines and Bach's Teachings

After 3 or 4 days, you can return to your "normal" practice routine. For the "memorizing" routine, we basically did nothing but memorize because mixing memorizing with other practice will slow down the memorizing process. In the "normal" routine, we can take advantage of the beginning, when the hands are still “cold”. If you had never done this before, you must practice playing your finished pieces “cold”. Of course, you cannot play difficult, fast pieces cold. Either play easier pieces, or play the difficult ones slowly. A good procedure is to start with easier ones and gradually play the harder ones. Once you become a strong enough performer so that you have no trouble playing cold (this may take a year), this step becomes optional, especially if you play the piano every day. If you do not play every day, you may lose the ability to play cold if you stop practicing it. Another thing that can be practiced during this warming-up period is scales and arpeggios; see sections 1.3.4.2 and 1.3.5 for details on how to practice them. You might also try the finger independence and lifting exercises of 1.3.7.5. Start practicing other compositions in addition to the Bach.

By this time, you should be able to play the entire Bach Invention in your mind, HS, with no trouble. This is a good time to conduct maintenance on pieces you had memorized previously, because learning a new piece will often result in forgetting portions of previously learned pieces. Alternate practice between the Bach Invention and your old pieces. You should practice the Bach HS most of the time until you have acquired all the necessary technique. Increase speed as quickly as you can, to speeds faster than the final speed. Practice mostly those sections that give you difficulty; there is no need to practice sections that are easy for you. Once you get to a certain speed HS, start practicing HT at a slower speed. As soon as you feel comfortable HT at a slow speed, bring it up to a faster speed. **To increase speed (HS or HT), do not use the metronome or force your fingers to play faster. Wait until you get the feeling that the fingers WANT to go faster, and then increase the speed by a comfortable amount.** This will allow you to practice relaxed and avoid all speed walls.

The most important function of HS practice is technique acquisition; therefore, **do not try to acquire technique HT,** because you can waste a lot of time trying to do that. **In order to transition successfully from HS to HT practice, cultivate the feeling that the two hands need each other in order to play.** This will help you to find those motions that help HT play. Thus HT play is not just a superposition of HS play, but a new mode of play. HS play is useful even during HT play; for example, if you make a mistake playing HT, you can correct it without interrupting the music by going back to HS play for the hand that made the error while continuing uninterrupted with the other hand. Without extensive HS practice, such a feat would be impossible.

In order to acquire the specific techniques that Bach had in mind, we must analyze this Invention in some detail. Bach’s Inventions were composed mainly as practice pieces for technique and each Invention teaches you specific new sets of techniques. Therefore, we must know what types of skills this Invention is intended to teach us. **Bach teaches us not only specific skills, but also HOW TO PRACTICE THEM! That is, by analyzing the Inventions, we can learn many of the practice methods of this book!!**

The main theme of this Invention is given by the first 4 bars of the RH. This is then repeated by the LH. The structure of these Inventions, consisting of 2 voices, has a dual purpose. The first is that it teaches us hand independence. The second, less obvious one, is that it is telling us to practice HS! Both hands play basically the same things, giving us the opportunity to balance the technical levels of the two hands; this can only be achieved by HS practice and giving the weaker hand more work. There is no better way to practice hand independence, the principal lesson of the Inventions, than by practicing the hands separately. The section where one hand is trilling would be devilishly difficult to practice HT from the beginning, whereas it is quite easy, HS. Some students who do not know HS practice will try to “match” the two hands by figuring out the trill notes ahead of time and then slowing it down for HT practice. This may be appropriate for beginners or youngsters who have not yet learned to trill. Most students should trill (HS) from the beginning, and work on accelerating the trill as soon as possible. There is no need to mathematically match the two hands; this is art, not mechanics! Bach wants you to trill one hand independently of the other. The reason why you should not match the notes is that these trills are just a device to sustain the notes for a long time, and the individual notes have no rhythmic value. What do you do, then, if you happen to end up with the wrong trill note at the end? You should be able to compensate for that by either waiting briefly or changing the speed of the trill near the end — that is the type of skill that this Invention teaches. Therefore, matching the trill to the other hand for practice defeats the lesson of this Invention. The staccato in bars 3 and 4 of the RH is another device for practicing hand independence; staccato in one hand versus legato in the other requires more control than both legato. The staccato should be used throughout the piece although, in many editions, they are indicated only at the beginning.

Most Bach lesson pieces teach not only independence between the hands but also independence of the fingers within one hand, and especially the 4th finger. Thus in bars 11 and 13, there are 6 notes in the RH that can be played as two triplets but are actually three doublets because of the 3/8 time signature. These bars can be difficult for beginners because they require the coordination of three difficult motions: (i) the RH fingering symmetry is that of 2 triplets (**3**45**3**45 rhythm), but it must be played as 3 doublets (**3**4**5**3**4**5), (ii) at the same time, the LH must play something completely different, and (iii) all this must be accomplished using mostly the three weakest fingers, 3, 4, and 5. Bach frequently used this device of forcing you to play a rhythm that is different from the fingering symmetry in order to cultivate finger independence. He also tries to give the 4th finger as much work as possible, as in the final **4**5.

The triplets are easier to play using 234 fingering instead of 345, especially for larger hands, and most editions suggest the 234 fingering. Knowledge of parallel set exercises indicates that Bach’s original intent was 345 (for maximum technical development value), and it is a “musical license” to change it to 234 in order to facilitate musicality. That is, in any composition other than these Inventions, 234 would be the correct fingering. Use of 234 can be further justified here because it teaches the student the principle of choosing the fingering with the greatest control. Therefore, the student can justifiably choose either fingering. A similar situation arises in bar 38 where Bach’s original intention for the LH was probably 154321 (a more complete parallel set) whereas musical license would indicate 143212 which is technically less demanding. Without help from parallel set exercises, the obvious choice is the musical license. By using parallel set exercises, the student can learn to use either fingering with equal ease.

The “triplets in 3/8 signature” is a good example of how reading the music incorrectly makes it difficult to get up to speed and how speed walls form. When playing HT, you will encounter problems if you play the RH triplets in two beats (wrong way) and the LH in three (correct). Even if you made a second mistake of playing the LH in two beats in order to match the RH, there will be a problem with the rhythmic change from adjacent bars. You might manage to play through these mistakes at slow speed, but when speeded up, they become impossible to play and you begin to build a speed wall. This is an example of the importance of rhythm. It is amazing how many lessons Bach can cram into something that looks so simple, and these complexities partly explain why, **without proper practice methods or guidance from knowledgeable teachers, many students find it impossible to memorize Bach or to play his compositions beyond a certain speed. The lack of proper practice methods is the main reason why so many students end up playing so few Bach pieces.**

The Inventions are excellent technical lesson pieces. Hanon, Czerny, etc., tried to achieve the same ends using what they thought were simpler, more systematic approaches but they failed because they tried to simplify something that is infinitely complex. By contrast, Bach squeezed as many lessons as he could into every bar, as demonstrated above. Hanon, Czerny, etc., must have been aware of the difficulties of learning Bach but were unaware of good practice methods, and tried to find simpler methods of acquiring technique by following their intuitive instincts. This is one of the best historical examples of the pitfalls of the intuitive approach.

Because the Inventions were composed for teaching specific skills, they can sound somewhat constrained. In spite of this constraint, all of Bach's lesson pieces contain more music than practically anything ever composed and there are enough of them to satisfy the needs of students at any level, including beginners. If the inventions are too difficult, consider studying the very large number of delightful (and eminently performable) simpler lesson pieces Bach composed. Most of them can be found in the "Clavier Book of Anna Magdalena Bach" (his second wife). Because there are so many, most books will contain only a small number of selections. **Because the Inventions are lesson pieces, almost every edition has the critical fingerings indicated.** Therefore, figuring out the fingerings, which is extremely important, should not be a problem.

The Inventions were composed by assembling well defined segments that are usually only a few bars long. This makes them ideal for using HS segmental practice, another key element of the methods of this book. This, and many other properties of Bach's compositions make them ideal music to learn using the methods of this book, and it is quite probable that they were composed with these practice methods in mind. Bach may have been aware of most of the material of this book!

Another important lesson of Bach's Inventions is parallel sets. The main technical lesson of this Invention #4 is the parallel set 12345, the basic set needed to play the scale and runs. However, Bach knew that a single parallel set is too dangerous from a technical point of view because you can cheat by phase locking without acquiring technique. In order to prevent phase locking, he added one or two notes to the parallel set. Now if you tried to cheat, you will be caught immediately because the music will not come out even: Bach has given you no choice but to acquire the required technique if you want to play this musically! Here is another example of Bach teaching us why music and technique are inseparable (by using music as a criterion for technique acquisition). Therefore, the quickest way to learn to play this Invention is to practice the 12345 and 54321 parallel sets. **As soon as you test your fingers using these parallel sets, you will understand why Bach composed this Invention.** If you can do these parallel set exercises satisfactorily, this piece will be quite easy, but you will find that the parallel sets are not easy at all, and will probably require lots of work even if you are at an intermediate level. First work on these sets using only white keys; then work on others that include black keys, as suggested by Bach. A good example is the LH 12345 parallel set of bars 39–40, with the difficult 4th finger on a white key following 3 on black. Bach extracts the most difficult part of this parallel set, 2345, and repeats it in bar 49.

Bach clearly saw the value of playing a small number of notes very quickly, such as ornaments and trills, for developing technique (velocity). Thus his ornaments are another key device for acquiring technique, and they are essentially a small assemblage of parallel sets. There are numerous discussions on how to play Bach's ornaments; these discussions are important from the point of view of correct musical expression, but **we must not miss the point that technically, ornaments in lesson pieces are an essential device for acquiring velocity, and are not just musical ornaments**. Play both the RH and LH trills with fingers 1 and 3, which will make the LH trill easier to learn. Most students will be able to play the RH trill better than the LH trill in the beginning; in that case, use the RH to teach the LH. This "technique transfer" from one hand to the other is easier if both hands use similar fingering. Because the purpose of the trill is simply to sustain the notes, there is no specific trill speed that is required; however, try to trill the two hands at the same speed. If you want to trill very fast, use the parallel sets to practice them as described in section 1.3.3.1. It is extremely important to start the first two notes rapidly if you want to trill fast. The easiest way to do this is to phase lock them. This phase-locked "non-musical play" will not be noticeable because it comes so quickly at the beginning of the trill. In fact, if the first 2 notes are faster than the rest of the trill, the audience will think that the entire trill is faster than it actually is. Watch the positions of fingers 2, 4, and 5 while trilling. They should be stationary, close to the keys, and slightly curved.

Most students find it difficult to play these Inventions beyond a certain speed, so let's visit a practice routine for increasing speed. Using this type of routine, you should be able to eventually play at practically any reasonable speed, including speeds at least as fast as those of Glen Gould and other famous pianists. We will learn to play bars 1 and 2 fast, and after that, you should be able to figure out how to accelerate the rest. Note that these two bars are self-cycling (see section 1.3.2). Try cycling it rapidly. Chances are, you will fail because stress develops rapidly with speed. Then just practice 212345 of bar 1 until it is smooth and fast. Then practice 154, then 54321 of the 2nd bar. Then connect them, and finally, cycle the two bars. You may not be able to complete everything the first day, but the PPI will make it easier on the second day. Using similar methods, solve all your technical difficulties in the entire piece. The key difficulty in the LH is the 521 of bar 4, so practice 521 parallel set until you can play it at any speed, completely relaxed. Note that the 212345 of the RH and the 543212 of the LH are thumb-passing exercises. Clearly, Bach recognized that thumb over and thumb under are critical technical elements at high speed and created numerous ingenious opportunities for you to practice them. Before you can play HT fast, you must get up to HS speeds that are much faster than the HT speed you want. "Getting up to speed" doesn't mean just being able to attain the speed, but you must be able to feel the quiet hands and have complete control of each individual finger. Beginners may need months of HS practice for the higher speeds. Many students tend to extract more speed from their fingers by playing loud; this is also not true speed, so play everything softly for these practice sessions. When starting to play HT fast, exaggerate the rhythm — this might make it easier. You cannot really accelerate until you can play musically; we will discuss this below. Although most Bach compositions can be played at different speeds, the minimum speed for the Inventions is the speed at which you can feel the quiet hands when you acquire the necessary technique, because if you don't get up to that speed, you have missed one of his most important lessons.

An intermediate level player should be able to conquer the technical difficulties of this Invention in about a week. **Now we are ready to practice playing it as a piece of music!** Listen to several recordings in order to get an idea of what can be done and what you want to do. Try different speeds and decide on your own final speed. Video-tape your own playing and see if the result is visually and musically satisfactory; usually, it is not, and you will find many improvements you will want to make. You may never be completely satisfied even if you practiced this piece all your life.

In order to play musically, you must feel each note before playing it, even if it is just for a split second. This will not only give you more control and eliminate errors, but also allow you to accelerate continuously through the keydrop so that the hammer shank is flexed by just the right amount when the hammer strikes the strings. Pretend that there is no bottom to the keydrop and let the bottom of the keydrop stop your finger. You can do this and still play softly. This is called "playing deeply into the piano". You cannot "raise your finger high and plonk it down" as Hannon recommended and expect to make music. Such a motion can cause the hammer shank to oscillate instead of flexing and produce an unpredictable and harsh sound. Therefore, as you practice HS, practice for musicality also. Use the "flat finger positions" of section 1.3.4.2. Combine these with a supple wrist. Play as much as possible with the flat, fleshy part of the finger (opposite the fingernail), not the bony finger tip. If you video tape your playing, the curled finger position will look childish and amateurish. You cannot play relaxed until you can completely relax the extensor muscles of the first 2 or 3 phalanges of fingers 2 to 5. This relaxation is the essence of the flat finger positions. At first, you will be able to include all these considerations only at slow speed. However, as soon as you develop quiet hands, you will gain the ability to include them at higher speeds. In fact, because these finger positions allow complete relaxation and control, you will be able to play at much faster speed. This is one of the (many) reasons why quiet hands is so important. If you have not been paying attention to musicality, you should hear an immediate change in the tonality of your music when you adopt these principles, even at slow speeds.

Tone and color: The improved tonality will be most clearly evident when playing softly; the softer play also helps relaxation and control. The flat finger position is what enables softer play with control. How soft is soft? This depends on the music, speed, etc., but for practice purposes one useful criterion is to play softer and softer until you start to miss some notes; this level (or slightly louder) is usually the best for practicing softly. Once you have control over tonality (sound of each individual note), try to add color to your music (effect of groups of notes). Color for each composer is different. Chopin requires legato, special staccato, rubato, etc. Mozart requires the utmost attention to the expression markings. Beethoven requires uninterrupted rhythms that run continuously over many, many bars; therefore, you need to develop the skill for "connecting" consecutive bars. Bach's Inventions are somewhat contrived and "boxed in" because they are mostly confined to simple parallel sets. You can easily overcome this handicap by emphasizing the multitude of musical concepts that give his music almost infinite depth. The most obvious musicality comes from the harmony/conversation between the two hands. The ending of every piece must be special, and Bach's endings are always convincing. Therefore, don't just let the ending catch up to you; make sure that the ending is purposeful. In this Invention, pay special attention to bar 50, in which the two hands move in opposite directions as you enter the authoritative ending. When you bring the music up to speed and develop quiet hands, the 6-note runs (e.g., 212345, etc.) should sound like rising and falling waves. The RH trill is bell-like because it is a full note, while the LH trill is more sinister because it is a half note. When practicing HS, note that the RH trill is not just a trill but it comes crashing down at the end. Similarly, the LH trill is an introduction to the ensuing counterpoint to the RH. **You cannot bring out color unless you lift each finger at precisely the right moment.** Most of Bach's lesson pieces contain lessons in lifting the fingers accurately. Of course, the coloration should initially be investigated HS. Quiet hands is also most easily acquired HS; therefore adequate HS preparation before HT practice is of critical importance for tone and color. Once the preparation work is done, you can start HT and bring out the incredible richness of Bach's music!

Tone and color have no limits in the sense that once you succeed, it becomes easier to add more, and the music actually becomes easier to play. All of a sudden, you may discover that you can play the entire composition without a single audible mistake. This is probably the clearest illustration of the statement that you cannot separate music from technique. The act of producing good music actually makes you a better pianist. This provides one of the explanations of why you have good days and bad days — when your mental mood and finger conditioning are just right so that you can control the tone and color, you will have a good day. This teaches us that on bad days, you may be able to "recover" by trying to remember the fundamentals of how you control tone and color. This ends the discussions on Invention #4. We now return to the practice routine.

You have been practicing for over one hour by now, and the fingers are flying. This is the time when you can really make music! You must make every effort to practice making music during at least half of the total practice time. Once you have built up a sufficiently large repertoire, you should try to increase this "music time" from 50% to 90%. Therefore, you must consciously set aside this portion of your practice routine for music. Play your heart out, with all the emotion and expression you can muster. **Finding musical expression is very difficult and exhausting; therefore, initially, it will require much more conditioning and effort than anything you can do with Hanon.** If you don't have a teacher, the only known ways to learn musicality are to listen to recordings and to attend concerts. If you are scheduled to perform a particular composition in the near future, play it slowly, or at least at a comfortable and fully controllable speed once, before going on to something different. Expression is not important when playing slowly. In fact, it may be beneficial to purposely play with little expression when playing slowly before noving on to something else.

Learning Bach is strongly emphasized in this book. Why? **Because Bach's music written for technical development is unique in piano pedagogy in its healthy, complete, efficient, and correct approach to technique acquisition — there is nothing else like it.** Every experienced teacher will assign some Bach pieces for study. As mentioned above, the only reason why students do not learn more Bach pieces is because, without the proper practice methods, they seem so difficult. You can demonstrate to yourself the benefits of the Bach lessons by learning five of his technical compositions and practicing them for half a year or more. Then go back and play the most difficult pieces that you had learned previously, and you will be amazed at the greater ease and control that you have gained. Bach's compositions were designed to create concert pianists with sound fundamental technique. Chopin's etudes were not designed for gradual, complete technical development and many of Beethoven's compositions can cause hand injury and ear damage if you don't get proper guidance (they appear to have damaged Beethoven's hearing). Neither of them teaches you how to practice. Therefore, Bach's compositions stand out above all others for technical development. With the practice methods of this book, we can now take full advantage of Bach's resources for technical development that has been sadly underutilized in the past.

In summary, there is no magical practice routine for faster learning. Only practitioners of intuitive methods who do not know how to teach practice methods need the concept of a "standard practice routine" which is a poor substitute for the missing practice methods. To those who know the practice methods, the concept of a standard practice routine becomes a somewhat silly idea. For example, a typical standard routine might start with Hanon exercises; however, you can easily bring the Hanon exercises up to ridiculous speeds by applying the methods of this book. And once you accomplish that, you begin to wonder why you are doing this. Now, what will you gain by playing these ridiculously fast Hanon pieces every day?? Instead of a standard practice routine, you must define what your objective for the practice session is, and select the practice methods needed to achieve that goal. In fact, your practice routine will constantly evolve during each practice session. Thus the key for designing a good practice routine is an intimate knowledge of all the practice methods. How different this is, from the intuitive routine described in section 1.2.1! No more extensive finger exercises, or Czerny and other pieces just for technical work with no music. No more structured practice sessions with interminable repetitions with the brain shut off. No more speed limits, speed walls, or the boring slow practice with the metronome. Our method is pure empowerment, freeing us to quickly master the technical material so that we can concentrate on music, and even to learn as many Bach pieces as we desire.

1.3.20 Bach: the Greatest Composer and Teacher (15 Inventions and their Parallel Sets)

Updated:
February, 2004

In this section, we briefly analyze Bach's fifteen 2-part Inventions (from simple structural points of view) in order to explore how and why he composed them. The objective is to better understand how to practice and benefit from Bach's compositions. As a by-product, we can use these results to speculate on what music is and how Bach produced such incredible music out of what (we will demonstrate) is basic "teaching material" that should be no different from Czerny or Cramer-Bulow. Clearly, Bach used advanced musical concepts in harmony, counterpoint, etc., that music theoreticians are still debating to this day, while others wrote "lesson music" mainly for their finger training value. Here, we only examine the Inventions at the simplest structural level. Even at this basic level, there are some educational and intriguing ideas that we can explore and arrive at the realization that music and technique are inseparable.

There is a nice essay (`http://www.music.qub.ac.uk/~tomita/essay/inventions.html`) on Bach's Inventions and their history, etc., by Dr. Yo Tomita of Queen's University in Belfast, Ireland. This is one of the best analysis of the Inventions and what they contain. The name "Inventions" does not seem to have any specific meaning in terms of the contents of the Inventions. Each Invention uses a different scale (in ascending order by key) that was important in the Well Temperaments favored during Bach's time. They were initially written for his oldest son Wilhelm Friedemann Bach when Friedemann was 9 years old, around 1720. They were subsequently upgraded and taught to other students.

The single most striking feature common to all the Inventions is that each one concentrates on a small number of parallel sets, usually less than three. Now, you might say, "That's not fair — since practically every composition can be decomposed into parallel sets, of course, the Inventions must be all parallel sets, so what's new?" The new element is that each Invention is based on only one to three specific parallel sets that Bach chose for practice. To demonstrate this, we list these parallel sets below for each Invention. In order to concentrate entirely on simple parallel sets, Bach completely avoids the use of thirds and more complex chords (in one hand), that Hanon uses in his highest numbered exercises. Thus Bach wanted his students to master parallel sets before chords.

Single parallel sets are almost trivial from a technical point of view. That is why they are so useful — they are easy to learn. Anyone with a some piano experience can learn to play them pretty fast. The real technical challenges arise when you have to join two of them with a conjunction in between. Bach obviously knew this and therefore used only combinations of parallel sets as his building blocks. Thus the Inventions teach how to play parallel sets and conjunctions — learning parallel sets is of no use if you can't connect them. Below, I use the term "linear" parallel set to denote sets in which the fingers play sequentially (e.g., 12345), and "alternating" sets when alternate fingers play (132435). These joined parallel sets form what is normally called "motifs" in these Inventions. However, the fact that they are created using the most basic parallel sets suggests that the "motifs" were not chosen because of their musical content, but were chosen for their pedagogical value and the music was then added with the genius of Bach. Thus only Bach could have achieved such a feat; this explains why Hanon failed. Only one representative combination of parallel sets is listed below for each Invention; Bach used them in many variations, such as reversed, inverted, etc. Note that Hanon based his exercises on essentially the same parallel sets, although he probably accomplished this by accident, by extracting these motifs from Bach's works. Perhaps the most convincing evidence that Bach knew about parallel sets is the beautiful progressive complexity of the sets he chose with increasing Invention number.

List of the parallel sets in each Invention (for the RH):

#1 1234 and 4231 (linear followed by alternating); in a later modification of this Invention, Bach replaced the 4231 alternating set with two linear sets, 432,321. This change is logical because it converts this Invention from one that teaches two different types of parallel sets to one that concentrates on only one, since these inventions are arranged in order of increasing parallel set complexity. Thus the alternating parallel set 4231 was out of order for the first Invention. However, the order of difficulty of each Invention may not follow the same order as parallel set complexity for most people, because the structural simplicity of the parallel sets does not always equate to easier playing.

#2 Linear sets as in #1, but with a wider variety of conjunctions. An added complexity is that the same motif, appearing at different times, requires a different fingering. Thus the first two inventions deal mainly with linear sets, but the second one is more complex.

#3 324 and 321 (alternating followed by linear). A short alternating set is introduced.

#4 12345 and 54321 with an unusual conjunction. These longer linear sets with the unusual conjunction increase the difficulty.

#5 4534231; full blown alternating sets.

#6 545, 434, 323, etc., the simplest example of the most basic 2-note parallel sets joined by one conjunction; these are difficult when the weak fingers are involved. Although they are simple, they are an extremely important basic technical element, and alternating them between the two hands is a great way to learn how to control them (using one hand to teach the other, section 1.2.20). It also introduces the arpegic sets.

#7 543231; this is like a combination of #3 and #4 and is therefore more complex than either one.

#8 14321 and first introduction of the "Alberti" type combination 2434. Here, the progression in difficulty is created by the fact that the initial 14 is only one or two semitones which makes it difficult for combinations involving the weaker fingers. It is amazing how Bach not only knew all the weak finger combinations, but was able to weave them into real music.

#9 The lessons here are similar to those in #2 (linear sets), but are more difficult.

#10 This piece consists almost entirely of arpegic sets. Because arpegic sets involve larger finger travel distances between notes, they represent another progression in difficulty.

#11 Similar to #2 and #9; again, difficulty is increased, by making the motif longer than for the preceding pieces. Note that in all the other pieces, there is only a short motif followed by a simple counterpoint section which makes it easier to concentrate on the parallel sets.

#12 This one combines linear and arpegic sets, and is played faster than previous pieces.

#13 Arpegic sets, played faster than #10.

#14 12321, 43234; a more difficult version of #3 (5 notes instead of 3, and faster).

#15 3431, 4541, difficult combinations involving finger 4. These finger combinations become especially difficult to play when many of them are strung together.

The above list shows that:

1. There is a systematic introduction of increasingly complex parallel sets.
2. There tends to be a progressive increase in difficulty, with emphasis on developing the weaker fingers.
3. The "motifs" are, in reality, carefully chosen parallel sets and conjunctions, chosen for their technical value just as in the Hanon series. However, Bach succeeded where Hanon failed because Bach understood the difference between music and noise, and that music and technique cannot be learned separately.

The fact that motifs, chosen simply for their technical usefulness, can be used to create some of the greatest music ever composed is intriguing. This fact is nothing new to composers. To the average music aficionado who has fallen in love with

Bach's music, these motifs seem to take on special significance with seemingly deep musical value because of the familiarity created by repeated listening. In reality, it is not the motifs themselves, but how they are used in the composition that produces the magic. If you look simply at the barest, basic motifs, you can hardly see any difference between Hanon and Bach, yet no one would consider the Hanon exercises as music. The complete motif actually consists of the parallel sets and the attached counterpoint section, so-called because it acts as the counterpoint to what is being played by the other hand. Bach's clever use of the counterpoint obviously serves many purposes, one of which is to create the music. The counterpoint (which is missing in the Hanon exercises) might appear to add no technical lessons (the reason why Hanon ignored it), but Bach uses it for practicing skills such as trills, ornaments, staccato, etc., and the counterpoint certainly makes it much easier to compose the music and adjust its level of difficulty.

Thus music is created by some "logical" sequence of notes or sets of notes that is recognized by the brain, just as ballet, beautiful flowers, or magnificent scenery is recognized visually. What is this "logic"? A large part of it is automatic, almost hardwired brain data processing, as in the visual case; it starts with an inborn component (newborn babies will fall asleep when they hear a lullaby), but a large component can be cultivated (e.g., Bach versus Rock and Roll). But even the cultivated component is mostly automatic. In other words, when any sound enters the ears, the brain instantaneously begins to process and interpret the sounds whether we consciously try to process the information or not. An enormous amount of this automatic processing goes on without our even noticing it, such as depth perception, eye focusing, direction of origin of sounds, walking/balancing motions, etc. Most of that processing is inborn and/or cultivated but is basically out of our conscious control. The result of that mental processing is what we call music appreciation. Chord progressions and other elements of music theory give us some idea of what that logic is. But most of that "theory" today is a simple compilation of various properties of existing original music. They do not provide a sufficiently basic theory to allow us to create new music, though they allow us to avoid pitfalls and extend/complete a composition once you have somehow generated a viable motif. Thus it appears that music theory today is still very incomplete. Hopefully, by further analyzing music from the great masters, we can, slowly, step by step, approach that goal of developing a better understanding of music.

Finally, it is clear that the Inventions were created for technique development. However, Bach's music has not been utilized as much as they should have been in the past because of the difficulty of learning to play them for students unfamiliar with effective practice methods. The methods of this book should eliminate those difficulties and allow more widespread use of this most valuable resource for healthy technique acquisition. Hopefully, this section illustrates the synergy between Bach's teachings and the methods of this book which will allow more students to benefit from the world's greatest music composed by the world's greatest teacher.

1.3.21 The Psycology

We are all aware that psychology plays a major role not only in music, but also in piano learning. There are numerous ways for taking advantage of our understanding of psychology and we will discuss some of these methods in this section. However, the more important immediate task is to uncover the psychological pitfalls that have created seemingly insurmountable obstacles to learning piano, such as "lack of talent", or "nervousness" when performing. Another example is the phenomenon of the great artists' inability to teach discussed in section 1.3.16.5 above. This phenomenon was explained in terms of the artists' psychological approach to teaching which mirrored their approach to composing music. Since the psychology of music is only minimally understood, composers simply create music in their minds "out of nothing" — there is no such thing as a formula for creating music. They similarly acquired technique by imagining the musical output and letting the hands find a way to accomplish it. It is a terrific shortcut to a complex result, when it works, and is still the only way for composing music. However, for most students, it is a most inefficient way for acquiring technique and we now know that there are better approaches. Therefore, an analysis of these psychological approaches is a necessary component of piano pedagogy.

Psychology is mostly controlled by knowledge and it is often difficult to distinguish between psychology and knowledge. In most cases, it is knowledge that controls how we psychologically approach a subject. What we are discussing here is clearly psychology because knowledge is not enough — you need to actually change the mental approach in order to accomplish the objective. Knowledge makes this change possible, or even easy. It is now time to examine some specific items.

Perhaps the most important one is how we view piano learning, or our general attitude towards the process of learning to play. The methods of this book are diametrically opposite to most other older methods. For example, when a student fails to learn, it was because of a lack of talent according to the old system, so failure was the student's fault. In the system of this book, failure is the teacher's fault because the teacher's job is to provide all the information necessary for success. This new assignment of fault is possible only if there is sufficient information so that all reasonably competent students (over 90% of the human population) can succeed; but that is indeed the case with the material available here. Previously, the teacher was the master of the art, and the student had to follow strict rules provided by the teacher. In our new system, the student is the employer and master of the learning process and the teacher must provide what the student needs; in other words, the teacher supplies the necessary information and the student designs her/is own practice routines using this information. Now the responsibility for understanding the learning process falls on the student because s/he is in charge of the learning process — there is no more blind faith that practicing Hanon for one hour every day will transform you into a virtuoso. In fact, nothing should be taken on faith and it is the teacher's responsibility to explain each method so that the student understands it. This will require the teacher to be knowledgeable in a wide variety of disciplines, especially the sciences. We have come to a point in history when art teachers cannot ignore science any more. Therefore, the psychology of piano learning requires profound changes in the requirements for both the student and the teacher.

In short, the old system was a system of rules based on historical practices; the new one is a system of methods based on knowledge.

For the students, especially those trained in the old system with rules, the transition from the old to the new ranges from "very easy" to complete confusion. Some students will instantly enjoy the new empowerment and freedom and, within a week, are enjoying the full benefits of the methods. On the other extreme are those students who don't immediately realize that there are no more rules and are still looking for "new rules" to follow. They are full of questions: When I cycle one hand, is 10 times enough, or do I need 10,000 times? Do I cycle as fast as I can, or at a slower, more accurate speed? Is HS practice necessary, even if I can already play HT? For simple music, HS practice can be awfully boring — why do I need it? Such questions reveal the extent to which the student has adapted to the new psychology, or failed to adapt. To illustrate, let us psycho-analyze the last question. In order to ask such a question, that person must have been practicing blindly because s/he read that it was necessary to practice HS. In other words, s/he was blindly following a rule. That is not the method of this book. Here, we first define an objective, and then use HS practice to achieve it. This objective might be more secure memory in order to avoid blackouts during performances, or technical development so that when you play HT, you can hear that the playing is based on superior technical skills. When these objectives are achieved, the practice is not boring at all!

For the teacher, there is no question that everything in modern society is based on broad education. There is no need to become a scientist or to study advanced concepts in psychology. Success in the real world is not tied to academic achievements; most successful business entrepreneurs don't have an MBA. Perhaps the most important advance of modern society is that all these concepts that used to be considered specialized knowledge in advanced fields are becoming easier to understand, not because they have changed, but because a better understanding always simplifies and the teaching methods are always improving. Moreover, we are becoming more familiar with them because we need them more and more in our daily lives. This information age is also making such knowledge more easily accessible. Thus a teacher simply needs to expend the necessary energy to explore, and the results will follow automatically. What will not work is the attitude that a method has been developed for 30 years and therefore should work indefinitely without modification. The teacher needs to adopt a new psychology of open communications and perpetual learning.

Many of us need a psychological device to overcome the unfounded fear of the inability to memorize. In this book, we are not talking about memorizing Für Elise only. We are talking about a repertoire of over 5 hours of real music, most of which you can just sit down and play at a moment's notice. Some people have no difficulty memorizing, but most have preconceived notions that memorizing significant repertoires is only for the "gifted" few. For them, accepting the idea that "memorizing large repertoires can be routine" will only come in stages. The main reason for this unfounded fear is the past experience in which students are first taught to play a piece well, then taught to memorize which, as explained in section 1.3.6, is one of the most difficult ways to memorize. Because so many students were taught in this way, and had tremendous difficulties, there is a general perception that memorizing is difficult. For students who were taught correctly from the beginning, memorizing is like second nature; it is an integral part of learning any new composition. For those who have not learned to memorize, the first stage is to incorporate the memorizing into the learning routine, and to understand the concept that learning and memorizing at the same time is actually faster than learning alone — this concept is often a difficult psychological barrier to overcome. The second stage is to develop a maintenance routine, such as practicing cold, and using finished pieces to warm up your hands instead of exercises, or playing finished pieces for polishing your technique and practicing musical playing. The third stage is to find ways to maintain a large repertoire without forgetting it, such as making sure that you can still play them HS, that you can play them in your head, away from the piano, or that you can play the piece from anywhere in the middle.

Note that with each stage, you will improve your psychological health. For example, the first stage tells you that there is a better way, there is hope. In the second stage, you eliminate the fear of forgetting — after all, it is just another stage in the memorizing process. In the third stage, you will feel a pride in your achievements and enjoy the real fruits of your efforts — making music. Thus memorizing is just one example of how knowledge contributes to the psychological health of the pianist.

Nervousness is a particularly difficult psychological barrier to overcome. In order to succeed, you must understand that nervousness is a purely mental process. The present system of railroading young students into recitals without proper psychological preparation is counter productive, and generally produces students that are more prone to nervousness problems than when they started their lessons. Once a student experiences intense nervousness from their piano experience, it can negatively influence anything else that they do that is similar, such as appearing in plays or any other type of public performance. Therefore, the present system is bad for psychological health in general. As discussed in section 1.3.15 above, nervousness is an eminently solvable problem for most people and a good program for overcoming nervousness will contribute to mental health because of the pride, joy, and sense of accomplishment that you will feel.

In summary, this new method is devoid of faith (in rules), mystique (of great masters or established schools), or even "talent" (so often fictitious or arbitrary); instead, it is based on psychological devices derived from knowledge. These psychological devices help to nurture a healthy brain. For the student, a healthy psychological approach is an important key to successfully learning to play the piano. A piano teacher must have a deep understanding of the psychology of the piano.

1.3.22 Outline Summary of Entire Method

This method is based on 4 major concepts: Hand Separate Practice (HS, 1.2.25), Segmental Practice (1.2.6), Parallel Sets (1.2.11, 1.3.7.2, 1.4.2), and Memorization (1.3.6).

1. Learn only musical compositions, no Hanon, Czerny, etc., but Scales and Arpeggios (1.3.5) are necessary.
2. Listen to performances/recordings, but do not try to imitate them exactly.
3. Practice old finished pieces Cold (without warm-ups, 1.3.6.7).
4. When starting a new piece, sight read to identify difficult sections, and practice the most difficult sections first; then
   (a) Practice Hands Separate, in overlapping Segments (Continuity Rule, 1.2.8).
   (b) Memorize first, HS, then start practice; the key to memorizing is to get up to speed as quickly as you can. Memorizing slowly can be impossibly difficult.
   (c) Use Parallel Sets to diagnose your weaknesses; Cycle (1.3.2) parallel sets to strengthen those weaknesses and for getting up to speed quickly.
5. Play the last repetition of any repeated practice slowly before switching hands or moving to a new segment.
6. Practice Relaxation (1.2.10, 1.2.14) at all times, especially HS; this includes the entire body, including Breathing (1.2.21) and swallowing.
7. Play through all mistakes; do not stop to correct it. Correct it later using segmental practice only at the mistake.
8. Use the metronome to check the rhythm or speed briefly; do not use it for "slowly ramping up speed".
9. Use pedal only where indicated; practice without pedal until satisfactory, then add pedal.
10. To learn Hands Together (HT, 1.2.25): practice HS until faster than final HT speed; then pick a short segment, play the more difficult hand, and progressively add notes of the other hand.
11. Practice musically, softly but with authority and expression. Piano practice is not finger strength exercise; it is the development of brain power and nerve cells for control and speed. Add forte after you have acquired the necessary technique.
12. Before quitting practice, play everything you practiced (on this day) slowly for ensuring correct Post Practice Improvement (PPI, 1.2.15), which occurs mainly during sleep. The last thing you want is to include your mistakes (especially from Fast Play Degradation [1.2.25]) in PPI!

1.4 Mathematical Theory of Piano Playing

This section is till under construction; it is just a preliminary draft.

Updated:
August 25, 2003;
sections 1, 2, 3, 5, 6

1.4.1 Why do we need a Mathematical Theory?

Any discipline can benefit from a basic mathematical theory if a valid theory can be formulated. Every field that was successfully mathematized has inexorably advanced by leaps and bounds. This is because once the theory is correctly formulated, the powerful mathematical tools and conclusions can all be applied with great certainty. Below is my first attempt at such a formulation for piano. As far as I know, it is the first of its kind in the history of man. Such virgin territory has historically yielded enormous benefits very quickly. I was surprised myself by how many useful, and sometimes hitherto unknown, conclusions we can draw from some very rudimentary theories, as you will see. Whatever math I use below is truly simple math. At this early stage, we can do a lot with the simplest concepts. Further advances are obviously possible by application of higher mathematics. I will also discuss some of those possibilities.

There is little question that the art of piano playing suffers from a total lack of mathematical analysis. In addition, no one doubts that speed, acceleration, momentum, force, etc., play critical roles in piano play. No matter what genius lies behind the artist, the music must be transmitted, through flesh and bone, and via a mechanical contraption consisting of wood, felt, and metal. Therefore, we are dealing with not only a mathematical, but also a total scientific approach that involves human physiology, psychology, mechanics and physics that all tie together to represent what we do at the piano.

The need for such an approach is demonstrated by the fact that there are many questions for which we still have no answers. What is a speed wall? How many are there? What causes them? Is there a formula for overcoming speed walls? What are pianists doing when they play harsh versus sweet, or shallow versus deep? Is it possible to teach two different pianists to play the same passage in exactly the same way? Is there any way to classify different finger motions like there is for the horse's gaits? We answer all of these questions below.

The advantages of a mathematical theory are obvious. For example, if we can mathematically answer the question of what a speed wall is (or what they are — if the theory predicts more than one!), then the theory should immediately provide us with possible solutions on how to break the speed wall(s). Today, no one knows how many speed walls there are. Just knowing how many there are would be a terrific advance. It may be important to prove mathematically that no two pianists (or one pianist) can ever play the same piece exactly the same way. This is because, in that case, listening to someone else play may not be harmful because you cannot imitate it exactly anyway (assuming that exact imitation is not desirable), and trying to teach a student to imitate a famous artist exactly is then proven to be impossible. This will clearly affect how teachers teach students using examples of recordings from famous artists.

Until quite recently, chemists scoffed at physicists who were able to apply equations to lots of things but couldn't even come close explaining simple chemical reactions. Biology and medicine also initially developed in their own ways, with little math and using methods that were far removed from fundamental science. Medicine, biology, and chemistry, all started initially as pure art. Now, all three disciplines are intensely mathematical and rely on the most advanced scientific principles. The ensuring accomplishments in these fields are too numerous to discuss here. One example: in chemistry, the chemists' most basic foundation, the periodic table of the elements, was explained by physicists using quantum mechanics. As a result of becoming more scientific, all three disciplines are enormously successful and are advancing in leaps and bounds. The "scientification" of any discipline is inevitable; it is only a matter of time, because of the enormous benefits that can follow. The benefits of scientification will also apply to music.

So how do we apply the exact science of mathematics to something that is perceived as art? Certainly, in the beginning, it will be crude, but refinements are certain to follow. Already, piano technicians know that the piano itself is a marvel in the use of basic physics in its design. Piano technicians must be familiar with an enormous amount of science, math, and physics in order to ply their "art". A mathematical theory of piano playing must start with a scientific approach in which each item under discussion is clearly defined and classified; see "The Scientific Method" in Chapter Three. Once this is accomplished, we search for all relevant relationships between these objects. These procedures comprise the essence of Group Theory. It is elementary! Let us begin.

1.4.2 The Theory of Finger Motion for Piano

Serial, Parallel Play

The finger motions for playing the piano can be classified at the most basic level as serial or parallel. In serial play, each finger is lowered in succession in order to play. A scale is an example of something that can be played serially. In parallel play, all fingers move together. A chord is an example of parallel play. As we shall see later, a scale can also be played parallel.

Serial play can be described by any oscillatory function such as a trigonometric function of hyperbolic function. It is basically characterized by an amplitude (the distance you move the finger up and down) and a frequency (how fast you play). Except for chords and rapid rolls, most slow pieces can be played serially, and beginners tend to start by playing serially. In parallel play, there is a well defined phase relationship between different fingers. Therefore, we must now discuss phase in some detail.

Phase is a measure of where the finger is, in relation to the other fingers. Suppose that we use the trigonometric function (sine, cosine, etc.) to describe finger motion. Then in its rest position, the finger is, say, at zero degrees in phase space. Since we know how pianos should be played, we will build some of that knowledge into our definition of phase. Since lifting the fingers off from the keys is in general not the correct way to play, we will define the zero of the phase as the upper rest positions of the keys. Thus the zero phase position of the black keys will be higher than the zero phase position of the white keys by the extra height of the black keys. Furthermore, we assume that if you lift the fingers off the keys, this extra motion does not count as far as the phase is concerned. These conventions are in accord with good technique and also simplify the mathematics. Then the phases of this motion can be defined as: finger depressing half way down = 90 degrees; depressing to bottom position = 180 degrees, rising half way up = 270 degrees, and rising back to the original position = 360 degrees, which is also zero degrees again. Now in parallel play, if the second finger starts its motion when the first finger is at 90 degrees, the third finger starts off when the first finger is at 180 degrees, etc., then this parallel play will play notes 4 times faster than serial play at the same finger speed. In this case the phase difference between fingers is 90 degrees. If you were to decrease the phase difference to 9 degrees, the notes will be played 40 times faster — this example illustrates the power of parallel playing for speeding up your play. In a chord, the phase difference is zero.

Serial play can be defined as parallel play in which the phase difference between successive fingers is about 360 degrees or larger, or in which the phases are not interrelated. Hand motion helps both serial and parallel play, but in different ways. It helps serial play by adding to the amplitude. But it affects parallel play in a most important way by helping you to control the phase. With these simple definitions, we can start to generate some useful results.

Speed Walls

Let's assume that a person starts practicing a piece of music by first playing slowly, using mostly serial play, since that is the easiest way (let's ignore chords for the time being). As the finger speed is gradually increased, s/he will naturally hit a speed wall because human fingers can move only so fast. Thus we have mathematically discovered one speed wall, and that is the speed wall of serial play. How do we break this speed wall? We need to find a play method that has no speed limit. That is parallel play. In parallel play, you increase the speed by decreasing the phase difference. That is, speed is numerically proportional to the inverse of the phase difference. Since we know that the phase difference can be decreased to zero (which gives you a chord), we know that parallel play has the potential give you infinite speed and therefore it has no theoretical speed limit. We have arrived at a mathematical foundation for the chord attack!

The distinction between serial and parallel play is somewhat artificial and oversimplified. In reality, practically everything is played parallel. Thus the above discussion served only as an illustration of how to define or identify a speed wall. The actual situation with each individual is too complex to describe (because speed walls are caused by bad habits, stress and HT play), but it is clear that wrong playing methods are what create speed walls and each person has her/is own mistakes that result in speed walls. This is demonstrated by the use of parallel set exercises which overcome the speed walls. This means that speed walls are not always there by themselves, but are *created* by the individual. Therefore, there is any number of possible speed walls depending on each individual and every individual has a different set of speed walls. There are, of course common classes of speed walls, such as those created by stress, by wrong fingering, by lack of HS technique, lack of HT coordination, etc. It would be, in my opinion, very counterproductive to say that such complex concepts will never be scientifically or mathematically treated. We have to. For example, in parallel play, phase plays a very important part. By decreasing the phase to zero, we can play infinitely fast, in principle.

Can we really play infinitely fast? Of course not. So then what is the ultimate parallel speed limit, and what mechanism creates this limit? We know that different individuals have different speed limits, so the answer must include a parameter that depends on the individual. Knowing this parameter will tell us how to play faster! Clearly, the fastest speed is determined by the smallest phase difference that the individual can control. If the phase difference is so small that it cannot be controlled, then "parallel play speed" loses its meaning. How do we measure this minute phase difference for each individual? This can be accomplished by listening to her/is chords. The accuracy of chord play (how accurately all the notes of the chord can be played simultaneously) is a good measure of an individual's ability to control the smallest phase differences. Therefore, in order to be able to play parallel fast, you must be able to play accurate chords. This means that, when applying the chord attack, you must first be able to play accurate chords before proceeding to the next step.

It is clear that there are many more speed walls and the particular speed wall and the methods for scaling each wall will depend on the type of finger or hand motion. For example you can attain infinite speed with parallel play only if you have an infinite number of fingers (say, for a long run). Unfortunately, we have only ten fingers and often only five are available for a particular passage because the other five are needed to play other parts of the music. As a rough approximation, if serial play allows you to play at a maximum speed of M, then you can play at $2M$ using two fingers, $3M$ using three fingers, etc., serially. The maximum speed is limited by how rapidly you can recycle these fingers. Actually, this is not quite true because of momentum balance (it allows you to play faster), which will be treated separately below. Thus each number of available fingers will give you a different new speed wall. We therefore arrive at two more useful results. (1) there can be any number of speed walls, and (2) you can change your speed wall by changing your fingering; in general, the more fingers you can use in parallel before you need to recycle them, the faster you can play. Putting it differently, most conjunctions bring with them their own speed walls.

Increasing Speed

These results also provide the mathematical basis for explaining the well known trick of alternating fingers when playing the same note many times. One might think at first that using just one finger would be easier and offer more control, but that note can be played repetitively faster by playing parallel using as many fingers as you can for that situation, than playing serially.

The need for parallel play also singles out trills as a particularly difficult challenge to play fast because trills must in general be executed with only two fingers. If you tried to trill with one finger, you will hit a speed wall at, say, speed M; if you trill with two fingers, the speed wall will be at $2M$ (again, ignoring momentum balance). Does mathematics suggest any other way of attaining even higher speeds? Yes: phase truncation.

What you can do is to lower the finger to play the note but then raise the finger only sufficiently to reset the repetition mechanism, before playing the next note. You may need to raise the finger by only 90 degrees instead of the normal 180 degrees. This is what I mean by phase truncation; the unnecessary part of the total phase is truncated off. If the original amplitude of finger travel for the 360 degree motion was 2 cm, with a 180 degree truncation, the finger now moves only 1 cm. This 1 cm can be further reduced until the limit at which the repetition mechanism stops working, at about 5 mm. Phase truncation is the mathematical basis for the fast repetition of the grand and explains why the rapid repetition is designed to work with a short return distance.

A good analogy to gaining speed in this way is the dribbling action of a basketball, as contrasted to the swinging action of a pendulum. A pendulum has a fixed frequency of swing regardless of the swing amplitude. A basketball, however, will dribble faster as you dribble closer to the ground (as you reduce the dribble amplitude). A basketball player will generally have a hard time dribbling until s/he learns this change in dribble frequency with dribble height. A piano acts more like a basketball than a pendulum (fortunately!), and the trill frequency increases with decreasing amplitude until you reach the limit of the repetition mechanism. Note that even with the fastest trill, the backcheck is engaged for a correct trill, because the keys must always be depressed completely. The trill is possible because the mechanical response of the backcheck is faster than the fastest speed that the finger can achieve.

The trill speed is not limited by the piano mechanism except for the height at which the repetition stops working. Thus it is more difficult to trill rapidly with most uprights because phase truncation is not as effective. These mathematical conclusions are consistent with the fact that to trill fast, we need to keep the fingers on the keys and to reduce the motions to the minimum necessary for the repetition mechanism to work. The fingers must press “deeply into the piano” and just lifted sufficiently to activate the repetition mechanism. Furthermore, it helps to use the strings to bounce the hammer back, just as you bounce the basketball off the floor. Note that a basketball will dribble faster, for a given amplitude, if you press down harder on it. On the piano, this is accomplished by pressing the fingers firmly down on the keys and not letting them “float up” as you trill.

Another important factor is the functional dependence of finger motion (purely trigonometric, or hyperbolic, etc.) for controlling tone, staccato, and other properties of the piano sound relating to expression. With simple electronic instruments, it is an easy task to measure the exact finger motion, complete with key speed, acceleration, etc. These characteristics of each pianist's playing can be analyzed mathematically to yield characteristic electronic signatures that can be identified with what we hear aurally, such as angry, pleasant, boisterous, deep, shallow, etc. For example, the motion of the key travel can be analyzed using FFT (fast Fourier transform), and it should be possible, from the results, to identify those motion elements that produce the corresponding aural characteristics. Then, working backwards from these characteristics, it should be possible to decipher how to play in order to produce those effects. This is a whole new area of piano play that has not been exploited yet. This kind of analysis is not possible by just listening to a recording of a famous artist, and may be the most important topic for future research.

1.4.3 Thermodynamics of Piano Playing

An important field of mathematics is the study of large numbers. Even when single events of a particular type are not predictable, large numbers of such events often behave according to strict laws. Although the energies of individual molecules of water in a glass may differ considerably, the temperature of the water can stay very constant and can be measured with high accuracy. Does piano playing have an analogous situation that would allow us to apply the laws of large numbers and thereby draw some useful conclusions?

Piano playing is a complex process because of a large number of variables that enter into the production of music. The study of large numbers is accomplished by counting the "number of states" of a system. The grand total of meaningful states so counted might be called the "canonical ensemble", a meaningful assembly that sings together a tune that we can decipher. Believe it or not, "canonical ensemble" (see *Statistical Mechanics* by Kerson Huang, Wily, 1963, p. 75) is legitimate thermodynamic terminology! Therefore, all we need to do is to calculate the canonical ensemble, and when finished, we simply apply the known mathematical rules of large systems (i.e., thermodynamics) and voila! We are done!

The variables in question here are clearly the different motions of the human body, especially those parts important in playing the piano. Our job is to count all the ways in which the body can be moved in playing the piano; this is clearly a very large number; the question is, is it large enough for a meaningful canonical ensemble?

Since no one has ever attempted to calculate this canonical ensemble, we are exploring new territory here, and I will attempt only a very approximate estimate. The beauty of canonical ensembles is that, in the end, if the calculations are correct (a legitimate concern for something this new), the method used to arrive at it is usually immaterial — you always arrive at the same answers. We calculate the ensemble by listing all the relevant variables, and counting the total parameter space of these variables. So here we go.

Let's start with the fingers. Fingers can move up and down, sideways, and be curled or straight (three variables). Say there are 10 measurably different positions for each variable (parameter space = 10); counting only the number of 10s, we have 4 so far, including the fact that we have 10 fingers. There are actually many more variables (such as rotating the fingers around each finger axis) and more than 10 measurable parameters per variable, but we are counting only those states that can be reasonably used to play the piano, for a given piece of music. The reason for this restriction is that we will be using the results of these calculations for comparing how two persons play the same piece, or how one person would play it twice in a row. This will become clearer later on.

Now the palms can be raised or lowered, flexed sideways, and rotated around the axis of the forearm. That's 3 more 10s for a total of 7. The forearm can be raised or lowered, and swung sideways; new total is 9. The upper arm can be swung forward-backwards, or sideways; new total is 11. The body can be moved forwards-backwards, and sideways: new total is 13. Then there are the variables of force, speed, and acceleration, for a total of at least 16. Thus the total parameter space of a pianist has many more than 10^{16} states (one followed by 16 zeros!). The actual number for a given piece of music is many orders of magnitude larger because of the above calculation is only for one note and a typical piece of music contains thousands or tens of thousands of notes. The final parameter space is therefore about 10^{20}. This is approaching the ensemble space for molecules; for example, one cc of water has 10^{23} molecules, each with several degrees of freedom of motion and many possible energy states. Since thermodynamics applies to volumes of water very much smaller than 0.0001 cc, the canonical ensemble of the pianist is pretty close to thermodynamic conditions.

If the canonical ensemble of the pianist is nearly thermodynamic in nature, what conclusion can we draw? The most important result is that any single point in this phase space is totally irrelevant, because the chances of your reproducing this particular point is essentially zero. From this result, we can draw some immediate conclusions:

First Law of Pianodynamics: no two persons can play the same piece of music in exactly the same way. A corollary to this first law is that the same person, playing the same piece of music twice, will never play it exactly the same way.

So what? Well, what this means is that the notion that listening to someone play might decrease your creativity by your imitating that artist is not a viable idea, since it is never possible to imitate exactly. It really supports the school of thought which claims that listening to good artists play cannot hurt. Each pianist is a unique artist, and no one will ever reproduce her/is music. The corollary provides a scientific explanation for the difference between listening to a recording (which reproduces a performance exactly) and listening to a live performance, which can never be reproduced (except as a recording).

Second Law of Pianodynamics: we can never completely control every aspect of how we play a given piece.

This law is useful for understanding how we can unconsciously pick up bad habits, and how, when we perform, the music takes on its own life and in some ways, goes out of our own control. The powerful laws of pianodynamics take over in these cases and it is useful to know our limitations and to know the sources of our difficulties in order to control them as much as possible. It is a truly humbling thought, to realize that after a long, hard practice we could have picked up any number of bad habits without ever even suspecting it. This may in fact provide the explanation of why it is so beneficial to play slowly on the last run-through during practice. By playing slowly and accurately, you are greatly narrowing the ensemble space, and excluding the "bad" ones that are far away from the "correct" space of motions. If this procedure does indeed eliminate bad habits, and is cumulative from practice session to practice session, then it could produce a huge difference in the rate at which you acquire technique in the long run.

1.4.4 Mozart's Formula, Beethoven and Group Theory

Updated: March 12, 2004

There is an intimate, if not absolutely essential, relationship between mathematics and music. At the very least, they share a large number of the most fundamental properties in common, starting with the fact that the chromatic scale is a simple logarithmic equation (see section 2.2) and that the basic chords are ratios of the smallest integers. Now few musicians are interested in mathematics for mathematics' sake. However, practically everyone is curious and has wondered at one time or other whether mathematics is somehow involved in the creation of music. Is there some deep, underlying principle that governs both math and music? In addition, there is the established fact that every time we succeeded in applying mathematics to a field, we have made tremendous strides in advancing that field. One way to start investigating this relationship is to study the works of the greatest composers from a mathematical point of view.

The following analyses contain no inputs from music theory. When I first heard of Mozart's formula, I felt a great excitement, because I thought that it might shed light on music theory and on music itself. You may at first be disappointed, as I was, when you find out that Mozart's formula appears to be strictly structural. Structural analyses have so far not yet provided much information on how you come up with famous melodies; but then, music theory doesn't either. Today's music theory only helps to compose "correct" music or expand on it once you have come up with a musical idea. Music theory is a classification of families of notes and their arrangements in certain patterns. We can not yet rule out the possibility that music is ultimately based on certain identifiable types of structural patterns. I first learned of Mozart's formula in a lecture given by a music professor. I have since lost the reference — if anyone reading this book knows of a reference, please let me know.

It is now known that Mozart composed practically all of his music, from when he was very young, according to a single formula that expanded his music by over a factor of ten. That is, whenever he concocted a new melody that lasted one minute, he knew that his final composition would be at least ten minutes long. Sometimes, it was a *lot* longer. The first part of his formula was to repeat every theme. These themes were generally very short — only 4 to 10 notes, much shorter than you would think when you think of a musical theme. These themes, that are much shorter than the over-all melody, simply disappear into the melody because they are too short to be recognized. This is why we do not normally notice them, and is almost certainly a conscious construct by the composer. The theme would then be modified two or three times and repeated again to produce what the audience would perceive as a continuous melody. These modifications consisted of the use of various mathematical and musical symmetries such as inversions, reversals, harmonic changes, clever positioning of ornaments, etc. These repetitions would be assembled to form a section and the whole section would be repeated. The first repetition provides a factor of two, the various modifications provide another factor of two to six (or more), and the final repetition of the entire section provides another factor of two, or $2\times2\times2 = 8$ at a minimum. In this way, he was able to write huge compositions with a minimum of thematic material. In addition, his modifications of the original theme followed a particular order so that certain moods or colors of music were arranged in the same order in each composition.

Because of this pre-ordained structure, he was able to write down his compositions from anywhere in the middle, or one voice at a time, since he knew ahead of time where each part belonged. And he did not have to write down the whole thing until the last piece of the puzzle was in place. He could also compose several pieces simultaneously, because they all had the same structure. This formula made him look like more of a genius than he really was. This naturally leads us to question: how much of his reputed "genius" was simply an illusion of such machinations? This is not to question his genius — the music takes care of that! However, many of the wonderful things that these geniuses did were the result of relatively simple devices and we can all take advantage of that by finding out the details of these devices. For example, knowing Mozart's formula makes it easier to dissect and memorize his compositions. The first step towards understanding his formula is to be able to analyze his repetitions. They are not simple repetitions; Mozart used his genius to modify and disguise the repetitions so that they produced music and, more importantly, so that the fact of the repetition will not be recognized.

As an example of repetitions, let's examine the famous melody in the Allegro of his Eine Kleine Nachtmusik. This is the melody that Salieri played and the pastor recognized in the beginning of the movie, "Amadeus". That melody is a repetition posed as a question and an answer. The question is a male voice asking, "Hey, are you coming?" And the reply is a female voice, "OK, OK, I'm coming!" The male statement is made using only two notes, a commanding fourth apart, repeated three times (six notes), and the question is created by adding three rising notes at the end (this appears to be universal among most languages — questions are posed by raising the voice at the end). Thus the first part consists of 9 notes. The repetition is an answer in a female voice because the pitch is higher, and is again two notes, this time a sweeter minor third apart, repeated (you guessed it!) three times (six notes). It is an answer because the last three notes wiggle down. Again, the total is 9 notes. The efficiency with which he created this construct is amazing. What is even more incredible is how he disguises the repetition so that when you listen to the whole thing, you would not think of it as a repetition. Practically all of his music can be analyzed in this way, mostly as repetitions. If you are not yet convinced, take any of his music and analyze it, and you will find this pattern.

Let's look at another example, the Sonata #16 in A, K.300 (or KV.331, the one with the Alla turca ending). The basic unit of the beginning theme is a quarter note followed by an eighth note. The first introduction of this unit is disguised by the addition of the 16th note, which is followed by the basic unit. Thus in the first bar, the unit is repeated twice. He then translates (in pitch) the whole double unit of the 1st bar and repeats it in the 2nd bar. The 3rd bar is just the basic unit repeated twice. In the 4th bar, he again disguises the first unit by use of the 16th notes. Bars 1 to 4 are then repeated with minor modifications in bars 5–8. From a structural viewpoint, every one of the first 8 bars is patterned after the 1st bar. From a melodic point of view, these 8 bars produce two long melodies with similar beginnings but different endings. Since the whole 8 bars is repeated, he has basically multiplied his initial idea embodied in the 1st bar by 16! If you think in terms of the basic unit, he has multiplied it by 32. But then he goes on to take this basic unit and creates incredible variations to produce the entire sonata, so the final multiplication factor is even larger. This is what is meant by the statement that he uses repetitions of repetitions. By stringing the repetitions of modified units, he creates a final melody that sounds like a long melody until you break it up into its components.

In the 2nd half of this exposition, he introduces new modifications to the basic unit. In bar 10, he first adds an ornament with melodic value to disguise the repetition and then introduces another modification by playing the basic unit as a triplet. Once the triplet is introduced, it is repeated twice in bar 11. bar 12 is similar to bar 4;

it is a repetition of the basic unit, but structured in such a way as to act as a conjunction between the preceding 3 related bars and the following 3 related bars. Thus bars 9 to 16 are similar to bars 1 to 8, but with a different musical idea. The final 2 bars (17 and 18) provide the ending to the exposition. With these analyses as examples, you should now be able to dissect the remainder of this piece. You will find that the same pattern of repetitions is found throughout the entire piece. As you analyze more of his music you will need to include more complexities; he may repeat 3 or even 4 times, and mix in other modifications to hide the repetitions. What is clear is that he is a master of disguise so that the repetitions and other structures are not usually obvious when you just listen to the music without any intent to analyze it.

Mozart's formula was probably devised mostly to increase his productivity. Yet he may have found certain magical (hypnotic? addictive?) powers to repetitions of repetitions and he probably had his own musical reasons for arranging the moods of his themes in the sequence that he used. That is, if you further classify his themes according to the moods they evoke, it is found that he always arranges the moods in the same order. The question here is, if we dig deeper and deeper, will we just find more of these simple structural/mathematical devices, just stacked one on top of each other, or is there more to music? Almost certainly, there must be more, but no one has yet put a finger on it, not even the great composers themselves — at least, as far as they have told us. Thus it appears that the only thing we mere mortals can do is to keep digging.

The music professor mentioned above who lectured on Mozart's formula also stated that the formula is followed so strictly that it can be used to identify Mozart's compositions. However, elements of this formula are well known among composers. Thus Mozart is not the inventor of this formula and similar formulas were probably used widely by composers of his time. In particular, some of Salieri's compositions follow a very similar formula; perhaps this was an attempt by Salieri so emulate Mozart. Thus you will need to know some details of Mozart's specific formula in order to use it to identify his compositions.

There is little doubt that a strong interplay exists between music and genius. We don't even know if Mozart was a composer because he was a genius or if his extensive exposure to music from birth created the genius. The music certainly contributed to his brain development. It may very well be that the best example of the "Mozart effect" was Wolfgang Amadeus himself, even though he did not have the benefit of his own masterpieces. In these first few years of the new millennium, we are just beginning to understand some of the secrets of how the brain works. For example, until recently, we had it partly wrong when we thought that certain populations of mentally handicapped people had unusual musical talent. It turns out that music has a powerful effect on the actual functioning of the brain and its motor control. This is one of the reasons why we always use music when dancing or exercising. The best evidence for this comes from Alzheimer's patients who have lost their ability to dress themselves because they cannot recognize each different type of clothing. It was discovered that when this procedure is set to the proper music, these patients can often dress themselves! "Proper music" is usually music that they heard in early youth or their favorite music. Thus mentally handicapped people who are extremely clumsy when performing daily chores can suddenly sit down and play the piano if the music is the right type that stimulates their brain. Therefore, they may not be musically talented; instead, it is the music that is giving them new capabilities. Of course, on a broader scale, it is not only music that has these magical effects on the brain, as evidenced by idiot savants who can memorize incredible amounts of information or carry out mathematical feats normal folks cannot perform. There is a more basic internal rhythm in the brain that music happens to excite. I don't know what this mechanism is, but it must be somewhat analogous to the clock cycle of computer chips. Without the clock cycle, these chips would not operate, and we measure their power by the cycle speed — 3 GHz chips are better than 1 GHz chips.

If music can produce such profound effects on the handicapped, imagine what it could do to the brain of a budding genius, especially during the brain's development in early childhood. These effects apply to anyone who plays the piano, not just the handicapped or the genius. Have you ever had good days and bad days? Have you ever noticed that when you learn a new piece for the first time, you can suddenly play it incredibly well, and then lose that as you keep practicing, or that you play much better when playing with good players as in a chamber group? Have you found it difficult to perform when the audience consists of people who can play that piece better than you can? Do you play better when the music comes out well, and worse as soon as you make mistakes? Most probably, and answers to these questions lie in the relationship between music and the brain. Thus understanding this relationship should help us greatly in overcoming some of these difficulties.

The use of mathematical devices is deeply embedded in Beethoven's music. Therefore, this is one of the best places to dig for information on the relationship between mathematics and music. I'm not saying that other composers do not use mathematical devices. Practically every musical composition has mathematical underpinnings. However, Beethoven was able to extend these mathematical devices to the extreme. It is by analyzing these extreme cases that we can find more convincing evidence on what types of devices he used.

We all know that Beethoven never really studied advanced mathematics. Yet he incorporates a surprising amount of math in his music, at very high levels. The beginning of his Fifth Symphony is a prime case, but examples such as this are legion. He "used" group theory type concepts to compose this famous symphony. In fact, he used what crystallographers call the Space Group of symmetry transformations! This Group governs many advanced technologies, such as quantum mechanics, nuclear physics, and crystallography that are the foundations of today's technological revolution. At this level of abstraction, *a crystal of diamond and Beethoven's 5th symphony are one and the same!* I will explain this remarkable observation below.

The Space Group that Beethoven "used" (he certainly had a different name for it) has been applied to characterize crystals, such as silicon and diamond. It is the properties of the Space Group that allow crystals to grow defect free and therefore, the Space Group is the very basis for the existence of crystals. Since crystals are characterized by the Space Group, an understanding of the Space Group provides a basic understanding of crystals. This was neat for materials scientists working to solve communications problems because the Space Group provided the framework from which to launch their studies. It's like the physicists needed to drive from New York to San Francisco and the mathematicians handed them a map! That is how we perfected the silicon transistor, which led to integrated circuits and the computer revolution. So, what is the Space Group? And why was this Group so useful for composing this symphony?

Groups are defined by a set of properties. Mathematicians found that groups defined in this way can be mathematically manipulated and physicists found them to be useful: that is, these particular groups that interested mathematicians and scientists provide us with a pathway to reality. One of the properties of groups is that they consist of Members and Operations. Another property is that if you perform an Operation on a Member, you get another Member of the same Group. A familiar group is the group of integers: -1, 0, 1, 2, 3, etc. An Operation for this group is addition: 2 + 3 = 5. Note that the application of the operation + to Members 2 and 3 yields another Member of the group, 5. Since Operations also transform one member into another, they are also called Transformations. A Member of the Space Group can be anything in any space: an atom, a frog, or a note in any musical space dimension such as pitch, speed, or loudness. The Operations of the Space Group relevant to crystallography are Translation, Rotation, Mirror, Inversion, and the Unitary operation. These are almost self explanatory (Translation means you move the Member some distance in that space) except for the Unitary operation which basically leaves the Member unchanged. However, it is somewhat subtle because it is not the same as the equality transformation, and is therefore always listed last in textbooks. Unitary operations are generally associated with the most special member of the group, which we might call the Unitary Member; in the integer group noted above, this Member would be 0 for addition and 1 for multiplication ($5+0=5\times1=5$).

Let me demonstrate how you might use this Space Group, in ordinary everyday life. Can you explain why, when you look into a mirror, the left hand goes around to the right (and vice versa), but your head doesn't rotate down to your feet? The Space Group tells us that you can't rotate the right hand and get a left hand because left-right is a mirror operation, not a rotation. Note that this is a strange transformation: although your right hand is your left hand in the mirror, the wart on your right hand in now on your left hand image in the mirror. The mirror operation is why, when you look into a flat mirror, the right hand becomes a left hand; however, a mirror cannot perform a rotation, so your head stays up and the feet stay down. Curved mirrors that play optical tricks (such as reversing the positions of the head and feet) are more complex mirrors that can perform additional Space Group operations, and group theory will be just as helpful in analyzing images in a curved mirror. The solution to the flat mirror image problem appeared to be rather easy because we had a mirror to help us, and we are so familiar with mirrors. The same problem can be restated in a different way, and it immediately becomes much more difficult, so that the need for group theory to help solve the problem becomes more obvious. If you turned a right hand glove inside out, will it stay right hand or will it become a left hand glove? I will leave it to you to figure that one out (hint: use a mirror).

Let's see how Beethoven used his intuitive understanding of spatial symmetry to compose his 5th Symphony. That famous first movement is constructed largely by using a single short musical theme consisting of four notes, of which the first three are repetitions of the same note. Since the fourth note is different, it is called the surprise note, and carries the beat. This musical theme can be represented schematically by the sequence 555**3**, where **3** is the surprise note. This is a pitch based space group; Beethoven used a space with 3 dimensions, pitch, time, and volume. I will consider only the pitch and time dimensions in the following discussions. Beethoven starts his Fifth Symphony by first introducing a Member of his Group: three repeat notes and a surprise note, 555**3**. After a momentary pause to give us time to recognize his Member, he performs a Translation operation: 444**2**. Every note is translated down. The result is another Member of the same Group. After another pause so that we can recognize his Translation operator, he says, "Isn't this interesting? Let's have fun!" and demonstrates the potential of this Operator with a series of translations that creates music. In order to make sure that we understand his construct, he does not mix other, more complicated, operators at this time. In the ensuing series of bars, he then successively incorporates the Rotation operator, creating **3**555, and the Mirror operator, creating **7**555. Somewhere near the middle of the 1st movement, he finally introduces what might be interpreted as the Unitary Member: 555**5**. Note that these are simply repeated, which is the Unitary operation.

In the final fast movements, he returns to the same group, but uses only the Unitary Member, and in a way that is one level more complex. It is always repeated three times. What is curious is that this is followed by a fourth sequence — a surprise sequence 765**4**, which is not a Member. Together with the thrice repeated Unitary Member, the surprise sequence forms a Supergroup of the original Group. He has generalized his Group concept! The supergroup now consists of three members and a non-member of the initial group, which satisfies the conditions of the initial group (three repeats and a surprise).

Thus, the beginning of Beethoven's Fifth symphony, when translated into mathematical language, reads just like the first chapter of a textbook on group theory, almost sentence for sentence! Remember, group theory is one of the highest forms of mathematics. The material is even presented in the correct order as they appear in textbooks, from the introduction of the Member to the use of the Operators, starting with the simplest, Translation, and ending with the most subtle, the Unitary operator. He even demonstrates the generality of the concept by creating a supergroup from the original group.

Beethoven was particularly fond of this four-note theme, and used it in many of his compositions, such as the first movement of the Appassionata piano sonata, see bar 10, LH. Being the master that he is, he carefully avoids the pitch based Space Group for the Appassionata and uses different spaces — he transforms them in tempo space and volume space (bars 234 to 238). This is further support for the idea that he must have had an intuitive grasp of group theory and consciously distinguished between these spaces. It seems to be a mathematical impossibility that this many agreements of his constructs with group theory just happened by accident, and is virtual proof that he was somehow playing around with these concepts.

Why was this construct so useful in this introduction? It certainly provides a uniform platform on which to hang his music. The simplicity and uniformity allow the audience to concentrate only on the music without distraction. It also has an addictive effect. These subliminal repetitions (the audience is not supposed to know that he used this particular device) can produce a large emotional effect. It is like a magician's trick — it has a much larger effect if we do not know how the magician does it. It is a way of controlling the audience without their knowledge. Just as Beethoven had an intuitive understanding of this group type concept, we may all feel that some kind of pattern exists, without recognizing it explicitly. Mozart accomplished a similar effect using repetitions.

Knowledge of these group type devices that he uses is very useful for playing his music, because it tells you exactly what you should and should not do. Another example of this can be found in the 3rd movement of his Waldstein sonata, where the entire movement is based on a 3-note theme represented by 15**5** (the first CG**G** at the beginning). He does the same thing with the initial arpeggio of the 1st movement of the Appassionata, with a theme represented by 53**1** (the first CA♭**F**). In both cases, unless you maintain the beat on the last note, the music loses its structure, depth and excitement. This is particularly interesting in the Appassionata, because in an arpeggio, you normally place the beat on the first note, and many students actually make that mistake. As in the Waldstein, this initial theme is repeated throughout the movement and is made increasingly obvious as the movement progresses. But by then, the audience is addicted to it and does not even notice that it is dominating the music. For those interested, you might look near the end of the 1st movement of the Appassionata where he transforms the theme to 31**5** and raises it to an extreme and almost ridiculous level at bar 240. Yet most in the audience will have no idea what device Beethoven was using, except to enjoy the wild climax, which is obviously ridiculously extreme, but by now carries a mysterious familiarity because the construct is the same, and you have heard it hundreds of times. Note that this climax loses much of its effect if the pianist does not bring out the theme (introduced in the first bar!) and emphasize the beat note.

Beethoven tells us the reason for the inexplicable 53**1** arpeggio in the beginning of the Appassionata when the arpeggio morphs into the main theme of the movement at bar 35. That is when we discover that the arpeggio at the beginning is an inverted and schematized from of his main theme, and why the beat is where it is. Thus the beginning of this piece, up to bar 35, is a psychological preparation for one of the most beautiful themes he composed. He wanted to implant the idea of the theme in our brain before we heard it! That may be one explanation for why this strange arpeggio is repeated twice at the beginning using an illogical chord progression. With analysis of this type, the structure of the entire 1st movement becomes apparent, which helps us to memorize, interpret, and play the piece correctly.

The use of group theoretical type concepts might be just an extra dimension that Beethoven wove into his music, perhaps to let us know how smart he was, in case we still didn't get the message. It may or may not be the mechanism with which he generated the music. Therefore, the above analysis gives us only a small glimpse of the mental processes that inspire music. Simply using these devices does not result in music. Or, are we coming close to something that Beethoven knew but didn't tell anyone?

1.4.5 Learning Rate Calculation (1000 Times Faster!)

Here is my crude attempt to mathematically calculate the piano learning rate of the methods of this book. The result indicates that it is about 1000 times faster than the intuitive method. The huge multiple of 1000 makes it unnecessary to calculate an accurate number in order to show that there is a big difference. This result appears plausible in view of the fact that many students who worked hard all their lives using the intuitive method are not able to perform anything significant, whereas a fortunate student who used the correct learning methods can become a concert pianist in less than 10 years. It is clear that the difference in practice methods can make the difference between a lifetime of frustration and a rewarding career in piano. Now, "1000 times faster" does not mean that you can become a pianist in a millisecond; all it means is that the intuitive methods are 1000 times *slower* than the good methods. The conclusion we should draw here is that, with the proper methods, our learning rates should be pretty close to those of the famous composers such as Mozart, Beethoven, Liszt, and Chopin. Remember that we have certain advantages not enjoyed by those past geniuses. They did not have those wonderful Beethoven sonatas, Liszt and Chopin etudes, etc., with which to acquire technique, or those Mozart compositions with which to benefit from the "Mozart effect", or books like this one with an organized list of practice methods. Moreover, there are now hundreds of time-proven methods for using those compositions for acquiring technique (Beethoven often had difficulty playing his own compositions because nobody knew the correct or wrong way to practice them). An intriguing historical aside here is that the only common material available for practice for all of these great pianists was Bach's compositions. Thus, we are led to the idea that studying Bach may be sufficient for acquiring most basic keyboard skills.

I will try to make a detailed calculation starting with the most fundamental precepts and progressing to the final result without jumping over unknown gaps. In this way, if there are errors in this calculation, it can be refined as we improve our understanding of how we acquire technique. This is, obviously, the scientific approach. There is nothing new in these calculations except for their application to musical learning. The mathematical material is simply a review of established algebra and calculus.

Mathematics can be used to solve problems in the following way. First, you define the conditions that determine the nature of the problem. If these conditions have been correctly determined, they allow you to set up what are called differential equations; these are accurate, mathematical statements of the conditions. Once the differentials equations are set up, mathematics provides methods for solving them to provide a function which describes the answers to the problems in terms of parameters that determine these answers. The solutions to the problems can then be calculated by inserting the appropriate parameter values into the function.

The physical principle we use to derive our learning equation is the linearity with time. Such an abstract concept may seem to have nothing to do with piano and is certainly non-biological, but it turns out that, that is exactly what we need. So let me explain the concept of "the linearity with time". It simply means proportional to time. For example, if we learn an amount of technique L (stands for Learning) in time T, then if we repeat this process again a few days later, we should learn another increment L in the same T. Thus we say that L is linear with respect to T in the sense that they are proportional; in $2T$, we should learn $2L$. Of course, we know that learning is highly non-linear. If we practice the same short segment for 4 hours, we are likely to gain a lot more during the first 30 minutes than during the last 30 minutes. However, we are talking about an optimized practice session averaged over many practice sessions that are conducted over time intervals of years (in an optimized practice session, we are not going to practice the same 4 notes for 4 hours!). If we average over all of these learning processes, they tend to be quite linear. Certainly within a factor of 2 or 3, linearity is a good approximation, and that amount of accuracy is all we need. Note that linearity does not depend, to first approximation, on whether you are a fast learner or a slow learner; this changes only the proportionality constant. Thus we arrive at the first equation:

$$L = kT \tag{1.1}$$

where L is an increment of learning in the time interval T and k is the proportionality constant. What we are trying to find is the time dependence of L, or $L(t)$ where t is time (in contrast to T which is an interval of time). Similarly, L is an increment of learning, but $L(t)$ is a function.

Now comes the first interesting new concept. We have control over L; if we want $2L$, we simply practice twice. But that is not the L that we retain because we *lose* some L over time after we practice. Unfortunately, the more we know, the more we can forget; that is, the amount we forget is proportional to the original amount of knowledge, $L(0)$. Therefore, assuming that we acquired $L(0)$, the amount of L we lose in T is:

$$L = -kTL(0) \tag{1.2}$$

where the k's in equations 1.1 and 1.2 are different, but we will not re-label them for simplicity. Note that k has a negative sign because we are losing L. Eq. 1.2 leads to the differential equation

$$\frac{dL(t)}{dt} = -kL(t) \tag{1.3}$$

where "d" stands for differential (this is all standard calculus), and the solution to this differential equation is

$$L(t) = Ke^{-kt} \tag{1.4}$$

where "e" is a number called the natural logarithm which satisfies Eq. 1.3, and K is a new constant related to k (for simplicity, we have ignored another term in the solution that is unimportant at this stage). Eq. 1.4 tells us that once we learn L, we will immediately start to forget it exponentially with time if the forgetting process is linear with time.

Since the exponent is just a number, k in Eq. 1.4 has the units of 1/time. We shall set $k = 1/T(k)$ where $T(k)$ is called the characteristic time. Here, k refers to a specific learning/forgetting process. When we learn piano, we learn via a myriad of processes, most of which are not well understood. Therefore, determining accurate values for $T(k)$ for each process is generally not possible, so in the numerical calculations, we will have to make some "intelligent guesses". In piano practice, we must repeat difficult material many times before we can play them well, and we need to assign a number (say, "i") to each practice repetition. Then Eq. 1.4 becomes

$$L(i,t,k) = K_i e^{-\frac{t_i}{T(k)}} \tag{1.5}$$

for each repetition i and learning/forgetting process k. Let's examine some relevant examples. Suppose that you are practicing 4 parallel set notes in succession, playing rapidly and switching hands, etc., for 10 minutes. We assign $i = 0$ to one parallel set execution, which may take only about half a second. You might repeat this 10 or 100 times during the 10 minute practice session. You have learned $L(0)$ after the first parallel set. But what we need to calculate is the amount of $L(0)$ that we retain after the 10 minute practice session. In fact, because we repeat many times, we must calculate the cumulative learning from all of them. According to Eq. 1.5, this cumulative effect is given by summing the L's over all the parallel set repetitions:

$$L_{\text{Total}} = \sum_i K_i e^{-\frac{t_i}{T(k)}} \tag{1.6}$$

Now let's put in some numbers into Eq. 1.6 in order to get some answers. Take a passage that you can play slowly, HT, in about 100 seconds (intuitive method). This passage may contain 2 or 3 parallel sets that are difficult and that you can play rapidly in less than a second, so that you can repeat them over 100 times in those 100 seconds (method of this book). Typically, these 2 or 3 difficult spots are the only ones holding you back, so if you can play them well, you can play the entire passage at speed. Of course, even with the intuitive method, you will repeat it many times, but let's compare the difference in learning for each 100 second repetition. For this quick learning process, our tendency to "lose it" is also fast, so we can pick a "forgetting time constant" of around 30 seconds; that is, every 30 seconds, you end up forgetting almost 30% of what you learned from one repetition. Note that you never forget everything even after a long time because the forgetting process is exponential — exponential decays never reach absolute zero. Also, you can make many repetitions in a short time for parallel sets, so these learning events can pile up quickly. This forgetting time constant of 30 seconds depends on the mechanism of learning/forgetting, and I have chosen a relatively short one for rapid repetitions; we shall examine a much longer one below.

Assuming one parallel set repetition per second, the learning from the first repetition is $e^{-100/30} = 0.04$ (you have 100 seconds for forget the first repetition), while the last repetition gives $e^{-1/30} = 0.97$, and the average learning is somewhere in between, about 0.4 (we don't have to be exact, as we shall see), and with over 100 repetitions, we have over 40 units of learning for the use of parallel sets. For the intuitive method, we have a single repetition or $e^{-100/30} = 0.04$. The difference is a factor of $40/0.04 = 1,000$! With such a large difference factor, we do not need much accuracy to demonstrate that there is a big difference. The actual difference in learning may be even bigger because the intuitive method repetition is at slow speed whereas the parallel set repetition rate is at, or even faster than, the final speed.

The 30 second time constant used above was for a "fast" learning process, such as that associated with learning *during* a single practice session. There are many others, such as technique acquisition by PPI (post practice improvement). After any rigorous conditioning, your technique will improve by PPI for a week or more. The rate of forgetting, or technique loss, for such slow processes is not 30 seconds, but much longer, probably several weeks. Therefore, in order to calculate the total difference in learning rates, we must calculate the difference for all known methods of technique acquisition using the corresponding time constant, which can vary considerably from method to method. PPI is largely determined by conditioning, and conditioning is similar to the parallel set repetition calculated above. Thus the difference in PPI should also be about 1,000 times.

Once we calculate the most important rates as described above, we can refine the results by considering other factors that influence the final results. There are factors that make the methods of this book slower (initially, memorizing may take longer than reading, or HS may take longer than HT because you need to learn each passage 3 times instead of once, etc.) and factors that make them faster (such as learning in short segments, getting up to speed quickly, avoiding speed walls, etc.). There are many more factors that make the intuitive method slower, so that the above "1000 times faster" result may be an under-estimate. However, it is probably not possible to take full advantage of the 1000 times factor, since most students may already be using some of the ideas of this book.

The effects of speed walls are difficult to calculate because speed walls are artificial creations of each pianist and I do not know how to write an equation for them. Experience tells us that the intuitive method is susceptible to speed walls. The methods of this book provide many ways of avoiding them. Moreover, speed walls are clearly defined here so that it is possible to pro-actively avoid them during practice. Parallel sets are the most powerful tools for avoiding them because speed walls do not generally form when you decrease speed from high speed. Therefore, speed walls greatly retard the learning rate for intuitive methods. Some teachers who do not understand speed walls adequately will prohibit their students from practicing anything risky and fast, thus slowing progress even more, even when this slow play succeeds in completely avoiding speed walls. When all these factors are taken into account we come to the conclusion that the "up to 1000 times faster" result is basically correct. We also see that the use of parallel sets, practicing difficult sections first, practicing short segments, and getting up to speed quickly, are the main factors that accelerate learning. HS practice, relaxation, and early memorization are some of the tools that enable us to optimize the use of these accelerating methods.

1.4.6 Future Research Topics

Every subsection in this section is incomplete; I am just putting down some initial ideas.

This book is based on the scientific approach, which ensures that errors are corrected as soon as possible, that all known facts are explained, documented, and organized in a useful way, and that we only make forward progress. The past situation of one piano teacher teaching a very useful method and another knowing nothing about it, or two teachers teaching completely opposite methods, should not occur. An important part of the scientific approach is a discussion of what is still unknown and what still needs to be researched. The following is a collection of such topics.

Momentum Theory of Piano Playing

Slow play in piano is called "playing in the static limit". This means that when depressing a key, the force of the finger coming down is the main force used in the playing. As we speed up, we transition from the static limit to the momentum limit. This means that the momenta of the hand, arms, fingers, etc., play much more important roles than the force in depressing the keys. Of course, force is needed to depress the key, but when in the momentum limit, the force and motion are usually 180 degrees out of phase. That is, your finger is moving up when your finger muscles are trying to press it down! This happens at high speed because you had earlier lifted the finger so rapidly that you have to start depressing it on its way up so that you can reverse its action for the next strike. The actual motions a complex because you use the hand, arms, and body to impart and absorb the momenta. This is one of the reasons why the entire body gets involved in the playing, especially when playing fast. Note that the swing of the pendulum and the dribbling of the basketball are in the momentum limit. In piano playing, you are generally somewhere between the static and momentum limits with increasing tendency towards momentum limit with increasing speed.

In static play, the force vector and motion of the finger are in phase. As we transition to momentum play, a phase difference develops, until, in the pure momentum regime, the phase difference is 180 degrees, as it is in the pendulum.

The importance of momentum play is obvious; it involves many new finger/hand motions that are not possible in static play. Thus knowing which motions are of the static or momentum type will go a long way toward understanding how to execute them and when to use them. Because momentum play has never been discussed in the literature until now, there is a vast area of piano play for which we have very little understanding.

The Physiology of Technique

We still lack even a rudimentary understanding of the bio-mechanical processes that underlie technique. It certainly originates in the brain, and is probably associated with how the nerves communicate with the muscles, especially the rapid muscles. What are the biological changes that accompany technique? when fingers are "warmed up"?

Brain Research (HS vs HT Play, etc.)

Brain research will be one of the most important fields of medical research in the near future. This research will initially concentrate on preventing mental deterioration with age (such as curing Alzheimer's disease). Then concurrent efforts at actually controlling the growth of mental capabilities will surely develop. Music should play an important role in such developments because we can communicate aurally with infants long before any other method, and it is already clear that, the earlier you start the control process, the better the results.

We are all familiar with the fact that, even if we can play HS quite well, HT may still be difficult. Why is HT so much more difficult? One of the reasons may be that the two hands are controlled by the different halves of the brain. If so, then learning HT requires the brain to develop ways to coordinate the two halves. This would mean that HS and HT practice use completely different types of brain functions and supports the contention that these skills should be developed separately so that we work on one skill at a time. One intriguing possibility is that we may be able to develop HT parallel sets that can solve this problem.

What Causes Nervousness?

In piano pedagogy, nervousness has been "swept under the rug" (ignored) for too long. We need to study it from medical and physiological points of view. We need to know if some individuals can benefit from proper medication. Moreover, is there a medical or psychological regiment whereby it can eventually be eliminated? Finally, from a formal psychological point of view, we must develop a teaching procedure that will reduce nervousness. Nervousness is clearly the result of a mental attitude/reaction/perception, and is therefore very amenable to active control. For example, pianists who play popular/jazz type music seem to be much less nervous in general than those who play classical. There is no reason why we shouldn't investigate why this is so, and take advantage of this phenomenon.

Causes and Remedies for Tinnitus

Cochlea structure, high and low frequency tinnitus.

There is evidence that moderate intake of aspirin can slow down hearing loss with age. However, there is also evidence that aspirin, under certain conditions, can aggravate tinnitus. There does not appear to be any evidence that tinnitus is caused purely by age; instead, there is ample evidence that it is caused by infection, disease, accidents, and abuse of the ear. Therefore, in most of these cases, the causes and the types of damage can be directly studied.

What is Music?

Cochlea structure vs music scales and chords. Parameters: timing (rhythm), pitch, patterns (language, emotions), volume, speed. Musical information processing in brain.

At What Age to Start Piano?

We need medical/psychological/sociological studies into how/when we should start youngsters. This type of research is already starting to be conducted in sports, at least informally, by individual sports organizations that have developed methods for teaching youngsters down to about 2 years of age. In music, we can start as soon as the babies are born, by letting them listen to the appropriate types of music. In music, we are probably interested more in the development of the brain than in acquiring motor skills. Because we expect brain research to explode in the near future, this is an opportune time to take advantage of that research and use the results for learning piano.

The Future of Piano

Finally, we look into the future. The "Testimonials" section gives ample evidence that our new approach to piano practice will enable practically anyone to learn piano to her/is satisfaction. It will certainly increase the number of pianists. Therefore, the following questions become very important: (1) can we calculate the expected increase in pianists? (2) what will this increase do to the economics of the piano: performers, teachers, technicians, and manufacturers, and (3) if piano popularity explodes, what will be the main motivation for such large numbers of people to learn piano?

Piano teachers will agree than 90% of piano students never really learn piano in the sense that they will not be able to play to their satisfaction and basically give up trying to become accomplished pianists. Since this is a well known phenomenon, it discourages youngsters and their parents from deciding to start piano lessons. Since serious involvement with piano will interfere materially with the business of making a living, the economic factor also discourages entry into piano. There are many more negative factors that limit the popularity of the piano (lack of good teachers, high expense of good pianos and their maintenance, etc.), almost all of which are eventually related to the fact that piano has been so difficult to learn. Probably only 10% of those who might have tried piano ever decide to give it a try. Therefore, we can reasonably expect the popularity of the piano to increase by 100 times if the promise of this book can be fulfilled.

Such an increase would mean that a large fraction of the population in developed countries would learn piano. Since it is a significant fraction, we do not need an accurate number, so let's just pick some reasonable number, say 30%. This would require at least a 10 fold increase in the number of piano teachers. This would be great for students because one of the big problems today is finding good teachers. In any one area, there are presently only a few teachers and the students have little choice. The number of pianos sold would also have to increase, probably by something in excess of 300%. Although many homes already have pianos, many of them are not playable. Since most of the new pianists will be at an advanced level, the number of good grand pianos needed will increase by an even larger percentage.

By using this book as a basic starting point for practice methods, piano teachers can concentrate on what they do best: teaching how to make music. Since this is what teachers have been doing all along, there will be only minor new changes needed in how teachers teach. The only new element is the addition of practice methods that take very little time to learn. The biggest change, of course, is that teachers will be liberated from the old slow process of teaching technique. It will be much easier for teachers to decide what to teach because technical difficulties will be much less of an impediment. Within a few teacher/student generations, the quality of teachers will improve dramatically which will further accelerate the learning rates of future students.

Is an increase of 100 times in the population of pianists reasonable? What would they do? They certainly can't all be concert pianists and piano teachers. The very nature of how we view piano playing will change. First of all, the piano will, by then, become a standard second instrument for all musicians, because it will be so easy to learn and there will be pianos everywhere. The joy of playing piano will be enough reward for many. The zillions of music lovers who could only listen to recordings can now play their own music — a much more satisfying experience. As anyone who has become an accomplished pianist will tell you, once you get to that level, you cannot help but compose music. Thus a piano revolution will also ignite a revolution in composition, and new compositions will be in great demand because many pianists will not be satisfied with playing "the same old things". Pianists will be composing music for every instrument because of the development of keyboards with powerful software and every pianist will have an acoustic piano and an electronic keyboard, or a dual instrument (see below). The large supply of good keyboardists would mean that entire orchestras will be created using keyboard players. Another reason why the piano would become universally popular is that it will be used as a method for increasing the IQ of growing infants. Brain research will certainly reveal that the intelligence can be improved by proper brain stimulation during its early developmental stages. Since there are only two inputs into the infant's brain, auditory and visual, and the auditory is initially much more advanced than visual, music is the most logical means for influencing the brain during early development.

With such huge forces at work, the piano itself will evolve rapidly. First, the electronic keyboard will increasingly intrude into the piano sector. The shortcomings of the electronic pianos will continue to decrease until the electronics become indistinguishable from the acoustics. Regardless of which instrument is used, the technical requirements will be the same. By then, the acoustic pianos will have many of the features of the electronics: they will be in tune all the time (instead of being out of tune 99% of the time, as they are now), you will be able to change temperaments by flicking a switch, and midi capabilities will be easily interfaced with the acoustics. The acoustics will never completely disappear because the art of making music using mechanical devices is so fascinating. In order to thrive in this new environment, piano manufacturers will need to be much more flexible and innovative.

Piano tuners will also need to adapt to these changes. All pianos will be self-tuning, so income from tuning will decrease. However, pianos in tune 100% of the time will need to be voiced more frequently, and how hammers are made and voiced will need to change. It is not that today's pianos do not need voicing just as much, but when the strings are in perfect tune, any deterioration of the hammer becomes the limiting factor to sound quality. Piano tuners will finally be able to properly regulate and voice pianos instead of just tuning them; they can concentrate on the quality of the piano sound, instead of just getting rid of dissonances. Since the new generation of more accomplished pianists will be aurally more sophisticated, they will demand better sound. The greatly increased number of pianos and their constant use will require an army of new piano technicians to regulate and repair them. Piano tuners will also be much more involved in adding and maintaining electronic (midi, etc.) capabilities to acoustics. Therefore, the piano tuners' business will extend into the maintenance and upgrading of electronic pianos. Thus most people will either have a hybrid or both an acoustic and electronic piano.

The Future of Education

The Internet is obviously changing the nature education. One of my objectives in writing this book on the WWW is to explore the possibilities of making education much more cost effective than it has been. Looking back to my primary education and college days, I marvel at the efficiency of the educational processes that I had gone through. Yet the promise of much greater efficiency via the internet is staggering by comparison. My experience thus far has been very educational. Here are some of the advantages of internet based education:

1. No more waiting for school buses, or running from class to class; in fact no more cost of school buildings and associated facilities.

2. No costly textbooks. All books are up-to-date, compared to many textbooks used in universities that are over 10 years old. Cross referencing, indexing, topic searches, etc., can be done electronically. Any book is available anywhere, as long as you have a computer and internet connection.

3. Many people can collaborate on a single book, and the job of translating into other languages becomes very efficient, especially if a good translation software is used to assist the translators.

4. Questions and suggestions can be emailed and the teacher has ample time to consider a detailed answer and these interactions can be emailed to anyone who is interested; these interactions can be stored for future use.

5. The teaching profession will change drastically. On the one hand, there will be more one-on-one interactions by email, video-conferencing, and exchange of data (such as audio from a piano student to the teacher) but on the other, there will be fewer group interactions where the group of students physically assembles in one classroom. Any teacher can interact with the “master text book center” to propose improvements that can be incorporated into the system. And students can access many different teachers, even for the same topic.

6. Such a system would imply that an expert in the field cannot get rich writing the best textbook in the world. However, this is as it should be — education must be available to everyone at the lowest cost. Thus when educational costs decrease, institutions that made money the old way must change and adopt the new efficiencies. Wouldn’t this discourage experts from writing textbooks? Yes, but you need only one such “volunteer” for the entire world; in addition, the internet has already spawned enough such free systems as Linux, browsers, Adobe Acrobat, etc., that this trend is not only irreversible but well established. In other words, the desire to contribute to society becomes a large factor in contributing to education. For projects that provide substantial benefits to society, funding mechanisms (government, philanthropists, and sponsoring businesses) will certainly evolve.

7. This new paradigm of contributing to society may bring about even more profound changes to society. One way of looking at business as conducted today is that it is highway robbery. You charge as much as you can regardless of how much or how little good your product does to the buyer. In an accurate accounting paradigm, the buyer should always get his money’s worth. That is

the only situation in which that business can be viable in the long run. This works both ways; well-run businesses should not be allowed to go bankrupt simply because of excessive competition. In an open society in which all relevant information is immediately available, we can have financial accounting that can make pricing appropriate to the service. The philosophy here is that a society consisting of members committed to helping each other succeed will function much better than one consisting of robbers stealing from each other. In particular, in the future, practically all basic education should be essentially free. This does not mean that teachers will lose their jobs because teachers can greatly accelerate the learning rate and should be paid accordingly.

It is clear from the above considerations that free exchange of information will transform the educational (as well as practically every other) field. This book is one of the attempts at taking full advantage of these new capabilities.

Chapter 2

Tuning Your Piano

2.1 Introduction

Updated: September 3, 2003

This chapter is for those who had never tuned a piano and who would like to see if they are up to the task. The book, *Piano Servicing, Tuning, and Rebuilding*, by Arthur Reblitz, will be a very helpful reference. The hardest part of learning to tune is getting started. For those fortunate enough to have someone teach them, that is obviously the best route. Unfortunately, piano tuning teachers aren't readily available. Try the suggestions in this chapter and see how far you can get. After you are familiar with what gives you trouble, you might negotiate with your tuner for 30 minute lessons for some agreed-upon fee, or ask him to explain what he is doing as he tunes. Be careful not to impose too much on your tuner; tuning and teaching can take more than four times longer than simply tuning it up. Also, be forewarned that piano tuners are not trained teachers and some may harbor unfounded fears that they might lose a customer. These fears are unfounded because the actual number of people who succeed in displacing professional tuners is negligibly small. What you will most likely end up doing is getting a better understanding of what it takes to tune a piano.

For pianists, familiarity with the art of tuning provides an education that is directly relevant to their ability to produce music and to maintain their instruments. It will also enable them to communicate intelligently with their tuners. For example, the majority of piano teachers to whom I posed the question did not even know the difference between equal temperament and historical temperaments. The main reason why most people try to learn tuning is out of curiosity — for most, piano tuning is a baffling mystery. Once people are educated to the advantages of tuned (maintained) pianos, they are more likely to call their tuners regularly. Piano tuners can hear certain sounds coming from the piano that most people, even pianists, don't notice. Those who practice tuning will become sensitized to the sounds of out-of-tune pianos. It will probably take about one year to start feeling comfortable with tuning, assuming that you have the time to practice for several hours at least once very one or two months.

Let me digress a little here to discuss the importance of understanding the plight of the piano tuner and proper communications with her/im, from the point of view of getting your money's worth from the tuner so that your piano can be properly maintained. These considerations directly impact your ability to acquire piano technique as well as your decisions on what or how to perform, given a particular piano to play. For example, one of the most common difficulties I have noted with students is their inability to play pianissimo. From my understanding of piano tuning, there is a very simple answer to this — most of these students' pianos are under-maintained. The hammers are too worn/compacted and the action so out of regulation that playing pianissimo is impossible. These students will never even be able to practice pianissimo! This applies also to musical expression and tone control. These under-maintained pianos are probably one of the causes of the view that piano practice is ear torture, but it should not be.

Another factor is that you generally have no choice of a piano when asked to perform. You might encounter anything from a wonderful concert grand, to spinets, to (horrors!) a cheap baby grand that was totally neglected since it was purchased 40 years ago. Your understanding of what you can/cannot do with each of these pianos should be the first input into deciding what and how to play.

Once you start practicing tuning, you will quickly understand why your spouse vacuuming the floor, kids running around, the TV or HiFi blaring away, or pots clanging in the kitchen is not conducive to accurate, quality tuning. Why a quick, $70 tuning is no bargain compared to a $150 tuning in which the tuner reshapes and needles the hammers. Yet when you query owners what the tuner did to their pianos, they generally have no idea. A complaint I frequently hear from owners is that, after a tuning, the piano sounds dead or terrible. This often happens when the owner does not have a fixed reference from which to judge the piano sound — the judgement is based on whether the owner likes the sound or not. Such perceptions are too often incorrectly influenced by the owner's past history. The owner can actually become accustomed to the sound of a detuned piano with compacted hammers so that when the tuner restores the sound, the owner doesn't like it because it is now too different from the sound or feel to which he had become accustomed. The tuner could certainly be at fault; however, the owner will need to know a minimum of tuning technicalities in order to make such a judgement stick. The benefits of understanding tuning and properly maintaining the piano are obviously under-appreciated by the general public. Perhaps the most important objective of this chapter is to increase that awareness.

Piano tuning does not require good ears, such as perfect pitch, because all tuning is accomplished by comparison with a reference using beats, starting with the reference frequency of a tuning fork. In fact a perfect pitch ability may interfere with the tuning for some people. Therefore, the "only" hearing skill you will need is the ability to hear and differentiate between the various beats when two strings are struck. This ability develops with practice and is not related to knowledge of music theory or to musicality. Larger grands are easier to tune than uprights; however, most baby grands are harder to tune than good uprights. Therefore, although you should logically begin your practice with a lower quality piano, it will be more difficult to tune.

2.2 Chromatic Scale and Temperament

Updated: August 19, 2003

Most of us have some familiarity with the chromatic scale and know that it must be tempered, but what are their precise definitions? **Why is the chromatic scale so special and why is temperament needed?** We first explore the mathematical basis of the chromatic scale and tempering because the mathematical approach is the

Octave	5th	4th	Maj.3rd	Min.3rd		
C D E F G A B	C D E F	G A B	C ♯ D ♯	E F ♯	G ♯ A ♯ B	C
1	2	3	4	5	6	8

Table 2.1: Frequency Ratios of Chords in the Chromatic Scale

most concise, clear, and precise treatment. We then discuss the historical/musical considerations for a better understanding of the relative merits of the different temperaments. A basic mathematical foundation for these concepts is essential for a good understanding of how pianos are tuned. For information on tuning, see White, Howell, Fischer, Jorgensen, or Reblitz in the Reference section at the end of this book.

Mathematical Treatment

Three octaves of the chromatic scale are shown in table 2.1 using the A, B, C, … notation. Black keys on the piano are shown as sharps, e.g. the ♯ on the right of C represents C♯, etc., and are shown only for the highest octave. **Each successive frequency change in the chromatic scale is called a semitone and an octave has 12 semitones.** The major chords and the integers representing the frequency ratios for those chords are shown above and below the chromatic scale, respectively. The word chord is used here to mean two notes whose frequency ratio is a small integer. Except for multiples of these basic chords, integers larger than about 10 produce chords not readily recognizable to the ear. In reference to table 2.1, the most fundamental chord is the octave, in which the frequency of the higher note is twice that of the lower one. The interval between C and G is called a 5th, and the frequencies of C and G are in the ratio of 2 to 3. The major third has four semitones and the minor third has three. **The number associated with each chord, e.g. four in the 4th, is the number of white keys, inclusive of the two end keys for the C major scale, and has no further mathematical significance.** Note that the word "scale" in "chromatic scale", "C major scale", and "logarithmic or frequency scale" (see below) has completely different meanings; the second is a subset of the first.

We can see from the above that a 4th and a 5th "add up" to an octave and a major 3rd and a minor 3rd "add up" to a 5th. Note that this is an addition in logarithmic space, as explained below. The missing integer 7 is also explained below.

The "equal tempered" (ET) chromatic scale consists of "equal" half-tone or semitone rises for each successive note. They are equal in the sense that the ratio of the frequencies of any two adjacent notes is always the same. This property ensures that each note is the same as any other note (except for pitch). This uniformity of the notes allows the composer or performer to use any key without hitting bad dissonances, as further explained below. There are 12 equal semitones in an octave of an ET scale and each octave is an exact factor of two in frequency. Therefore, the frequency change for each semitone is given by

$$\begin{gathered}\text{semitone}^{12} = 2 \\ \text{or} \\ \text{semitone} = 2^{\frac{1}{12}} = 1.05946\end{gathered} \tag{2.1}$$

Equation 2.1 defines the ET chromatic scale and allows the calculation of the frequency ratios of "chords" in this scale. How do the "chords" in ET compare with

Chord	Freq. Ration	Eq. Tempered Scale	Difference
Min.3rd:	6/5 = 1.2000	semitone^3 = 1.1892	+0.0108
Maj.3rd:	5/4 = 1.2500	semitone^4 = 1.2599	-0.0099
Fourth:	4/3 = 1.3333	semitone^5 = 1.3348	-0.0015
Fifth:	3/2 = 1.5000	semitone^7= 1.4983	+0.0017
Octave:	2/1 = 2.0000	semitone^{12} = 2.0000	0.0000

Table 2.2: Ideal Chords versus the Equal Tempered Scale

the frequency ratios of the ideal chords? **The comparisons are shown in table 2.2 and demonstrate that the chords from the ET scale are extremely close to the ideal chords.**

The errors for the 3rds are the worst, over five times the errors in the other chords, but are still only about 1%. Nonetheless, these errors are readily audible, and some piano aficionados have generously dubbed them "the rolling thirds" while in reality, they are unacceptable dissonances. It is a defect that we must learn to live with, if we are to adopt the ET scale. The errors in the 4ths and 5ths produce beats of about 1 Hz near middle C, which is barely audible in most pieces of music; however, this beat frequency doubles for every higher octave.

The integer 7, if it were included in table 2.1, would have represented a chord with the ratio 7/6 and would correspond to a semitone squared. The error between those two numbers 7/6 and a semitone squared is over 4% and is too large to make a musically acceptable chord and was therefore excluded from table 2.1. It is just a mathematical accident that the 12-note chromatic scale produces so many ratios close to the ideal chords. **Only the number 7, out of the smallest 8 integers, results in a totally unacceptable chord. The chromatic scale is based on a lucky mathematical accident in nature! It is constructed by using the smallest number of notes that gives the maximum number of chords.** No wonder early civilizations believed that there was something mystical about this scale. Increasing the number of keys in an octave does not result in much improvement of the chords until the numbers become quite large, making that approach impractical for most musical instruments.

Note that the frequency ratios of the 4th and 5th do not add up to that of the octave (1.5000 + 1.3333 = 2.8333 vs. 2.0000). Instead, they add up in logarithmic space because (3/2) × (4/3) = 2. In logarithmic space, multiplication becomes addition. Why might this be significant? The answer is because the geometry of the cochlea of the ear seems to have a logarithmic component. Detecting acoustic frequencies on a logarithmic scale accomplishes two things: you can hear a wider frequency range for a given size of cochlea, and analyzing ratios of frequencies becomes simple because instead of dividing or multiplying two frequencies, you only need to subtract or add their logarithms. For example, if C3 is detected by the cochlea at one position and C4 at another position 2 mm up, then C5 will be detected at a distance of 4 mm, exactly as in the slide rule calculator. To show you how useful this is, given F5, the brain knows that F4 will be found 2 mm down! Therefore, chords (remember, chords are frequency divisions) are particularly simple to analyze in a logarithmically constructed cochlea. When we play chords, we are performing mathematical operations in logarithmic space on a mechanical computer called the piano, as was done in the 1950's with the slide rule. **Thus the logarithmic nature of the chromatic scale has many more consequences than just providing a wider frequency range.** The logarithmic scale assures that the two notes of every chord are separated by the same distance no matter where you are on the piano. By adopting a logarithmic chromatic scale, the piano keyboard is mechanically matched to the human ear! This is probably one reason for why harmonies are pleasant to the ear — harmonies are most easily deciphered and remembered by the human hearing mechanism.

Suppose that we did not know 2.1; can we generate the ET chromatic scale from the chord relationships? If the answer is yes, a piano tuner can tune a piano without having to make any calculations. These chord relationships, it turns out, completely determine the frequencies of all the notes of the 12 note chromatic scale. A temperament is a set of chord relationships tha provides this determination. From a musical point of view, there is no single "chromatic scale" that is best above all else although ET has the unique property that it allows free transpositions. Needless to say, **ET is not the only musically useful temperament, and we will discuss other temperaments below.** Temperament is not an option but a necessity; we *must* choose a temperament in order to accommodate these mathematical difficulties. **No musical instrument based on the chromatic scale is completely free of temperament.** For example, the holes in wind instruments and the frets of the guitar must be spaced for a specific tempered scale. The violin is a devilishly clever instrument because it avoids all temperament problems by spacing the open strings in fifths. If you tune the A(440) string correctly and tune all the others in 5ths, these others will be close, but not tempered. You can still avoid temperament problems by fingering all notes except A(440). In addition, the vibrato is larger than the temperament corrections, making temperament differences inaudible.

The requirement of tempering arises because a chromatic scale tuned to one scale (e.g., C major with perfect chords) does not produce acceptable chords in other scales. If you wrote a composition in C major having many perfect chords and then transposed it, terrible dissonances can result. There is an even more fundamental problem. Perfect chords in one scale also produce dissonances in other scales needed in the same piece of music. Tempering schemes were therefore devised to minimize these dissonances by minimizing the de-tuning from perfect chords in the most important chords and shifting most of the dissonances into the less used chords. The dissonance associated with the worst chord came to be known as "the wolf".

The main problem is, of course, chord purity; the above discussion makes it clear that no matter what you do, there is going to be a dissonance somewhere. **It might come as a shock to some that the piano is a fundamentally imperfect instrument!** We are left to deal forever with some compromised chords in almost every scale.

The name "chromatic scale" generally applies to any 12-note scale with any temperament. Naturally, the chromatic scale of the piano does not allow the use of frequencies between the notes (as you can with the violin), so that there is an infinite number of missing notes. In this sense, the chromatic scale is incomplete. Nonetheless, the 12-note scale is sufficiently complete for the majority of musical applications. The situation is analogous to digital photography. When the resolution is sufficient, you cannot see the difference between a digital photo and an analog one with much higher information density. Similarly, **the 12-note scale apparently has sufficient pitch resolution for a sufficiently large number of musical applications.** This 12-note scale is a good compromise between having more notes per octave for greater completeness and having enough frequency range to span the range of the human ear, for a given instrument or musical notation system with a limited number of available notes.

There is healthy debate about which temperament is best musically. ET was known from the earliest history of tuning. There are definite advantages to standardizing to one temperament, but that is probably not possible or even desirable in view of the diversity of opinions on music and the fact that much music now exist, that were written with particular temperaments in mind. Therefore we shall now explore the various temperaments.

Temperament and Music

The above mathematical approach is not the way in which the chromatic scale was developed. Musicians first started with chords and tried to find a music scale with the minimum number of notes that would produce those chords. The requirement of a minimum number of notes is obviously desirable since it determines the number of keys, strings, holes, etc. needed to construct a musical instrument. Chords are necessary because if you want to play more than one note at a time, these notes will create dissonances that are unpleasant to the ear unless they form harmonious chords. The reason why dissonances are so unpleasant to the ear may have something to do with the difficulty of processing dissonant information through the brain. It is certainly easier, in terms of memory and comprehension, to deal with harmonious chords than dissonances. Some of which are nearly impossible for most brains to figure out if two dissonant notes are played simultaneously. Therefore, if the brain is overloaded with the task of trying to figure out complex dissonances, it becomes impossible to relax and enjoy the music, or follow the musical idea. Clearly, any scale must produce good chords if we are to compose advanced, complex music requiring more than one note at a time.

We saw obove that the optimum number of notes in a scale turned out to be 12. Unfortunately, there isn't any 12-note scale that can produce exact chords everywhere. Music would sound better if a scale with perfect chords everywhere could be found. Many such attempts have been made, mainly by increasing the number of notes per octave, especially using guitars and organs, but none of these scales have gained acceptance. It is relatively easy to increase the number of notes per octave with a guitar-like instrument because all you need to do is to add strings and frets. The latest schemes being devised today involve computer generated scales in which the computer adjusts the frequencies with every transposition; this scheme is called adaptive tuning (Sethares).

The most basic concept needed to understand temperaments is the concept of the circle of fifths. To describe a circle of 5ths, take any octave. Start with the lowest note and go up in 5ths. After two 5ths, you will go outside of this octave. When this happens, go down one octave so that you can keep going up in 5ths and still stay within the original octave. Do this for twelve 5ths, and you will end up at the highest note of the octave! That is, if you start at C4, you will end up with C5 and this is why it is called a circle. Not only that, but every note you hit when playing the 5ths is a different note. This means that the circle of 5ths hits every note once and only once, a key property useful for tuning the scale and for studying it mathematically.

Historical developments are central to discussions of temperament because the music of the time is tied to the temperament of the time. Pythagoras is credited with inventing the "Pythagorean temperament" at around 550 AD, in which the chromatic scale is generated by tuning in perfect 5ths, using the circle of 5ths. The twelve perfect fifths in the circle of fifths do not make an exact factor of two. Therefore, the final note you get is not exactly the octave note but is too high in frequency by what is called the “Pythagorean comma”, which is about 23 cents (a cent is one hundredths of a semitone). Since a 4th plus a 5th make up an octave, the Pythagorean temperament results in a scale with perfect 4ths and 5ths, except at the end where you get a very bad dissonance. It turns out that tuning in perfect 5ths leaves the 3rds in bad shape. This is another disadvantage of the Pythagorean temperament. Now if we were to tune by contracting each 5th by 23/12 cents, we would end up with exactly one octave and that is one way of tuning an ET scale. In fact, we shall use just such a method in the section on tuning. The ET scale was already known within a hundred years or so after invention of the Pythagorean temperament. Thus ET is not a “modern temperament”.

Following the introduction of the Pythagorean temperament, all newer temperaments were efforts at improving on it. The first method was to halve the Pythagorean comma by distributing it among two final 5ths. **One major development was Meantone temperament, in which the 3rds were made just instead of the 5ths.** Musically, 3rds play more prominent roles than 5ths, so that meantone made sense, especially during an age when music made greater use of 3rds. Unfortunately, meantone has a wolf worse than Pythagorean.

The next milestone is represented by Bach’s Well Tempered Clavier in which he wrote music for various Well temperaments (WT). These were temperaments that struck a compromise between meantone and Pythagorean. This concept worked because Pythagorean tuning ended up with notes that were too sharp, while meantone is too flat. In addition, WT presented the possibility of not only good 3rds, but also good 5ths. **The simplest WT was devised by Kirnberger, a student of Bach. Its biggest advantage is its simplicity. Better WTs were devised by Werkmeister and by Young. If we broadly classify tunings as Meantone, WT, or Pythagorean, then ET is a WT because ET is neither sharp nor flat.** There is no record of the temperaments Bach used. We can only guess at the temperaments from the harmonies in his compositions, especially his “Well Tempered Clavier”, and these studies indicate that essentially all the details of tempering were already worked out by Bach’s time (before 1700) and that Bach used a temperament not very different from Werkmeister

The violin appears to have taken advantage of its unique design to effectively circumvent these temperament problems. The open strings make intervals of a 5th with each other, so that the violin naturally tunes Pythagorean. Since the 3rds can always be played just, it has all the advantages of the Pythagorean, meantone, and WT, with no wolf in sight!

In the last 100 years or so, ET had been almost universally accepted. Thus all the other temperaments are generically classified as “historical temperaments” (HsT), which is clearly a misnomer. The historical use of a WT gave rise to the concept of key color in which each key, depending on the temperament, endowed specific colors to the music, mainly through the small de-tunings that create “tension” and other effects. This greatly complicated issues because now musicians were dealing not only with pure chords versus wolves, but with colors that were not easily defined. The extent to which the colors can be brought out depends on the piano, the pianist, and the listener, as well as the tuner. Note that the tuner can blend stretch (see “What is stretch?” near the end of section 2.4) with temperament to control color. After listening to music played on pianos tuned to WT, ET tends to sound more muddy and bland. Thus key color does matter. More important are the wonderful sounds of pure (stretched) intervals in WT. On the other hand, there is always some kind of a wolf in the WTs which is reduced in ET.

For playing most of the music composed around the times of Bach, Mozart, and Beethoven, WT works best. As an example, Beethoven chose chords for the dissonant ninths in the first movement of his Moonlight Sonata that are least dissonant in WT, and are much worse in ET. These great composers were acutely aware of temperament. Most works from Chopin's and Liszt's time were composed with ET in mind and key color is not a issue. Although these compositions sound different in ET and WT to the trained ear, it is not clear that WT is objectionable because pure intervals always sound better than detuned ones.

My personal view for the piano is that we should get away from ET because it deprives us of one of the most enjoyable aspects of music — pure intervals. You will see a dramatic demonstration of this if you can listen to the last movement of Beethoven's Waldstein played in ET and WT. Meantone can be somewhat extreme unless you are playing music of that period (before Bach), so that we are left with the WTs. For simplicity and ease of tuning, you cannot beat Kirnberger. I believe that once you get used to WT, ET will not sound as good. Therefore, the world should standardize to the WTs. Which one you choose does not make a big difference for most people because those not educated in the temperaments will generally not notice a big difference even among the major temperaments, let alone among the different WTs. This is not to say that we should all use Kirnberger but that we should be educated in the temperaments and have a choice instead of being straight-jacketed into the bland ET. This is not just a matter of taste or even whether the music sounds better. We are talking about developing our musical sensitivity and knowing how to use those really pure intervals. One disadvantage of WT is that if the piano is out of tune by even a small amount, it becomes audible. However, I would be very happy if all piano students developed their sensitivity to the point at which they can notice that a piano is very slightly out of tune.

2.3 Tuning Tools

You will need one tuning lever, several rubber wedges, a felt muting strip, and one or two tuning forks and ear plugs or ear muffs. Professional tuners nowadays also use an electronic tuning aid, but we will not consider it here because it is not cost effective for the amateur and its proper use requires advanced knowledge of the fine points of tuning. The tuning method we consider here is called aural tuning — tuning by ear. All good professional tuners must be good aural tuners even when they make heavy use of electronic tuning aids.

Grands use the larger rubber muting wedges and uprights require the smaller ones with wire handles. Four wedges of each type will suffice. You can buy these by mail order or you can ask your tuner to buy the whole set of things you need for you.

The most popular muting strips are felt, about 4 ft long, 5/8 inch wide. They are used to mute out the two side strings of the 3-string notes in the octave used to "set the bearings" (see below). They also come as ganged rubber wedges but these don't work as well. The strips also come in rubber, but rubber does not mute as well and is not as stable as felt (they can move or pop out while tuning). The disadvantage of the felt strip is that it will leave a layer of felt fiber on the soundboard after you are finished, which will need to be vacuumed out.

A high quality tuning lever consists of an extendable handle, a head that attaches to the tip of the handle, and an interchangeable socket that screws into the head. It is a good idea to have a piano tuning pin which you can insert into the socket using a vise grip so that you can screw the socket into the head firmly. Otherwise, if you grab on the socket with the vise grip, you can scratch it up. If the socket is not firmly in the head, it will come off during tuning. Most pianos require a #2 socket, unless your piano has been re-strung using larger tuning pins. The standard head is a 5 degree head. This “5 degree” is the angle between the socket axis and the handle. Both the heads and sockets come in various lengths, but “standard” or “medium” length will do.

Get two tuning forks, A440 and C523.3 of good quality. Develop a good habit of holding them at the narrow neck of the handle so that your fingers do not interfere with their vibrations. Tap the tip of the fork firmly against a muscular part of your knee and test the sustain. It should be clearly audible for 10 to 20 seconds when placed close to your ear. The best way to hear the fork is to place the tip of the handle against the triangular cartilage (ear lobe) that sticks out towards the middle of your ear hole. You can adjust the loudness of the fork by pressing the ear lobe in or out using the end of the fork. Do not use whistles; they are too inaccurate.

Ear muffs are a necessary protection device, since ear damage is a tuner’s occupational hazard. It is necessary to hit the keys hard (pound the keys — to use a tuners’ jargon) in order to tune properly as explained below, and the sound intensity from such pounding can easily damage the ear, resulting in hearing loss and tinnitus.

2.4 Preparation

Prepare for tuning by removing the music stand so that the tuning pins are accessible (grand piano). For the following section, you need no further preparation. For “setting the bearings”, you need to mute all the side strings of the triplet strings within the “bearings octave” using the muting strip so that when you play any note within this octave, only the center string will vibrate. You will probably have to mute close to two octaves depending on the tuning algorithm. Try out the entire algorithm first to determine the highest and lowest notes you need to mute. Then mute all the notes in between. Use the rounded end of the wire handle of the upright mute to press the felt into the spaces between the outer strings of adjacent notes.

2.5 Getting Started

Without a teacher, you cannot dive right into tuning. You will quickly lose your bearing and have no idea how to get back. Therefore, **you must first learn/practice certain tuning procedures so that you don’t end up with an unplayable piano that you cannot restore.** This section is an attempt to get you to the level at which you might try a real tuning, without running into those types of difficulties.

The first things to learn are what not to do, in order to avoid destroying the piano, which is not difficult. If you tighten a string too much, it will break. The initial instructions are designed to minimize string breakage from amateurish moves, so read them carefully. Plan ahead so that you know what to do in case you break a string. A broken string per se, even when left for long periods of time, is no disaster to a piano. However, it is probably wise to conduct your first practices just before you intend to call your tuner. Once you know how to tune, string breakage is a rare problem except for very old or abused pianos. The tuning pins are turned by such small amounts during tuning that the strings almost never break. One common mistake beginners make is to place the lever on the wrong tuning pin. Since turning the pin does not cause any audible change, they keep turning it until the string breaks. One way to avoid this is to always start by tuning flat, as recommended below, and to never turn the pin without listening to the sound.

The most important consideration for a starting tuner is to preserve the condition of the pinblock. The pressure of the pinblock on the pin is enormous. Now you will never have to do this, but if you were to hypothetically turn the pin 180 degrees very rapidly, the heat generated at the interface between pin and pinblock would be sufficient to cook the wood and alter its molecular structure. Clearly, all rotations of the pin must be conducted in slow, small, increments. If you need to remove a pin by turning it, rotate only a quarter turn (counter clock-wise), wait a moment for the heat to dissipate away from the interface, then repeat the procedure, etc., so as to avoid damaging the pinblock.

I will describe everything assuming a grand piano, but the corresponding motion for the upright should be obvious. **There are two basic motions in tuning. The first is to turn the pin so as to either pull or release the string. The second is to rock the pin back towards you (to pull on the string) or rock it forwards, towards the string, to release it.** The rocking motion, if done to extreme, will enlarge the hole and damage the pinblock. Note that the hole is somewhat elliptical at the top surface of the pinblock because the string is pulling the pin in the direction of the major axis of the ellipse. Thus a small amount of backwards rocking does not enlarge the ellipse because the pin is always pulled into the front end of the ellipse by the string. Also, the pin is not straight but bent elastically towards the string by the pull of the string. Therefore, the rocking motion can be quite effective in moving the string. Even a small amount of forward rocking, within the elasticity of the wood, is harmless. It is clear from these considerations that **you must use the rotation whenever possible, and use the rocking motion only when absolutely necessary.** Only very small rocking motions should be used. For the extreme high notes (top two octaves), the motion needed to tune the string is so small that you may not be able to control it adequately by rotating the pin. Rocking provides much finer control, and can be used for that final miniscule motion to bring it into perfect tune.

Now, what is the easiest way to start practicing? First, let's choose the easiest notes to tune. These lie in the C3–C4 octave. Lower notes are harder to tune because of their high harmonic content, and the higher notes are difficult because the amount of pin rotation needed to tune becomes smaller with higher pitch. Note that middle C is C4; the B just below it is B3 and the D immediately above middle C is D4. That is, the octave number 1, 2, 3, ... changes at C, not at A. Let's choose G3 as our practice note and start numbering the strings. Each note in this region has 3 strings. Starting from the left, let's number the strings 123 (for G3), 456 (for G♯3), 789 (for A3), etc. Place a wedge between strings 3 and 4 in order to mute string 3 so that when you play G3, only 1 and 2 can vibrate. Place the wedge about midway between the bridge and agraffe.

There are two basic types of tuning: unison and harmonic. In unison, the two strings are tuned identically. In harmonic tuning, one string is tuned to a harmonic of the other, such as thirds, fourths, fifths, and octaves. The three strings of each note are tuned in unison, which is easier than harmonic tuning, so let's try that first.

Engaging and Moving the Tuning Lever

If your tuning lever has adjustable length, pull it out about 3 inches and lock it in place. Hold the handle of the tuning lever in your RH and the socket in your LH and engage the socket over the pin. Orient the handle so that it is approximately perpendicular to the strings and pointing to your right. Lightly jiggle the handle around the pin with your RH and engage the socket with your LH so that the socket is securely engaged, as far down as it will go. From day one, **develop a habit of jiggling the socket so that it is securely engaged.** At this point, the handle is probably not perfectly perpendicular to the strings; just choose the socket position so that the handle is as close to perpendicular as the socket position will allow. Now find a way to brace your RH so that you can apply firm pressure on the lever. For example, you can grab the tip of the handle with the thumb and one or two fingers, and brace the arm on the wooden piano frame or brace your pinky against the tuning pins directly under the handle. If the handle is closer to the plate (the metal frame) over the strings, you might brace your hand against the plate. You should not grab the handle like you hold a tennis racket and push-pull to turn the pin — this will not give enough control. You may be able to do that after years of practice, but in the beginning, grabbing the handle and pushing without bracing against something is too difficult to control accurately. So **develop a habit of finding good places to brace your hand against, depending on where the handle is.** Practice these positions making sure that you can exert controlled, constant, powerful pressure on the handle, but do not turn any pins yet.

The lever handle must point to the right so that when you turn it towards you (the string goes sharp), you counteract the force of the string and free the pin from the front side of the hole (towards the string). This allows the pin to turn more freely because of the reduction in friction. When you tune flat, both you and the string are trying to turn the pin in the same direction. Then the pin would turn too easily, except for the fact that both your push and the string's pull jam the pin against the front of the hole, increasing the pressure (friction) and preventing the pin from rotating too easily. If you had placed the handle to the left, you run into trouble for both the sharp and flat motions. For the sharp motion, both you and the string jam the pin against the front of the hole, making it doubly difficult to turn the pin, and damaging the hole. For the flat motion, the lever tends to lift the pin off from the front edge of the hole and reduces the friction. In addition, both the lever and string are turning the pin in the same direction. Now the pin now turns too easily. The lever handle must point to the left for uprights. Looking down on the tuning pin, the lever should point to 3 o'clock for grands and to 9 o'clock for uprights. In both cases, the lever is on the side of the last winding of the string.

Professional tuners do not use these lever positions. Most use 1–2 o'clock for grands and 10–11 o'clock for uprights and Reblitz recommends 6 o'clock for grands and 12 o'clock for uprights. In order to understand why, let's first consider positioning the lever at 12 o'clock on a grand (it is similar at 6 o'clock). Now the friction of the pin with the pinblock is the same for both the sharp and flat motions. However, in the sharp motion, you are going against the string tension and in the flat motion, the string is helping you. Therefore, the difference in force needed between sharp and flat motions is much larger than the difference when the lever is at 3 o'clock, which is a disadvantage. However, unlike the 3 o'clock position, the pin does not rock back and forth during tuning so that when you release the pressure on the tuning lever, the pin does not spring back — it is more stable — and you can get higher accuracy.

The 1–2 o'clock position is a good compromise that makes use of both of the advantages of the 3 o'clock and 12 o'clock positions. Beginners do not have the accuracy to take full advantage of the 1–2 o'clock position, so my suggestion is to start with the 3 o'clock position, which should be easier at first, and transition to the 1–2 o'clock position as your accuracy increases. When you become good, the higher accuracy of the 1–2 o'clock position can speed up your tuning so that you can tune each string in just a few seconds. At the 3 o'clock position, you will need to guess how much the pin will spring back and over-tune by that amount, which takes more time. Clearly, exactly where you place the lever will become more important as you improve.

Setting the Pin

It is important to "set the pin" correctly in order for the tuning to hold. If you look down on the pin, the string comes around the right side of the pin (grands — it is on the left for uprights) and twirls around it. Therefore if you rotate the pin cw (clockwise), you will tune sharp and vice versa. The string tension is always trying to rotate the pin ccw (counter clock-wise, or flat). Normally, a piano de-tunes flat as you play it. However, because the grip of the pinblock on the pin is so strong, the pin is never straight but is always twisted.

If you rotate it cw and stop, the top of the pin will be twisted cw with respect to the bottom. In this position, the top of the pin wants to rotate ccw (the pin wants to untwist) but can't because it is held by the pinblock. Remember that the string is also trying to rotate it ccw. The two forces together can be sufficient to quickly de-tune the piano flat when you play something loud.

If the pin is turned ccw, the opposite happens — the pin will want to untwist cw, which opposes the string force. This reduces the net torque on the pin, making the tuning more stable. In fact, you can twist the pin so far ccw that the untwisting force is much larger than the string force and the piano can then de-tune itself sharp as you play. Clearly, you must properly "set the pin" in order produce a stable tuning. This requirement will be taken into account in the following tuning instructions.

Tuning Unisons

Now engage the tuning lever on the pin for string 1. We will tune string 1 to string 2. **The motion you will practice is: (1) flat, (2) sharp, (3) flat, (4) sharp and (5) flat (tune).** Except for (1), each motion must be smaller than the previous one. As you improve, you will add or eliminate steps as you see fit. We are assuming that the two strings are almost in tune. As you tune, you must follow two rules: **(a) never turn the pin unless you are simultaneously listening to the sound, and (b) never release the pressure on the tuning lever handle until that motion is complete.**

For example, let's start with motion (1) flat: keep playing the note every second or two with the LH, so that there is a continuous sound, while pushing the end of the lever handle away from you with the thumb and 2nd finger. Play the note in such a way as to maintain a continuous sound. Don't lift the key for any length of time, as this will stop the sound. Keep the key down and play with a quick up-and-down motion so that there is no break in the sound. The pinky and the rest of your RH should be braced against the piano. The required motion of the lever is just a few millimeters. First, you will feel an increasing resistance, and then the pin will start to rotate. Before the pin begins to rotate, you should hear a change in the sound. As you turn the pin, listen for string 1 going flat, creating a beat with the center string; the beat frequency increasing as you turn. Stop at a beat frequency of 2 to 3 per second. The tip of the tuning lever should move less than one cm. Remember, never rotate the pin when there is no sound because you will immediately lose track of where you are with respect to how the beats are changing. Always maintain constant pressure on the lever until that motion is completed for the same reason.

What is the rationale behind the above 5 motions? Assuming that the two strings are in reasonable tune, you first tune string 1 flat in step (1) to make sure that in step (2) you will pass the tuning point. This also protects against the possibility that you had placed the lever on the wrong tuning pin; as long as you are turning flat, you will never break a string.

After (1) you are flat for sure, so in step (2) you can listen to the tuning point as you pass through it. Go past it until you hear a beat frequency of about 2 to 3 per second on the sharp side, and stop. Now you know where the tuning point is, and what it sounds like. The reason for going so far past the tuning point is that you want to set the pin, as explained above.

Now go back flat again, step (3), but this time, stop just past the tuning point, as soon as you can hear any incipient beats. The reason why you don't want to go too far past the tuning point is that you don't want to undo the "setting of the pin" in step (2). Again, note exactly what the tuning point sounds like. It should sound perfectly clean and pure. This step assures that you did not set the pin too far.

Now conduct the final tuning by going sharp (step 4), by as little as you can beyond perfect tune, and then bringing it into tune by turning flat (step 5). Note that your final motion must always be flat in order to set the pin. Once you become good, you might be able to do the whole thing in two motions (sharp, flat), or three (flat, sharp, flat).

Ideally, from step (1) to final tune, you should maintain the sound with no stoppage, and you should always be exerting pressure on the handle; never letting go of the lever. Initially, you will probably have to do this motion by motion. When you become proficient, the whole operation will take just a few seconds. But at first, it will take *a lot* longer. Until you develop your "tuning muscles" you will tire quickly and may have to stop from time to time to recover. Not only the hand/arm muscles, but the mental and ear concentration required to focus on the beats can be quite a strain and can quickly cause fatigue. You will need to develop "tuning stamina" gradually. Most people do better by listening through one ear than through both, so turn your head to see which ear is better.

The most common mistake beginners make at this stage is to try to listen for beats by pausing the tuning motion. Beats are difficult to hear when nothing is changing. If the pin is not being turned, it is difficult to decide which of the many things you are hearing is the beat that you need to concentrate on. **What tuners do is to keep moving the lever and then listening to *the changes in the beats.*** When the beats are changing, it is easier to identify the particular beat that you are using for tuning that string. Therefore, slowing down the tuning motion doesn't make it easier. Thus the beginner is between a rock and a hard place. Turning the pin too quickly will result in all hell breaking loose and losing track of where you are. On the other hand, turning too slowly will make it difficult to identify the beats. Therefore work on determining the range of motion you need to get the beats and the right speed with which you can steadily turn the pin to make the beats come and go. In case you get hopelessly lost, mute strings 2 and 3 by placing a wedge between them, play the note and see if you can find another note on the piano that comes close. If that note is lower than G3, then you need to tune it sharp to bring it back, and vice versa.

Now that you have tuned string 1 to string 2, reposition the wedge so that you mute 1, leaving 2 and 3 free to vibrate. Tune 3 to 2. When you are satisfied, remove the wedge and see if the G is now free of beats. You have tuned one note! If the G was in reasonable tune before you started, you haven't accomplished much, so find a note nearby that is out of tune and see if you can "clean it up". Notice that in this scheme, you are always tuning one single string to another single string. In principle, if you are really good, strings 1 and 2 are in perfect tune after you finish tuning 1, so you don't need the wedge any more. You should be able to tune 3 to 1 and 2 vibrating together. In practice this doesn't work until you become really proficient. This is because of a phenomenon called sympathetic vibration.

Sympathetic Vibration

The accuracy required to bring two strings into perfect tune is so high that it is a nearly impossible job. It turns out that, in practice, this is made easier because **when the frequencies approach within a certain interval called the "sympathetic vibration range", the two strings change their frequencies towards each other so that they vibrate with the same frequency.** This happens because the two strings are not independent, but are coupled to each other at the bridge. When coupled, the string vibrating at the higher frequency will drive the slower string to vibrate at a slightly higher frequency, and vice versa. The net effect is to drive both frequencies towards the average frequency of the two. Thus when you tune 1 and 2 unison, you have no idea whether they are in perfect tune or merely within the sympathetic vibration range (unless you are an experienced tuner). In the beginning, you will most likely not be in perfect tune.

Now if you were to try to tune a third string to the two strings in sympathetic vibration, the third string will bring the string closest to it in frequency into sympathetic vibration. But the other string may be too far off in frequency. It will break off the sympathetic vibration, and will sound dissonant. The result is that no matter where you are, you will always hear beats — the tuning point disappears! It might appear that if the third string were tuned to the average frequency of the two strings in sympathetic vibration, all three should go into sympathetic vibration. This does not appear to be the case unless all three frequencies are in perfect tune. If the first two strings are sufficiently off, a complex transfer of energy takes place among the three strings. Even when the first two are close, there will be higher harmonics that will prevent all beats from disappearing when a third string is introduced. In addition, there are frequent cases in which you cannot totally eliminate all beats because the two strings are not identical. Therefore, a beginner will become totally lost, if he were to try to tune a third string to a pair of strings. **Until you become proficient at detecting the sympathetic vibration range, always tune one string to one; never one to two.** In addition, just because you tuned 1 to 2 and 3 to 2, it does not mean that the three strings will sound "clean" together. Always check; if it is not completely "clean", you will need to find the offending string and try again.

Note the use of the term "clean". With enough practice, you will soon get away from listening to beats, but instead, you will be looking for a pure sound that results somewhere within the sympathetic vibration range. This point will depend on what types of harmonics each string produces. In principle, when tuning unisons, you are trying to match the fundamentals. In practice, a slight error in the fundamentals is inaudible compared to the same error in a high harmonic. Unfortunately, these high harmonics are generally not exact harmonics but vary from string to string. Thus, when the fundamentals are matched, these high harmonics create high frequency beats that make the note "muddy" or "tinny". When the fundamentals are de-tuned ever so slightly so that the harmonics do not beat, the note "cleans up". **Reality is even more complicated because some strings, especially for the lower quality pianos, will have extraneous resonances of their own, making it impossible to completely eliminate certain beats.** These beats become very troublesome if you need to use this note to tune another one.

Making that Final Infinitesimal Motion

We now advance to the next level of difficulty. Find a note near G5 that is slightly out of tune, and repeat the above procedure for G3. The tuning motions are now much smaller for these higher notes, making them more difficult. In fact you may not be able to achieve sufficient accuracy by rotating the pin. We need to learn a new skill. **This skill requires you to pound on the notes, so put on your ear muffs or ear plugs.**

Typically, you would get through motion (4) successfully, but for motion (5) the pin would either not move or jump past the tuning point. **In order to make the string advance in smaller increments, press on the lever at a pressure slightly below the point at which the pin will jump. Now strike hard on the note while maintaining the same pressure on the lever.** The added string tension from the hard hammer blow will advance the string by a small amount. Repeat this until it is in perfect tune. It is important to never release the pressure on the lever and to keep the pressure constant during these repeated small advances, or you will quickly lose track of where you are. When it is in perfect tune, and you release the lever, the pin might spring back, leaving the string slightly flat. You will have to learn from experience, how much it will spring back and compensate for it during the tuning process.

The need to pound on the string to advance it is one reason you often hear tuners pounding on the piano. It is a good idea to get into the habit of pounding on most of the notes because this stabilizes the tuning. The resulting sound can be so loud as to damage the ear, and one of the occupational hazards of tuners is ear damage from pounding. Use of ear plugs is the solution. When pounding, you will still easily hear the beats even with ear plugs. The most common initial symptom of ear damage is tinnitus (ringing in the ear). You can minimize the pounding force by increasing the pressure on the lever. Also, less pounding is required if the lever is parallel to the string instead of perpendicular to it, and even less if you point it to the left. This is another reason why many tuners use their levers more parallel to the strings than perpendicular. Note that there are two ways to point it parallel: towards the strings (12 o'clock) and away from the strings (6 o'clock). As you gain experience, experiment with different lever positions as this will give you many options for solving various problems. For example, with the most popular 5-degree head on your lever, you may not be able to point the lever handle to the right for the highest octave because it may hit the wooden piano frame.

Equalizing String Tension

Pounding is also helpful for distributing the string tension more evenly among all the non-speaking sections of the string, such as the duplex scale section, but

especially in the section between the capo bar and the agraffe. There is controversy as to whether equalizing the tension will improve the sound. There is little question that the even tension will make the tuning more stable. However, whether it makes a *material* difference in stability may be debatable, especially if the pins were correctly set during tuning. In many pianos, the duplex sections are almost completely muted out using felts because they might cause undesirable oscillations. In fact, the overstrung section is muted out in almost every piano. Beginners need not worry about the tension in these "non-speaking" sections of the strings. Thus heavy pounding, though a useful skill to learn, is not necessary for a beginner.

My personal opinion is that the sound from the duplex scale strings does not add to the piano sound. In fact, this sound is inaudible and is muted out when they become audible in the bass. Thus the "art of tuning the duplex scale" is a myth although most piano tuners (including Reblitz!) have been taught to believe it by the manufacturers, because it makes for a good sales pitch. The only reason why you want to tune the duplex scale is that the bridge wants to be at a node of both the speaking and non-speaking lengths; otherwise, tuning becomes difficult, sustain may be shortened, and you lose uniformity. Using mechanical engineering terminology, we can say that tuning the duplex scale optimizes the vibrational impedance of the bridge. In other words, the myth does not detract from the tuners' ability to do their job. Nonetheless, a proper understanding is certainly preferable. The duplex scale is needed to allow the bridge to move more freely, not for producing sound. Obviously, the duplex scale will improve the quality of the sound (from the speaking lengths) because it optimizes the impedance of the bridge, but not because it produces any sound. The facts that the duplex scale is muted out in the bass and is totally inaudible in the treble prove that the sound from the duplex scale is not needed. Even in the inaudible treble, the duplex scale is "tuned" in the sense that the aliquot bar is placed at a location such that the length of the duplex part of the string is a harmonic length of the speaking section of the string in order to optimize the impedance ("aliquot" means fractional or harmonic). If the sound from the duplex scale were audible, the duplex scale would have to be tuned as carefully as the speaking length. However, for impedance matching, the tuning need only be approximate, which is what is done in practice. Some manufacturers have stretched this duplex scale myth to ridiculous lengths by claiming a second duplex scale on the pin side. Since the hammer can only transmit tensile strain to this length of string (because of the rigid Capo bar), this part of the string cannot vibrate to produce sound. Consequently, practically no manufacturer specifies that the non-speaking lengths on the pin side be tuned.

Rocking It in the Treble

The most difficult notes to tune are the highest ones. Here you need incredible accuracy in moving the strings and the beats are difficult to hear. Beginners can easily lose their bearing and have a hard time finding their way back. One advantage of the need for such small motions is that now, you can use the pin-rocking motion to tune. Since the motion is so small, rocking the pin does not damage the pinblock. **To rock the pin, place the lever parallel to the strings and pointing towards the strings (away from you). To tune sharp, pull up on the lever, and to tune flat, press down.** First, make sure that the tuning point is close to the center of the rocking motion. If it is not, rotate the pin so that it is. Since this rotation is much larger than that needed for the final tuning, it is not difficult, but remember to correctly set the pin. It is better if the tuning point is front of center (towards the string), but bringing it too far forward would risk damaging the pinblock when you try to tune flat. Note that tuning sharp is not as damaging to the pinblock as tuning flat because the pin is already jammed up against the front of the hole.

Rumblings in the Bass

The lowest bass strings are second in difficulty (to the highest notes) to tune. These strings produce sound composed mostly of higher harmonics. Near the tuning point, the beats are so slow and soft that they are difficult to hear. Sometimes, you can "hear" them better by pressing your knee against the piano to feel for the vibrations than by trying to hear them with your ears, especially in the single string section. You can practice unison tuning only down to the last double string section. **See if you can recognize the high pitched, metallic, ringing beats that are prevalent in this region.** Try eliminating these and see if you need to de-tune slightly in order to eliminate them. If you can hear these high, ringing, beats, it means that you are well on your way. Don't worry if you can't even recognize them at first– beginners are not expected to.

Harmonic Tuning

Once you are satisfied with your ability to tune unisons, start practicing tuning octaves. Take any octave near middle C and mute out the upper two side strings of each note by inserting a wedge between them. Tune the upper note to the one an octave below, and vice versa. As with unisons, start near middle C, then work up to the highest treble, and then practice in the bass. Repeat the same practice with 5ths, 4ths, and major 3rds.

After you can tune perfect harmonics, try de-tuning to see if you can hear the increasing beat frequency as you deviate very slightly from perfect tune. Try to identify various beat frequencies, especially 1 bps (beat per second) and 10 bps, using 5ths. These skills will come in handy later.

What is Stretch?

Harmonic tuning is always associated with a phenomenon called stretch. Harmonics in piano strings are never exact because real strings attached to real ends do not behave like ideal mathematical strings. This property of inexact harmonics is called inharmonicity. The difference between the actual and theoretical harmonic frequencies is called stretch. Experimentally, it is found that most harmonics are sharp compared to their ideal theoretical values, although there can be a few that are flat.

According to one research result (Young, 1952), stretch is caused by inharmonicity due to the stiffness of strings. Ideal mathematical strings have zero stiffness. Stiffness is what is called an extrinsic property — it depends on the dimensions of the wire. If this explanation is correct, then stretch must also be extrinsic. Given the same type of steel, the wire is stiffer if it is fatter or shorter. One consequence of this dependence on stiffness is an increase in the frequency with harmonic mode number; i.e., the wire appears stiffer to harmonics with shorter wavelengths. Stiffer wires vibrate faster because they have an extra restoring force, in addition to the string tension. This inharmonicity has been calculated to within several percent accuracy so that the theory appears to be sound, and this single mechanism appears to account for most of the observed stretch.

These calculations show that stretch is about 1.2 cents for the second mode of vibration at C4 and doubles about every 8 semitones at higher frequency (C4 = middle C, the first mode is the lowest, or fundamental frequency, one cent is one hundredth of a semitone, and there are 12 semitones in an octave). The stretch becomes smaller for lower notes, especially below C3, because the wire wound strings are quite flexible. Stretch increases rapidly with mode number and decreases even more rapidly with string length. In principle, stretch is smaller for larger pianos and larger for lower tension pianos if the same diameter strings are used. Stretch presents problems in scale design since abrupt changes in string type, diameter, length, etc., will produce a discontinuous change in stretch. Very high mode harmonics, if they happen to be unusually loud, present problems in tuning because of their large stretch — tuning out their beats could throw the lower, more important, harmonics audibly out of tune.

Since larger pianos tend to have smaller stretch, but also tend to sound better, one might conclude that smaller stretch is better. However, the difference in stretch is generally small, and the tone quality of a piano is largely controlled by properties other than stretch.

In harmonic tuning you tune, for example, the fundamental or a harmonic of the upper note to a higher harmonic of the lower note. The resulting new note is not an exact multiple of the lower note, but is sharp by the amount of stretch. What is so interesting about stretch is that a scale with stretch produces "livelier" music than one without! This has caused some tuners to tune in double octaves instead of single octaves, which increases the stretch.

The amount of stretch is unique to each piano and, in fact, is unique to each note of each piano. Modern electronic tuning aids are sufficiently powerful to record the stretch for all the desired notes of individual pianos. Tuners with electronic tuning aids can also calculate an average stretch for each piano or stretch function and tune the piano accordingly. In fact, there are anecdotal accounts of pianists requesting stretch in excess of the natural stretch of the piano. In aural tuning, stretch is naturally, and accurately, taken into account. Therefore, although stretch is an important aspect of tuning, the tuner does not have to do anything special to include stretch, if all you want is the natural stretch of the piano.

Precision, Precision, Precision

The name of the game in tuning is precision. All tuning procedures are arranged in such a way that you tune the first note to the tuning fork, the second to the first, etc., in sequence. Therefore, any errors will quickly add up. In fact, an error at one point will often make some succeeding steps impossible. This happens because you are listening for the smallest hint of beats and if the beats were not totally eliminated in one note, you can't use it to tune another as those beats will be clearly heard. In fact, for beginners, this will happen frequently before you learn how precise you need to be. When this happens, you will hear beats that you can't eliminate. In that case, go back to your reference note and see if you hear the same beat; if you do, there is the source of your problem — fix it.

The best way to assure precision is by checking the tuning. Errors occur because every string is different and you are never sure that the beat you hear is the one you are looking for, especially for the beginner. Another factor is that you need to count beats per second (bps), and your idea of, say 2 bps, will be different on different days or at different times of the same day until you have those "beat speeds" well memorized. Because of the critical importance of precision, it pays to check each tuned note. This is especially true when "setting the bearings" which is explained below. Unfortunately, it is just as difficult to check as it is to tune correctly; that is, a person who cannot tune sufficiently accurately is usually unable to perform a meaningful check. In addition, if the tuning is sufficiently off, the checking doesn't work. Therefore, **I have provided methods of tuning below that use a minimum of checks.** The resulting tuning will not be very good initially, for equal temperament. The Kirnberger temperament (see below) is easier to tune accurately. On the other hand, beginners can't produce good tunings anyway, no matter what methods they use. At least, the procedures presented below will provide a tuning which should not be a disaster and which will improve as your skills improve. **In fact, the procedure described here is probably the fastest way to learn.** After you have improved sufficiently, you can then investigate the checking procedures, such as those given in Reblitz, or "Tuning" by Jorgensen.

2.6 Tuning Procedures and Temperament

Tuning consists of "setting the bearings" in an octave somewhere near middle C, and then appropriately "copying" this octave to all the other keys. You will need various harmonic tunings to set the bearings and only the middle string of each note in the "bearings octave" is initially tuned. The "copying" is performed by tuning in octaves. Once one string of each note is tuned in this way, the remaining string(s) of each note are tuned in unison.

In setting the bearings, we must choose which temperament to use. As explained in section 2.2 above, most pianos today are tuned to equal temperament (ET), but the historical temperaments (HsT) may be showing signs of gaining popularity, especially the Well temperaments (WT). Therefore, I have chosen ET and one WT, Kirnberger II (K-II), for this chapter. K-II is one of the easiest temperaments to tune; therefore, we will visit that first. Most people who are unfamiliar with the different temperaments may not notice any difference at first between ET and K-II; they will both sound terrific compared to a piano out of tune. Most pianists, on the other hand, should hear a distinct difference and be able to form an opinion or preference if certain pieces of music are played and the differences are pointed out to them. The easiest way to listen to the differences for the uninitiated is to use a modern electronic piano that has all these temperaments built into it, and to play the same piece, using each temperament. For an easy test piece, try Beethoven's Moonlight Sonata, 1st movement; for a more difficult piece, try the 3rd movement of his Waldstein Sonata. Also, try some of your favorite Chopin pieces. My suggestion is for a beginner to learn K-II first so that you can get started without too much difficulty, and then learn ET when you can tackle more difficult stuff. One drawback of this scheme is that you may like K-II so much over ET that you may never decide to learn ET. Once you get used to K-II, ET will sound a little lacking, or "muddy". However, you cannot really be considered a tuner unless you can tune ET. Also, there are many WT's that you may want to look into, that are superior to K-II in several respects.

WT tunings are desirable because they have perfect harmonies that are at the heart of music. However, they have one big disadvantage. Because the perfect harmonies are so beautiful, the dissonances in the "wolf" scales stand out and are very unpleasant. Not only that, but any string that is even slightly out of tune becomes immediately noticeable. Thus WT tunings will require much more frequent tunings than ET. You might think that a slight detuning of the unison strings in ET would be just as objectionable but, apparently, when the chords are as out of tune as they are in ET, the small unison detunings become less noticeable in ET. Therefore, for pianists who have sensitive ears to tuning, WT may be quite objectionable unless they can tune their own pianos. This is an important point because most pianists who can hear the advantages of WT are sensitive to tuning. The invention of the self-tuning piano may save the day for WT, because the piano will always be in tune. Thus WT may find wide acceptance only with electronic pianos and self-tuning pianos (when they become available — see section 1.4.5, "The Future of Piano").

You can start tuning ET anywhere, but most tuners use the A440 fork to start, because orchestras generally tune to A440. The objective in K-II is to have C major and as many "nearby" scales as possible to be just (have perfect chords), so the tuning is started from middle C (C4 = 261.6, but most tuners will use a C523.3 tuning fork to tune middle C). Now, the A that results from K-II tuned from the correct C does not result in A440. Therefore, you will need two tuning forks (A and C) to be able to tune both ET and K-II. Alternatively, you can just start with only a C fork and start tuning ET from C. Having two tuning forks is an advantage because whether you start from C or from A, you can now check yourself when you get to the other one for ET.

2.6.1 Tuning the Piano to the Tuning Fork

One of the most difficult steps in the tuning process is tuning the piano to the tuning fork. This difficulty arises from two causes. (1) the tuning fork has a different (usually shorter) sustain than the piano so that the fork dies off before you can make an accurate comparison. (2) the fork puts out a pure sine wave without the loud harmonics of the piano strings. Therefore, you cannot use beats with higher harmonics to increase the accuracy of the tuning as you can with two piano strings. One advantage of electronic tuners is that they can be programmed to provide square wave reference tones that contain large numbers of high harmonics. These high harmonics (they are needed to create those sharp corners of square waves) are useful for increasing the tuning accuracy. We must therefore solve these two problems in order to tune the piano accurately to the tuning fork.

Both difficulties can be solved if we can use the piano as the tuning fork and make this transfer from fork to piano using some high piano harmonic. To accomplish such a transfer, find any note within the muted notes that makes loud beats with the fork. If you can't find any, use the note a half tone down or up; for example, for tuning fork A, use A♭ or A♯ on the piano. If these beat frequencies are a bit too high, try these same notes an octave lower. Now tune the A on the piano so it makes the same frequency beats with these reference notes (A♭, A♯, or any other note you had picked). The best way to hear the tuning fork is to press it against your ear lobe, as described above, or to press it against any large, hard, flat surface.

2.6.2 Kirnberger II

Mute all side strings from F3 to F4. Tune C4 (middle C) to the fork. The use

C4 to tune G3 (4th), E4 (3rd), F3 (5th), and F4 (4th), and

G3 to tune D4 (5th) and B3 (3rd). Then use

B3 to tune F♯3 (4th),

F♯3 to tune D♭4 (5th),

F3 to tune B♭3 (4th), B♭3 to tune E♭4 (4th) and

E♭4 to tune A♭3 (5th). All tunings up to here are just. Now tune A3 such that the F3–A3 and A3–D4 beat frequencies are the same.

You are done with setting the bearings!

Now tune up in just octaves to the highest notes, then tune down to the lowest notes, starting with the bearings octave as reference. In all these tunings, tune just one new octave string while muting the others, then tune the remaining one or two strings in unison to the newly tuned string.

This is one time you should break the "tune one string against one" rule. For example, if your reference note is a (tuned) 3-string note, use it as it is, without muting anything. This will serve as a test of the quality of your tuning. If you have a hard time using it to tune a new single string, then your unison tuning of the reference note may not have been sufficiently accurate and you should go back and clean it up. Of course, if after considerable effort, you cannot tune 3 against 1, you will have no choice but to mute two of the three in order to advance. However, you are now grossly compromising the tuning quality. When all the treble and bass notes are done, the only un-tuned strings left are the ones you muted for setting the bearings. Tune these in unison to their center strings, starting with the lowest note, by pulling the felt off one loop at a time.

2.6.3 Equal Temperament

I present here the easiest, approximate, equal temperament scheme. More accurate algorithms can be found in the literature (Reblitz, Jorgensen). No self-respecting professional tuner would use this scheme; however, when you get good at it, you can produce a decent equal temperament. For the beginner, the more complete and precise schemes will not necessarily give better results. With the more complex methods, a beginner can quickly get confused without any idea of what he did wrong. With the method shown here, you can quickly develop the ability to find out what you did wrong.

Mute the side strings from G3 to C♯5. Tune A4 to the A440 fork. Tune A3 to A4. Then tune up in contracted 5ths from A3 until you cannot go up any more without leaving the muted range, then tune one octave down, and repeat this up-in-5ths and down-one-octave procedure until you get to A4. For example, you will start with a contracted A3–E4, then a contracted E4–B4. The next 5th will take you above the highest muted note, C♯5, so you tune one octave down, B4–B3. All octaves are, of course, just. The contracted 5ths should beat a little under 1 Hz at the bottom of the muted range and about 1.5 Hz near the top. The beat frequencies of the 5ths between these highest and lowest limits should increase smoothly with increasing pitch.

When going up in 5ths, you tune flat from just to create a contracted 5th. Therefore you can start from just and tune flat in order to increase the beat frequency to the desired value and set the pin correctly at the same time. If you had done everything perfectly, the last D4–A4 should be a contracted 5th with a beat frequency of 1 Hz without any tuning. Then, you are done. You have just done a "circle of 5ths".

The miracle of the circle of 5ths is that it tunes every note once, without skipping any within the A3–A4 octave!

If the final D4–A4 is not correct, you made some errors somewhere. In that case, reverse the procedure, starting from A4, going down in contracted 5ths and up in octaves, until you reach A3, where the final A3–E4 should be a contracted 5th with a beat frequency slightly under 1 Hz. For going down in 5ths, you create a contracted 5th by tuning sharp from just. However, this tuning action will not set the pin. Therefore, in order to set the pin correctly, you must first go too sharp, and then decrease the beat frequency to the desired value. Therefore, going down in 5ths is a more difficult operation than going up in 5ths.

An alternative method is to start with A and tune to C by going up in 5ths, and checking this C with a tuning fork. If your C is too sharp, your 5ths were not sufficiently contracted, and vice versa. Another variation is to tune up in 5ths from A3 a little over half way, and then tune down from A4 to the last note that you tuned coming up.

Once the bearings are set, continue as described in the Kirnberger section above.

2.7 Making Minor Repairs

Once you start tuning, you cannot help but get involved in small repairs and conducting some maintenance.

2.7.1 Hammer Voicing

A common problem seen with many pianos is compacted hammers. I raise this point because the condition of the hammer is much more important to the proper development of piano technique and for cultivating performance skills, than many people realize. Numerous places in this book refer to the importance of practicing musically in order to acquire technique. But you can't play musically if the hammer can't do its job, a critical point that is overlooked even by many tuners (often because they are afraid that the extra cost will drive customers away). For a grand piano, a sure sign of compacted hammers is that you find the need to close the lid at least partially in order to play soft passages. Another sure sign is that you tend to use the soft pedal to help you play softly. Compacted hammers either give you a loud sound or none at all. Each note tends to start with an annoying percussive bang that is too strong, and the sound is overly bright. It is these percussive bangs that are so damaging to the tuners' ear. A properly voiced piano enables control over the entire dynamic range and produces a more pleasing sound.

Let's first see how a compacted hammer can produce such extreme results. How do small, light hammers produce loud sounds by striking with relatively low force on strings under such high tension? If you were to try to push down on the string or try to pluck it, you will need quite a large force just to make a small sound. The answer lies in an incredible phenomenon that occurs when tightly stretched strings are struck at right angles to the string. **It turns out that the force produced by the hammer at the instant of impact is theoretically infinite!** This nearly infinite force is what enables the light hammer to overcome practically any achievable tension on the string and cause it to vibrate.

Here is the calculation for that force. Imagine that the hammer is at its highest point after striking the string (grand piano). The string at this point in time makes a triangle with its original horizontal position (this is just an idealized approximation, see below). The shortest leg of this triangle is the length between the agraffe and the impact point of the hammer. The second shortest leg is from the hammer to the bridge. The longest is the original horizontal configuration of the string, a straight line from bridge to agraffe. Now if we drop a vertical line from the hammer strike point down to the original string position, we get two right triangles back-to-back. These are two extremely skinny right triangles that have very small angles at the agraffe and at the bridge; we will call these small angles θs.

The only thing we know at this time is the force of the hammer, but this is not the force that moves the string, because the hammer must overcome the string tension before the string will yield. That is, the string cannot move up unless it can elongate. This can be understood by considering the two right triangles described above. The string had the length of the long legs of the right triangles before the hammer struck, but after the strike, the string is the hypotenuse, which is longer. That is, if the string were absolutely inelastic and the ends of the string were rigidly fixed, no amount of hammer force will cause the string to move.

It is a simple matter to show, using vector diagrams, that the *extra* tension force F (in addition to the original string tension) produced by the hammer strike is given by $f = F\sin(\theta)$, where f is the force of the hammer. It does not matter which right triangle we use for this calculation (the one on the bridge side or on the agraffe side). Therefore, the string tension $F = f/\sin(\theta)$. At the initial moment of the strike, $\theta = 0$, and therefore $F = \infty$! This happens because $\sin(0) = 0$. Of course, F can get to infinity only if the string cannot stretch and nothing else can move. What happens in reality is that as F increases towards infinity, something gives (the string stretches, the bridge moves, etc.) so that the hammer begins to move the string and θ increases from zero, making F finite.

This force multiplication explains why a small child can produce quite a loud sound on the piano in spite of the hundreds of pounds of tension on the strings. It also explains why an ordinary person can break a string just playing the piano, especially if the string is old and has lost its elasticity. The lack of elasticity causes the F to increase far more than if the string were more elastic, the string cannot stretch, and θ remains close to zero. This situation is greatly exacerbated if the hammer is also compacted so that there is a large, flat, hard groove that contacts the string. In that case, the hammer surface has no give and the instantaneous "f" in the above equation becomes very large. Since all this happens near $\theta = 0$ for a compacted hammer, the force multiplication factor is also increased. The result is a broken string.

The above calculation is a gross over-simplification and is correct only qualitatively. In reality, a hammer strike initially throws out a traveling wave towards the bridge, similarly to what happens when you grab one end of a rope and flick it. The way to calculate such waveforms is to solve certain differential equations that are well known. The computer has made the solution of such differential equations a simple matter and realistic calculations of these waveforms can now be made routinely. Therefore, although the above results are not accurate, they give a qualitative understanding of what is happening, and what the important mechanisms and controlling factors are.

For example, the above calculation shows that it is not the transverse vibration energy of the string, but the tensile force on the string, that is responsible for the piano sound. The energy imparted by the hammer is stored in the entire piano, not just the strings. This is quite analogous to the bow and arrow — when the string is pulled, all the energy is stored in the bow, not the string. And all of this energy is transferred via the tension in the string. In this example, the mechanical advantage and force multiplication calculated above (near $\theta = 0$) is easy to see. It is the same principle on which the harp is based.

The easiest way to understand why compacted hammers produce higher harmonics is to realize that the impact occurs in a shorter time. When things happen faster, the string generates higher frequency components in response to the faster event.

The above paragraphs make it clear that a compacted hammer will produce a large initial impact on the string whereas a properly voiced hammer will be much gentler on the string thus imparting more of its energy to the lower frequencies than the harmonics. Because the same amount of energy is dissipated in a shorter amount of time for the compacted hammer, the instantaneous sound level can be much higher than for a properly voiced hammer, especially at the higher frequencies. Such short sound spikes can damage the ear without causing any pain. Common symptoms of such damage are tinnitus (ringing in the ear) and hearing loss at high frequencies. Piano tuners, when they must tune a piano with such worn hammers, would be wise to wear ear plugs. It is clear that voicing the hammer is at least as important as tuning the piano, especially because we are talking about potential ear damage. An out-of-tune piano with good hammers does not damage the ear. Yet many piano owners will have their pianos tuned but neglect the voicing.

The two most important procedures in voicing are hammer re-shaping and needling.

When the flattened strike point on the hammer exceeds about 1 cm, it is time to re-shape the hammer. Note that you have to distinguish between the string groove length and flattened area; even in hammers with good voicing, the grooves may be over 5 mm long. In the final analysis you will have to judge on the basis of the sound. Shaping is accomplished by shaving the “shoulders” of the hammer so that it regains its previous rounded shape at the strike point. It is usually performed using 1 inch wide strips of sandpaper attached to strips of wood or metal with glue or double sided tape. You might start with 80 grit garnet paper and finish it off with 150 grit garnet paper. The sanding motion must be in the plane of the hammer; never sand across the plane. There is almost never a need to sand off the strike point. Therefore, leave about 2 mm of the center of the strike point untouched.

Needling is not easy because the proper needling location and needling depth depend on the particular hammer (manufacturer) and how it was originally voiced. Especially in the treble, hammers are often voiced at the factory using hardeners such as lacquer, etc. Needling mistakes are generally irreversible. Deep needling is usually required on the shoulders just off the strike point. Very careful and shallow needling of the strike point area may be needed. The tone of the piano is extremely sensitive to shallow needling at the strike point, so that you must know exactly what you are doing. When properly needled, the hammer should allow you to control very soft sounds as well as produce loud sounds without harshness. You get the feeling of complete tonal control. You can now open your grand piano fully and play very softly without the soft pedal! You can also produce those loud, rich, authoritative tones.

2.7.2 Polishing the Capstans

Polishing the capstans can be a rewarding maintenance procedure. They may need polishing if they have not been cleaned in over 10 years, sometimes sooner. Press down on the keys slowly to see if you can feel a friction in the action. A frictionless action will feel like sliding an oily finger along a smooth glassware. When friction is present, it feels like the motion of a clean finger on squeaky clean glass. In order to be able to get to the capstans, you will need to lift the action off from the keys by unscrewing the screws that hold the action down for the grand. For uprights you generally need to unscrew the knobs that hold the action in place; make sure that the pedal rods, etc., are disengaged.

When the action is removed, the keys can be lifted out after removing the key stop rail. First make sure that all the keys are numbered so that you can replace them in the correct order. This is a good time to remove all the keys and clean any previously inaccessible areas as well as the sides of the keys. You can use a mild cleaning agent such as a cloth dampened with Windex for cleaning the sides of the keys.

See if the top, spherical contact areas of the capstans are tarnished. If they do not have a shiny polish, they are tarnished. Use any good brass/bronze/copper polish (such as Noxon) to polish and buff up the contact areas. Reassemble, and the action should now be much smoother.

Chapter 3

Scientific Method, Theory of Learning and the Brain

3.1 Introduction

Updated: March 15, 2003

The first part of this chapter describes my idea of what a scientific method is and how I used it to write this book. This scientific approach is the main reason why this book differs from all other books on the subject of learning to play the piano.

The other sections cover topics on learning in general, and the equation for the learning rate is derived. This is the equation that was used for calculating the piano learning rates in section 1.4.5. I also discuss topics concerning the brain because obviously the brain is an integral part of the piano playing mechanism. However, except for the initial discussions on how the brain develops with age and how that development affects piano learning, the other topics on the brain have little direct relevance to piano. Clearly, we need much more research on the role that the brain plays when we learn to play the piano. I have also inserted a discussion on interpreting dreams, which sheds more light on how the brain operates. Finally, I describe my experiences with my subconscious brain which has served me well on numerous occasions.

3.2 The Scientific Approach

This book was written with the best scientific approach that I could muster, using what I learned during my 31-year career as a scientist. I was involved with not only fundamental research (I have been granted six patents) but also materials science (mathematics, physics, chemistry, biology, mechanical engineering, electronics, optics, acoustics, metals, semiconductors, insulators), industrial problem solving (failure mechanisms, reliability, manufacturing), and scientific reporting (I have published over 100 peer-reviewed articles in most of the major scientific journals). Even after obtaining my Doctorate in Physics from Cornell University, my employers had to spend over a million dollars to advance my education during my career. Looking back, all this scientific training was indispensable for writing this book. This need for understanding the scientific method suggests that most pianists would have a difficult time if they tried to duplicate my efforts. I further explain below that the results of scientific efforts are useful to everybody, not only to scientists. **Therefore, the fact that this book was written by a scientist means that everybody should be able to understand it more easily than if it was written by a non-scientist.** One objective of this section is to explain that message.

Learning: piano, algebra, sculpture, golf, physics, biology, quantum mechanics, carpentry, cosmology, medicine, politics, economics, etc., — what do these things have in common? They are all scientific disciplines and therefore share a large number of basic principles in common. In the following sections, **I will explain many of the important principles of the scientific method and show how they are needed in order to produce a useful product**, such as a piano learning manual. These requirements for a piano manual are no different from the requirements for writing an advanced textbook on quantum mechanics; the requirements are similar although the contents are worlds apart. I will begin with the definition of the scientific method, because it is so frequently misunderstood by the general public. Then I will describe the contributions of the scientific method to the writing of this book. In the process, I point out where piano teaching has historically been scientific or unscientific. In the last several hundred hears, we have had enormous successes in applying the scientific method to almost every important discipline; isn't it about time we did the same with piano learning/teaching?

This section was written mainly to outline the scientific method in the hopes of helping others to apply it to piano teaching. Another objective is to explain why it took a scientist like me to come up with such a book. Why couldn't musicians with no scientific training write better books on learning piano? After all, they are the foremost experts in the field! I will give some of the answers below.

I suspect that as you read the following, you will find concepts that are different from your idea of science. **Science is fundamentally not math, physics or equations. It is about human interactions that empower other humans** (see below). I have seen many "scientists" who do not understand what science is and therefore failed in their own vocation (got fired). Just as practicing 8 hours a day doesn't necessarily make you an accomplished pianist, passing all the physics and chemistry exams doesn't make you a scientist; you must accomplish something with that knowledge. I have been particularly impressed by many piano technicians who have a practical understanding of physics although they have no degree in science. These technicians need to be scientific because the piano is so deeply rooted in physics. Thus math, physics, etc., do not define science (a common misunderstanding); those fields were simply found to be useful to scientists because they empower in an absolutely predictable way. **What I hope to show you below is an insider's view of how science is conducted.**

Can someone totally untrained in science read the following and instantly start using the scientific approach? Most probably not. There is no easy recipe except to study science. You will see that the requirements and complexities of the scientific method will present insurmountable obstacles to most people. This is clearly one explanation why this book is so unique. But at least you will have some idea of what some of the useful suggestions are, if you want to follow the scientific approach.

Before we embark on defining science, let's examine a common example of how people misunderstand science because this will help to establish why we need a definition. You might hear a piano or dance teacher say that s/he described an emotion or feeling, or the flight of a bird or the motion of a cat, and her/is students instantly got the idea of how to play or dance, in a way that the teacher couldn't possibly accomplish by describing the motion of bones, muscles, arms, etc. The teacher then claims that the artist's approach is better than the scientific approach. What this teacher doesn't realize is that s/he probably used a very good scientific method. By drawing on an analogy or describing the end product of the music, you can often transfer a lot more information than by describing each component of the motion in detail. It is like going from narrow band to broadband transmission, and is a valid scientific approach; it has little to do with the distinction between science and art. This type of misunderstanding often arises because people think that science is black or white — that something is either scientific or not; most things in real life are more or less scientific, a matter of degree. What makes these teaching methods more scientific or not depends on how good they are in transmitting the necessary information. In this respect, many famous artists who are good teachers are masters of this type of science. Another frequent misunderstanding is that science is too difficult for artists. This really boggles the mind. The mental processes that artists go through in producing the highest levels of music or other arts are at least as complex as those of scientists contemplating the origin of the universe. There may be some validity to the argument that people are born with different talents in art or science; however, I do not subscribe to that view — for the vast majority of people, they can be artists or scientists depending on their exposure to each field, especially in early childhood. Thus most people who are good musicians have the capability to be great scientists. Finally, if you studied art all your life, you won't have much time to study science, so how can you combine the two? My understanding is that art and science are complementary; art helps scientists and vice versa. Artists who avoid science are only hurting themselves, and scientists who avoid art tend to be less successful scientists. The thing that most impressed me about my college days was the large number of my fellow science students who were musicians.

3.3 What is the Scientific Method?

One frequent misconception is that playing the piano is an art and therefore the scientific approach is not possible and not applicable. This misconception arises from misunderstanding what science is. It may surprise many people that science is, in fact, an art; science and art can't be separated, just as piano technique and musical playing cannot be separated. If you don't believe it, just go to any major university. It will always have one prominent department: the Department of Arts and Sciences. Both require imagination, originality, and the ability to execute. To say that a person does not know science and therefore can not use a scientific approach is equivalent to saying that if you know less, you should learn less. This does not make sense because it is precisely the person who knows less that needs to learn more. Obviously, we need to clearly define what science is.

Definition: The simplest definition of the scientific method is that it is any method that works. The scientific method is the one that is in closest harmony with reality or truth. Science is empowerment. Therefore, saying that "science is only for scientists" is like saying that jumbo jets are only for aeronautical engineers. It is true that planes can only be built by aeronautical engineers but that does not prevent any of us from using aircraft for our own travel — in fact the planes were built for us. Similarly, the purpose of science is to make life easier for everybody, not just scientists.

Although smart scientists are needed to advance science, anyone can benefit from science. Thus **another way of defining science is that it makes previously**

impossible tasks possible and simplifies difficult tasks. From this point of view, science benefits the less knowledgeable among us more than the better informed who can figure things out for themselves. Example: if an illiterate person were asked to add two 6-digit numbers, he would have no way of doing it by himself. However, any 3rd grader who has learned her/is arithmetic can perform that task, given a pen and paper. Today, you can teach that illiterate person to add those numbers on a calculator in minutes. Demonstrably, science has made a previously impossible task easy for everyone.

The definitions of the scientific method given above do not provide any direct information on how to execute a scientific project. **One practical definition of the scientific approach is that it is a set of uniquely defined objects and the relationships among them.**One of the most useful relationships is a classification scheme, which places the objects into classes and subclasses. Note that the word "defining" takes on a very special meaning. Objects must be defined in such a way that they are useful, and in such a way that the relationships between them can be described precisely. And all of these definitions and relationships must be scientifically correct (thats where non-scientists run into problems).

Let's look at some examples. Musicians have defined such basic objects as scales, chords, harmonies, ornamentals, etc. In this book important concepts such as hands separate practice, chord attacks, parallel sets, segmental practice, post practice improvement, etc., have been precisely defined. In order to make this scientific method of writing this book work (i.e., come up with a useful learning manual), it is necessary to know all the useful relationships among these objects. In particular, it is important to be able to anticipate what the reader *needs*. The chord attack was defined in response to a need to solve a speed problem. You can see here, why physics isn't as important as human empowerment. I have read several books that discuss staccato without ever defining it. Thus the science comes in at the most basic levels of definitions, explanations, and applications. The writer must be intimately familiar with the subject matter being discussed so as not to make any erroneous statements. That is the heart of science, not math or physics.

One of the problems with Whiteside's book is the lack of precise definitions. She uses many words and concepts, such as rhythm and outlining, without defining them. That makes it difficult for the reader to understand what she is saying or to make use of her instructions. Of course defining those complex concepts that we encounter frequently in music might appear impossible at first, especially if you want to include all the complexities and nuances surrounding a difficult concept. However, it is standard scientific procedure to use qualifiers to limit the definition when using specific examples and other qualifiers to expand the definition to other possibilities. It is just a matter of understanding the subject matter as well as the needs of the reader. Finks and Sandors books provide examples of excellent definitions. What they lack are the relationships: a systematic, organized approach on how to use these definitions to acquire technique in a step-by-step fashion. They also missed some of the important definitions given in this book.

The main ingredient of the scientific method is knowledge but knowledge alone is not enough. That knowledge must be assembled into a structure such that we can see, understand, and exploit the relationships between the objects. Without these relationships, you don't know if you have all the necessary parts or even how to use them. For example, parallel sets are fairly useless unless you know HS practice. The most common way of building that superstructure is a classification scheme. In this book, the various procedures are classified into beginning methods, intermediate stages of learning, memory methods, methods for increasing speed, bad habits, etc. Once you have the definitions and classification scheme, you must then fill in the details of how everything fits together, and if there are any missing elements. We now discuss some specific components of the scientific method.

Research A manual on piano playing is essentially a list of discoveries someone made on how to solve some technical problems. It is a product of research. In scientific research, you perform experiments, get the data, and write up the results in such a way that others can understand what you did and can reproduce your results. Teaching piano is no different. You must first research various practice methods, collect the results, and write them up so others can benefit from them. Sounds trivially simple. But if you look around, that is *not* what has been happening in piano teaching. Liszt never wrote down his practice methods. The "intuitive method" (as described in this book) requires no research; it is the least informed method of practice. This is why Whiteside's book was so successful — she conducted research and recorded her results. Unfortunately, she had no scientific training and botched up in important aspects such as clear, concise writing (especially definitions), and organization (classification and relationships). Clearly, if we can correct these deficiencies, then we have some hope of applying scientific methods to teaching piano. Obviously, a tremendous amount of research has been conducted by all the great pianists. Unfortunately, very little of that has been documented, falling victim to the non-scientific approach of piano pedagogy.

Documentation and Communication The foremost objective of documentation is the recording of all knowledge in the field — it is an incalculable loss that Bach, Chopin, Liszt, etc., did not write down their practice methods. Another function of scientific documentation is the elimination of errors. Clearly, a correct idea, enunciated by even a great master, passed down orally from teachers to students, is error prone and totally unscientific. Once an idea is written down, we can check for its accuracy and remove any errors and add new findings. That is, documentation creates a one-way street in which the idea can only improve in accuracy with time.

One finding that surprised even scientists is that about half of all new discoveries are made, not when performing the research, but when the results were being written up. For this reason, scientific writing has evolved into a field with specific requirements that are designed, not only to minimize errors, but also to maximize the discovery process. It was during the writing of this book, that I discovered the explanation for speed walls. I was faced with writing something about speed walls and naturally started asking what they are and what creates them. It is well known that once you ask the right questions, you are well on your way to finding an answer. Similarly, the concept of parallel sets was developed more during the writing than during my research (reading books, talking to teachers and using the internet) and personal experimentation at the piano. The concept of parallel sets was needed every time a certain practice procedure ran into trouble. Therefore it became necessary to define this concept precisely in order to use it repeatedly in so many places.

It is important to communicate with all other scientists doing similar work and to openly discuss any new research results. In this respect, the piano world has been woefully non-scientific. Most books on piano playing don't even have references (including my 1st edition book because it had to be written within a limited amount of time — this deficiency has been corrected in this 2nd edition), and they rarely build upon previous works of others. Teachers at the major music institutions do a better job of communicating, compared to private teachers, because they are confined to one institution and can't help running into each other. As a consequence, piano pedagogy at such institutions is superior to that of most private teachers. Too many piano teachers are inflexible about adopting or researching improved teaching methods and are often critical of anything that deviates from *their* methods. This is a very unscientific situation.

Examples of open communications in my book are the interweaving of the concepts from: arm weight methods and relaxation (Taubman type approach), ideas from Whiteside's books (criticisms of Hanon type exercises and the thumb under method) inclusion of the various hand motions described by Sandor, etc. Since the internet is the ultimate form of open communications, the advent of the internet may be the single most important event that will finally enable piano pedagogy to be conducted more scientifically. For that, there is no better example than this book.

A lack of communication is obviously the main reason why so many piano teachers still teach the intuitive method, although most of the methods described in this book were taught by one teacher or another during the last two hundred years. If the scientific approach of total open communication and proper documentation had been adopted by the piano teaching community earlier, the present situation would surely be very different, and large numbers of piano students would be learning at rates that would be considered unbelievable by today's standards.

In writing my first edition book, the importance of properly documenting and organizing the ideas was demonstrated to me by the fact that, although I knew most of the ideas in my book for about 10 years, I did not fully benefit from them until I finished that book. In other words, what happened to me was that, after finishing the book, I then re-read it and tried it out systematically. That's when I discovered how effective the method was! Apparently, although I knew most of the ingredients of the method, there were some gaps that weren't filled until I was faced with putting all the ideas in some useful, organized structure. It is as if I had all the components of a car, but they were useless for transportation until a mechanic assembled them and tuned up the car.

For example, I did not fully understand why the new method was so fast (1000 times faster than the intuitive method) until I made the learning rate calculations (see section 1.4.5). I initially made these calculations out of curiosity because I was hoping to write a chapter on the theory of learning. In fact, it took almost a year to convince myself that the calculation had some validity — a learning rate 1000 times faster seemed at first to be a laughably preposterous result, until I realized that students using the intuitive method often do not progress beyond intermediate level during their entire lifetime while others can become concert pianists in less than ten years. Most people tended to explain such differences in learning rate by ascribing them to talent, which did not agree with my observations. A byproduct of that calculation was a better understanding of *why* it was faster because you cannot write an equation without knowing what physical processes are involved. Once the mathematical formulas told me which parts accelerated the learning rate the most, I could design more effective practice methods.

A primary example of a new discovery that resulted from writing this book is the concept of parallel sets. Without this concept, I found it impossible to put all the ideas together in a coherent way. Once the parallel set concept was introduced, it led naturally to the parallel set exercises. None of this would have happened if I had not written the book, although I was using parallel set exercises all along without conscious knowledge of it. This is because a chord attack is a primitive form of a parallel set exercise; even Whiteside describes methods for practicing the trill that are basically parallel set exercises.

Self-consistency checks Many scientific discoveries are made as a result of self-consistency checks. These checks work as follows. Suppose that you know 10 facts about your experiment, and you discover an 11th fact. You now have the possibility of checking this new result against all the old results and often, that check will result in yet another discovery. In effect, a single discovery can potentially yield 10 more results without any more experimentation. For example, the new methods of this book yielded much faster learning, which then suggested that the intuitive method must contain practice procedures that actually hampered learning. With this knowledge, it became a simple matter to find aspects of the intuitive method that were slowing progress. This revelation of the weaknesses of the intuitive method would have been almost impossible if you knew only the intuitive method. This is a self-consistency check because if both methods were correct, they should be equally effective. Such a mental process of automatically checking self-consistency of everything that you encounter may not come naturally to a lot of people. However, as a scientist, I had been consciously doing that throughout my career out of sheer necessity.

Self consistency checks are the most economical and quickest ways to find mistakes and to make new discoveries because you get new results without performing more experiments. It costs little extra except for your time. You can now see why the process of documentation can be so productive. Every time a new concept is introduced, it can be checked against all other known concepts of piano practice to potentially yield new results. The method is powerful because of the large number of facts that are already known. Let's assume that you can count these known truths and they turn out to be, say, 1000. Then one new discovery means that you can now cross check 1000 more possibilities for new discoveries!

Self consistency checks are most important for eliminating mistakes and have been used to minimize mistakes in this book. For example, slow practice is both beneficial and harmful. This inconsistency must somehow be eliminated; it is done by carefully defining those conditions that require slow practice (memory, HT practice) and the conditions under which slow practice is detrimental (intuitive method without HS practice). Clearly, any blanket statement that says "slow practice is good because playing fast all the time leads to problems" is not self consistent with all the known facts. Whenever a writer makes an incorrect statement, a self-consistency check is often the easiest way to find that error.

Basic theory Scientific results must always be based on some theory or principle that can be verified by others. Very few concepts stand alone, independently of anything else. In other words, anything that someone claims works, better have a good explanation of why it works; otherwise, it is suspect. Explanations like "it worked for me," or "I've taught this for 30 years" or even "this is how Liszt did it" just isn't good enough. If a teacher had been teaching the procedure for 30 years, s/he should have had plenty of time to figure out why it works. The *explanations* are often more important than the procedures they explain. For example HS practice works because it simplifies a difficult task. Once this principle of simplification is established, you can start looking for more things like that, such as shortening difficult passages or outlining. An example of a basic explanation is the correlation between gravity and the arm weight method, and its relationship to key weight. In the example of the heavy hand of the sumo wrestler and the light hand of the midget (section 1.2.10), both must produce sound of equal intensity when their hands are dropped onto the piano from the same height, for a correct gravity drop. This is obviously more difficult for the sumo wrestler because of his tendency to lean on the piano in order to stop his heavier hand. Thus the correct gravity drop is more difficult to execute for the sumo wrestler. Understanding these fine details based on theory is what leads to the execution of a truly correct gravity drop. In other words, in a correct gravity drop, you cannot lean on the piano to stop the hand until after the key drop is complete. You need a very supple wrist to accomplish this feat.

Of course, there are always a few concepts that defy explanation, and it is extremely important to clearly classify them as "valid principles without explanations". In those cases, how are we to know that they are valid? They can be considered valid only after establishing an undeniable record of experimental verification. It is important to label these clearly because procedures without explanations are more difficult to apply and these procedures are subject to change as we learn more and understand them better. The nicest thing about methods that have good explanations is that we don't need to be told every detail about how to execute the procedure — we can often fill in the details ourselves from our understanding of the method.

Unfortunately, the history of piano pedagogy is full of procedures for acquiring technique, that have no basic theoretical support, that have nevertheless received wide acceptance. The Hanon Exercises is a prime example. Most instructions on how to do something without any explanation of why they work have little value in a scientific approach. This is not only because of the high probability of such procedures being wrong, but also because it is the explanation that helps us to use the procedure correctly. Because there is no theoretical basis behind the Hanon Exercises, when he exhorts us to "lift the fingers high" and "practice an hour every day", we have no way of knowing whether those procedures are indeed helpful. In any real life procedure, it is nearly impossible for anyone to describe all the necessary steps of a procedure under all contingencies. It is an understanding of why it works that allows each person to alter the procedure to meet the specific needs of individuals and changing circumstances.

For example, teachers who use the intuitive method will recommend that you start playing slowly and accurately, and to gradually ramp up the speed. Other teachers may discourage slow practice as much as possible because it is such a waste of time. Neither extreme is optimized. The slow play of the intuitive approach is undesirable because you might freeze in motions that will interfere with faster play. On the other hand, slow play, once you can play at speed, is very useful for memorizing and for practicing relaxation and accuracy. Thus the only way that you can pick and choose the right practice speed is to understand in detail why you need to pick that speed. In this age of information technology and the internet, there should be almost no room for blind faith.

This does not mean that rules without explanations don't exist. After all, there are still plenty of things in this world that we do not understand. In piano, the rule to play slowly before quitting is an example. There must be a good explanation, but I haven't heard of any that I consider satisfactory. In science, the Pauli Exclusion Principle (Two Fermions cannot occupy the same quantum state) and the Heizenberg Uncertainty Principle are examples of rules that cannot be derived from a deeper principle. Thus, it is just as important to understand something as to know what we don't understand. The most knowledgeable physics professors are the ones who can name all the things that we still don't understand.

Dogma and Teaching We all know that you can't break every rule you feel like breaking and still play musically, unless you have initials like LVB. It is in this restrictive environment of the difficulty of guiding students to produce music that the dogmatic teaching methods so prevalent in piano pedagogy evolved. To put it cynically, the dogmatic approach is a convenient way of hiding the teacher's ignorance by sweeping everything under the dogma rug. All of the great lectures that I have heard from famous artists are full of excellent scientific explanations for why you should or should not perform a certain way. However, not all great performers are good teachers or are able to explain what they do. The lesson for the student is that they should, in general, not accept anything they can't understand; this will tend to raise the level of instruction that they get. I am convinced that even the interpretation of music will also, in time, become more scientific, just as alchemy eventually evolved into chemistry.

Unfortunately, a dogmatic approach to teaching is not always a sign of an inferior teacher. In fact, the tendency appears to be the opposite, probably for historical reasons. Fortunately, many good younger teachers, and especially those at large institutions, are less dogmatic — they can explain. As teachers become more educated, they should be able to replace more dogma with a deeper understanding of the underlying principles. This should significantly enhance efficiency and ease of learning for the student.

Most people are aware that scientists must study all their life, not only when they are in college working for their degrees. However, most are unaware of the extent to which scientists devote their time to education, not only to learn but also to teaching everybody else, especially fellow scientists. In fact, in order to maximize discovery, education must become an all day, all-consuming passion. A scientist therefore often evolves into more of a teacher than say, a piano or school teacher because of the broader range of "students" they encounter as well as the breadth of the subjects that they must cover. It is truly astounding, how much you need to know in order to make just a small new discovery. Thus a necessary part of scientific documentation must include the highest skills of teaching. A scientific research report is not so much a documentation of what was done as it is a teaching manual on how to reproduce the experiment and to understand the underlying principles. Thus the scientific method is ideally designed for teaching. And it is a teaching method that is diametrically opposite to the dogmatic method.

Conclusions The scientific approach is more than just a precise way to document the results of an experiment. It is a process that is designed to remove errors and generate discovery. Above all, it is fundamentally a means of human empowerment. If the scientific approach had been adopted earlier, piano pedagogy would most certainly have been different today. The internet will certainly accelerate the adoption of more scientific approaches to learning piano.

3.4 Theory of Learning

Isn't it strange that, when we enter college, we find that "Learning 101" is not a required course (if it exists!)? Colleges and Universities are supposed to be centers of learning. Psychology departments often have ad-hoc courses on study habits, etc., but you would think that the science of learning would be the first order of business at any center for learning. In writing this book, I found that it was necessary to think about the learning process and to derive an equation, however approximate, for the learning rate.

3.5 What Causes Dreams and Methods for Controlling Them

Updated: Apr. 8, 2002

This section has nothing to do with pianos. It is included here because it sheds some light on how the brain works. I am not aware of any research into the causes of dreams and methods for controlling them as described below. If anyone knows of such a reference, please email me.

Have you ever had recurrent dreams and wondered what caused them? Or nightmarish dreams that you wish you could get rid of? I seem to have found answers to both these questions and in the process discovered some insight into how the brain works while we are asleep.

Most dream interpreters today are like palm readers. They strive to tell your future and ascribe magical powers or messages to dreams that would be wonderful if true but are unfortunately as realistic as séances or reading tea leaves. I have found that an interpretation of dreams based of physical evidence can tell us a lot about how our brains work. Here, I discuss four types of dreams that I have had and for which I have found physical explanations. In discussions with friends, I discovered that many others have similar dreams and, almost certainly, similar causes. In the final section, I discuss what these dreams tell us about how our brain works. I have come to the conclusion that this approach to dreams is a lot more rewarding than that of soothsayers and similar dream interpreters. The four dreams discussed below are: (1) falling, (2) inability to run, (3) being late to meetings, exams, or inability to find your destination, and (4) a long, complex dream specific to me, as described below. The first three, I believe, are fairly general dreams that many people have.

3.5.1 The Falling Dream

In this dream, I am falling, not from any specific place or down to any specific location, but definitely falling and scary. And I am totally powerless to stop the fall. Invariably, when I land, I am not injured. There is no pain. In fact, although I have hit bottom, it feels like a soft landing, and the dream always ends as soon as I land. The soft landing is especially curious because in any fall onto almost any surface you generally end up with some kind of disaster. What would explain all these details of this dream? I discovered the physical cause of this dream when, one day, I woke up immediately after the dream and realized that my knees had fallen down. I was sleeping on my back with both of my knees tucked up and, as I straightened my legs, the weight of the bed cover and my legs caused my feet to slip out and the knees to fall. This falling knee caused my brain to create the falling dream! At first, this was just a hypothetical explanation, and a patently silly one at that. Why couldn't my brain figure out that my knees are falling? But once the hypothesis was made, I was able to test it every time I had the dream (over a span of several years), and I succeeded in verifying it several times. Upon awakening, I could distinctly remember that my knees had just fallen down. The fact that the knees fall onto the soft bed explains the soft landing and since nothing happens after that, the dream ends. Why am I powerless to stop the knees from falling? As shown repeatedly below, when asleep, we sometimes have very little control over our muscles. Not only that, the sleeping brain can't even figure out the simple fact that the knee is falling. In addition, it concocts what should normally be an unbelievable scenario of a fall, and I actually end up believing it. This last part is the most preposterous, because I am effectively fooling myself!

3.5.2 Inability-to-Run Dream

This is a very frustrating dream. I want to run, but can't. It doesn't matter if someone is chasing me or I just want to go somewhere fast, I can't run. When you run, you need to lean forwards. Therefore, in the dream, I try to lean forwards, but can't. Something is almost pushing me backwards. In the dream, I have even reasoned that if I can't run forwards or lean forwards, then why not lean backwards and run backwards? That way, at least, I can get moving. What happens is that I can't lean backwards either, and my feet are immobilized and I don't make much progress forwards or backwards. When running, you need to first bring your knees forward and up so that you can kick backwards, but I can't do that either. What would cause such a sensation while I am sleeping? I discovered the cause of this dream after I had solved the falling dream, so the explanation was easier to find. Again, the explanation came to me when I awoke immediately after the dream and found myself sleeping face down, on my stomach. Eureeeka! When lying on your stomach, you cannot change the angle of your body with respect to the bed; you can't lean forwards. Can't bring the knees up either, because the bed is in the way. Can't lean backwards because gravity is pushing you down. Can't walk backwards because the bed is in the way. This demonstrates again that you don't have much control over your muscles while asleep because, if you were awake, pulling the knees up wouldn't be that difficult even when lying face down. After finding the explanation, I was again able to verify it several times; i.e., when I awoke, I was sleeping face down. At this point, I began to realize that maybe, most of my dreams had a physical explanation. However, the whole thing didn't quite make sense, because — why would my brain not know that my knees are dropping or that I am sleeping face down? How can my brain dream such a complex dream and yet not be able to figure out such simple things? And again, my brain has concocted a false situation and succeeded in making me believe it while dreaming.

3.5.3 Late-to-Exams or Getting-Lost Dream

This is another frustrating dream. Can you see a pattern emerging? I will speculate below why dreams tend to be negative or nightmarish. This is not one specific dream, but a class of dreams in which I am trying to get to an exam or go somewhere, but am late, and can't get there or find it. I might have to negotiate a steep slope or walk around buildings. Or if I am in a building, I am going through a maze of ramps, stairways, doors, elevators, etc., but I can't even get back to where I started. In fact, it gets worse and worse and more complex. After a while, I can get quite exhausted. This dream might occur when I am sleeping in an awkward or uncomfortable position from which I can't easily get out, like sleeping on my hand, or getting tangled up in the sheets or bedding. Any type of sleeping position that is uncomfortable, that I would like to get out of, but cannot do so easily while asleep. If I am tangled up in the sheets, I can't extricate myself easily while asleep, and the more I struggle, the more

I get tangled up, and it can become exhausting. I have not been able to uniquely tie this family of dreams, or any of its members, directly to any specific cause, as for the other 3 dreams. However, I have a moderate case of sleep apnea, and the first onset of this type of dream coincides with what I estimate was the first onset of my sleep apnea. Thus the dream might be caused by my inability to breathe.

Whatever the precise cause, whether an uncomfortable position or sleep apnea, it is clear that if I had been awake, I would have easily figured out a solution. Thus the pattern that is emerging is that my ability to reason and solve problems is greatly impaired; very simple problems can stymie me while I am asleep.

3.5.4 Solving My Long and Complex Dream

After solving the above three dreams, I was convinced that another recurrent dream I had also had a physical cause. This dream was long and complex, but always the same. It starts out pleasantly. I am going out for a hike, and in front of me is a gentle hill or rolling meadow leading, in the distance, to a mountain. The first indication that something was amiss came from that mountain. It went up in shear vertical cliffs and the top was so high that I could barely see it. Nevertheless, I would embark on my hike, but immediately a scary situation arises: I am at the edge of a vertical cliff, and I can't even see the bottom! Getting afraid, I immediately turn around and try to go back, but the ledge that I am traveling on becomes narrower, like I am walking on a gymnast's balancing beam. Finally, I am sensing that I am near the end, but must cross a final hurdle: a river! Before hopping over rocks to cross the river, I test it with my hand, and the water is cold and deep. At about this stage, the dream ends. How would I explain such a complex dream? I solved it again after I awoke immediately after the dream. I was sleeping at the edge of the bed, with one hand dangling down, out from under the blanket. Now I could explain every detail of my dream! My dream apparently starts with me sleeping on my stomach, my chin on the bed, and I am looking at the pillow in front of me (the rolling meadow). Beyond the pillow is the vertical wooden headboard made of blocks of Canadian walnut that look like a shear cliff, which is the mountain. With my chin on the bed, I can barely see the top of the headboard. So far, it is interesting that I am apparently looking at things in my sleep. Since I am sleeping on the edge of the bed, one hand falls off the edge, and that is the edge of the cliff that I am standing on. About seven inches from my bed is my night table with a narrow stepped edge like the top of a balancing beam (hard to describe). So my hand is apparently probing around. Since my hand is now out from under the blankets, it feels cold (the cold river). That's it! These explanations account for every detail of my dream! These explanations have convinced me that dreams CAN be interpreted, and that most of them may have physical causes. If this is all true, then we should be able to use the causes and explanations to deduce what the brain is doing during sleep. That's an exciting prospect even the soothsayer dream interpreters couldn't even dream of accomplishing.

3.5.5 Controlling the Dreams

The most amazing thing about explaining these dreams was that I developed some control over them. After I was completely convinced that each explanation was correct, these dreams disappeared! I couldn't fool myself anymore! Thinking that falling knees is the same as falling off a roof or cliff is clearly fooling myself. But once the mechanism is understood, the brain doesn't get fooled. Thus although the brain is sufficiently shut off to be easily fooled during sleep, it still has sufficient capacity to recognize the truth once the mechanism is solved.

Still, fooling myself appeared to me somewhat farfetched. In order to convince myself that this type of fooling is possible, I had to find a real life example. Luckily, I found one. It is what magicians do. When you watch a magic trick, you know that it is not magic, but you fall for it every time, in the sense that it is totally mystifying and very exciting. Now the story changes completely if someone were to explain to you how the magic was done. Then, all of a sudden, the mystery and excitement disappears, and you end up concentrating on how the magician is executing the trick. You can't be fooled into thinking that it is magic. Thus, in a dream, our brain can be fooled as long as it doesn't know that it is being fooled. Since most people don't know the explanation for the dream, they obviously are unaware of the foolery going on, and the dreams keep going. Once you know the cause of the dream, you know that the brain was being fooled; therefore, it is now much easier for the brain to figure out the truth and the dream disappears. Before you figured out the truth, the brain did not even know that it was being fooled, so it had no reason to even attempt to look for the truth. Now it all seems to make sense.

3.5.6 What these Dreams Teach Us about our Brain

These four examples suggest that most dreams have some concrete physical origin. I have never seen this type of explanation presented before, yet it all seems reasonable. As far as I know, the falling dream is quite universal — many have this dream. For me, it was the falling knee; for someone else, it might be an arm or leg slipping off the edge of the bed.

The above results provide a plethora of possibilities for speculating about how the brain works. Here are some ideas. During sleep, most of the brain is turned off, so it is no surprise that the brain is easily fooled. It appears that the higher functions are more completely turned off, so that the reasoning ability is impaired the most. It may be that fear is the emotion that is turned off last as you fall asleep and turned on first as you awake, perhaps for survival purposes. If an enemy attacks during sleep, fear is the first emotion that needs to be awakened. This suggests that the majority of dreams might tend to be nightmarish. But of course, it may be different from person to person and some people may have mostly pleasant dreams, depending on the person's disposition. In my case, the evidence suggests that the dreams that I have solved occur just before I wake up. This suggests that most dreams occur during that brief period of time between deep sleep and awakening. While there are sleep walkers who can control strong muscles during sleep, the above indicates that the effort to move muscles during a dream does not translate well into actual motion. Yet example (4) above indicates that there is plenty of motion during sleep, in addition to the normal motions needed to reposition the body periodically in order to prevent extended blood loss from pressure points, etc. Thus body movement during sleep is a perfectly normal process, in response to pain that develops after staying in one position for too long. A minority of people appear to be able to sleep all night in essentially one position; such people must have some method for supplying oxygen, etc., to pressure points so that sores do not develop (perhaps they shift imperceptibly to one side or the other to temporarily relieve the pressure).

I believe that I have given here some convincing examples of how dreams can be interpreted concretely based on reality rather than the false supernatural powers historically associated with dream interpretation. This approach seems to provide insight into how the brain works during sleep. One possible use of dreams that can be tied to reality is that they might become useful diagnostic tools for disorders such as sleep apnea. They might tell you a lot about your movements during sleep, and how you might change things so that you can get better sleep.

3.6 How to Use Your Subconscious Brain

Updated:
Mar. 4, 2002

The brain has a conscious and a subconscious part. Most people are unskilled at using the subconscious, but the subconscious is important because (1) it controls the emotions, (2) it functions 24 hrs a day whether you are awake or asleep, and (3) it can do some things that the conscious cannot do, simply because it is a different kind of brain. Although it is difficult to compare the conscious brain to the subconscious because they perform different functions and have different capabilities, we might guess statistically that for half the human population, the subconscious may be smarter than the conscious. Thus, in addition to the fact that you have an extra brain capability, it doesn't make any sense not to use this part of the brain that might be smarter than your conscious. In this section, I present my ideas about how the subconscious might work and demonstrate how we can accomplish some amazing feats using the subconscious.

3.6.1 Emotions

The subconscious controls emotions in at least two ways. The first is a rapid, fight or flight reaction — generation of instant anger or fear. When such situations arise, you must react faster than you can think, so that the conscious brain must be bypassed by something that is hardwired and preprogrammed for immediate reaction. The second is a very slow, gradual realization of a deep or fundamental situation. Whether the first and second type of subconscious brain are parts of the same subconscious is an academic question, since we almost certainly have many types of subconscious behaviors. Feelings of depression during a midlife crisis might be a result of the workings of the second type of subconscious: the subconscious brain has had time to figure out all the negative situations that develop as you age and the future begins to look less hopeful. Such a process requires the evaluation of myriads of good and bad possibilities of what the future might bring. When trying to evaluate such a future situation, the conscious brain would have to list all the possibilities, evaluate each, and try to remember them. The subconscious functions differently. It evaluates various situations in a non-systematic way; how it picks a particular situation for evaluation is not under your control; that is controlled more by every day events. The subconscious also stores its conclusions in what might be called "emotion buckets". For each emotion, there is a bucket, and every time the subconscious comes to a conclusion, say a happy one, it deposits the conclusion in a "happy bucket". The fullness of each bucket determines your emotional state. This explains why people often can sense what is right or wrong or whether a situation is good or bad without knowing exactly what the reasons are. Thus the subconscious affects our lives much more than most of us realize.

3.6.2 Using the Subconscious Brain

Usually, the subconscious goes its own way; you don't normally control which ideas it will consider, because most of us have not learned how to communicate with it. However, the events you encounter in daily life usually makes it quite clear which are important factors and which ones are unimportant, and the subconscious naturally gravitates towards the most important ideas. When these important ideas lead to important conclusions, it gets more interested. When a sufficient number of such important conclusions piles up, it will contact you. This explains why, all of sudden, an unexpected intuition will sometimes flash through your conscious mind. So the important question here is, how can you best communicate with your subconscious?

Any idea that you can convince yourself is important, or any puzzle or problem that you had tried to solve with great effort, will obviously be a candidate for consideration by the subconscious. So this is one way in which you can present your problem to the subconscious. Furthermore, in order to be able to solve a problem, the subconscious must have all the necessary information. Therefore it is important for you to do all the research and gather as much information about the problem as you can. In college, this is how I solved many homework problems that my smarter classmates could not solve. They tried to just sit down, do their assignments, and hoped to solve the problems. Problems in a school environment are such that they are always solvable with the information given in the classroom or textbook. You just need to assemble the right parts to come up with the answer. What I did, therefore, was not to worry about being able to solve any problem immediately but to just think about it intensely and make sure that I have studied all the course material. If I could not solve the problem right away, I knew that the subconscious would go to work on it, so I could just forget about the problem and return to it later on. Thus the only requirement was that I should not wait until the last minute to try to solve such problems. Some time afterwards, the answer would suddenly pop up in my head, often at strange, unexpected times. They most frequently popped up in the early morning, when my mind was rested and fresh. Thus with experience, you can learn to present material to your subconscious as well as to receive conclusions from it. In general, the answer would not come if I intentionally asked my subconscious for it, but would come when I was doing something unrelated to the problem. You can also use the subconscious to recall something you had forgotten. First, try to recall it as well as you can, and then completely abandon the effort for a while. After some time, your brain will often recall it for you.

Of course, we do not yet know of any direct ways to talk with your subconscious. And these communication channels are very different from person to person, so each person must experiment to see what works best. Clearly, you can improve communications with it as well as block the communication channels. Many of my smarter friends in college became very frustrated when they found out that I had effortlessly found the answer when they couldn't; and they knew they were smarter. That type of frustration can stall any communications between various parts of the brain. It is better to maintain a relaxed, positive attitude and to let the brain do its thing. That is probably why things like meditation and Chi Gong work so well. Those are effective, time tested, methods of communicating with the various parts of your brain and body. Note that different parts of the brain directly control many bodily functions such as heart beat rate, blood pressure, perspiration, digestion, salivation, the functioning of internal organs, sexual response, etc. These are powerful functions that can generate or waste huge amounts of energy so that how they function smoothly together or work against one another has an important effect on your general health and mental function. Another important method for making maximum use of the subconscious is to leave your subconscious alone without interference from the conscious brain, once your have presented it with your problem. In other words, you should forget about the problem and engage in sports or go to see a movie or do other things you enjoy, and the subconscious will do a better job because it is a completely different part of your brain. If you consciously think about the problem all the time, you will bias the subconscious and not allow it to go freely in its own explorations.

The brain has many parts, and it is to our advantage to know each part and to learn how to use it. The subconscious mind is probably one of the most underutilized parts of our brain because too many of us are unaware of its existence. There must certainly be many other parts of our brain that are useful. For example, there are numerous automatic brain processes that affect our daily lives. When we see an image with our eyes, many things happen immediately and automatically. When an image is received, the brain becomes temporarily overloaded with information processing so that it cannot perform other tasks well. This is why you feel less pain when your eyes are open than when they are closed. A similar effect happens with sound. Thus screaming in pain actually reduces the pain. The pleasing sound of music is another automatic reaction, as are reactions to visual inputs such as pretty flowers, soothing panoramic views of mountains and lakes, or the effect of unpleasant or pleasant odors. It is one of these automatic reactions that we invoke when we listen to music; yet, just as we cannot quite explain why a pretty flower looks pretty, we still can't quite explain why music sounds so good. Perhaps it is one of those hard-wired subconscious reactions.

The identification of the different parts of the brain must surely be one of the future revolutions to come. Medical science is advancing ever more rapidly and understanding the brain will be one of the biggest breakthroughs, starting with how it develops in childhood and how we can facilitate that development. Thus it is entirely possible that Mozart was not a musical genius, but a genius created by music.

Appendix A

References

Updated:
July 12, 2004

Fischer, http://www.music.qub.ac.uk/tomita/bachbib/ *Bach Bibliography.*

Bertrand, OTT., *Liszt et la Pedagogie du Piano, Collection Psychology et Pedaogie de la Musique*, (1978) E. A. P. France.

Boissier, August., *A Diary of Franz Liszt as Teacher 1831–32*, translated by Elyse Mach.

Chan, Angela, http://www.geocities.com/Paris/Metro/5453/maped.htm Comparative Study of the Methodologies of Three Distinguished Piano Teachers of the Nineteenth Century: Beethoven, Czerny and Liszt.

Fay, Amy, *Music Study in Germany.*

Fine, Larry, *The Piano Book*, Brookside Press, 4th Ed., Nov. 2000.

Fischer, J. C., *Piano Tuning*, Dover, N.Y., 1975.

Howell, W. D., *Professional Piano Tuning*, New Era Printing Co., Conn. 1966.

Jaynes, E. T., http://bayes.wustl.edu/etj/music.html *Physical Basis of Music.* (Explanation of why Liszt could not teach, best description of Thumb Over method in literature.)

Jorgensen, Owen H, *Tuning*, Michigan St. Univ. Press, 1991..

Reblitz, Arthur, *Piano Servicing, Tuning, and Rebuilding*, 2nd Ed., 1993.

Moscheles, *Life of Beethoven.*

Sethares, William A., *Adaptive tunings for musical scales*, J. Acoust. Soc. Am. **96**(1), July, 1994, p. 10.

White, W. B., *Piano Tuning and Allied Arts*, Tuners' Supply Co., Boston, Mass, 1948.

Young, Robert W., *Inharmonicity of Plain Wire Piano Strings*, J. Acoust. Soc. Am., **24**(3), 1952.

Tomita, Yo, http://www.music.qub.ac.uk/~tomita/essay/inventions.html *J. S. Bach: Inventions and Sinfonia*, 1999.

Book Reviews

General Conclusions from the Reviewed Books

1. In the last 100 years, the piano literature evolved from attention to fingers and finger exercises to using the entire body, relaxation, and musical performance. Therefore, the older publications tend to contain concepts that are now discredited. This does not mean that Mozart, Beethoven, Chopin, and Liszt didn't have proper technique; just that the literature recorded mostly the great performances but not what you had to do to become that good. In short, the piano literature has been woefully inadequate, up to modern times.

2. One concept that has not changed is that musical considerations, such as rhythm, tone, phrasing, etc., cannot be separated from technique.

3. Almost every book deals with a subset of the same subjects; the main differences are in the approach and degree of detail that each presents. Almost all of them are partial treatment and are incomplete. They treat first the human mind and anatomy and their relationships to the piano: mental attitude and preparation, sitting posture, bench height, role of arms, hands and fingers — often with appropriate exercises, and discussions of injury. Then concepts of technique and musicality: touch, tone, thumb, legato, staccato, fingering, scales, arpeggios, octaves, chords, repeated notes, velocity, glissando, pedal, practice time, memorization, etc. There is surprisingly little literature on sight reading.

4. With a few older exceptions, most discourage the use of "thumb under" for playing scales; however, thumb under is a valuable movement for some specific applications. Chopin preferred thumb under for its legato, but taught thumb over where it was technically advantageous.

5. The lack of references in many books is a reflection of the fact that piano teaching methods have never been adequately or properly documented. Each author in effect had to re-invent the wheel each time. This is also reflected in the actual teaching methods. Piano teaching methods were basically handed down by word mouth from teacher to student, reminiscent of the way in which prehistoric humans handed down their folklore and medical practices through generations. This basic flaw almost completely arrested the development of teaching methods and they have remained basically unchanged for hundreds of years.

   Whiteside's book was widely acclaimed mostly because it was the first real attempt at a scientific approach to discovering the best practice methods. However, according to anecdotal accounts, most of her "discoveries" had been taught by Chopin, although this information was apparently not available to Whiteside. However, it may be more than just coincidence that she used Chopin's music most extensively in her teachings. Whiteside's book failed miserably because, although she conducted experiments and documented the results, she did not use clear language, organize her results, and make any cause-and-effect analyses, etc., that are needed for good scientific project. Nonetheless, her book was one of the best available at the time of its publication, because of the inferior quality of all the others.

An inordinate number of teachers claim to teach the Liszt method, but there is only fragmentary and preciously little documentation of what that method is. There is abundant literature on where Liszt visited, whom he met and taught, what he played, and what magical feats of piano he performed, but there is practically no record of what a student must do to be able to play like that.

6. Chang's book (especially this 2nd edition) is the only one that provides practice methods for solving specific early technique problems (overcoming speed walls, relaxation, stamina, memorizing, slow vs. fast practice, etc.) that should have been learned at the beginner stage, but are not always taught. The other books deal mostly with "higher" levels of piano playing, and assume that by some magic, the student had acquired the basic technique. Obviously, it is important to learn those "higher level" skills from the beginning, so that Chang's book fills a real gap in the literature on acquiring technique.

Book Review Format: Author, Title, Year of publication, number of Pages in book, and whether References are cited.

The references are an indication of how scholarly the book is. By this criterion, Chang's 1st edition is not scholarly at all; this deficiency has been corrected in this 2nd edition. These reviews are not meant to be objective or comprehensive; they are concerned mainly with how relevant these books are to the piano student interested in piano technique. Most "irrelevant" material has been ignored.

Bree, Malwine "The Leschetizky Method". 1997 (1913), 92 pp., no references.

Although this book appeared in 1997, it is a re-publication of 1913 material.

Teaching lineage: Beethoven-Czerny-Leschetizky-Bree.

Book of exercises for developing technique, photos of finger positions. Advocates thumb under method. Hand position, finger independence exercises, scales, chords, touch, glissando, pedal, performance, etc., a relatively complete treatment. Read this to find out about the older "established" methods.

Bruser, Madeline "The Art of Practicing". 1997, 272 pp., references.

`http://artofpracticing.com/`

Based on starting with preparing the mind (meditation) and body (stretching exercises), then goes into some useful specifics of piano skills. The amount of piano instruction is unfortunately reduced by the parallel instructions for other instruments (mostly string and wind). Though physical exercise (calisthenics) is good, exercises such as scales are not helpful. Contains a small amount of useful information.

Chang, Chuan C. `http://members.aol.com/cc88m/PianoBook.html` "Fundamentals of Piano Practice", 1st edition. 1994, 130 pp., no references.

Teaching lineage: Long-Combe

Teaches the most basic practice methods for acquiring technique quickly (hands separate practice, chord attack [parallel sets], shortening difficult passages, memorizing, relaxation, eliminating speed walls, etc.). No other book discusses all of these essential elements needed for fast progress and correct technique. Also treats sight reading, preparing for recitals, controlling nervousness, gravity drop, which exercises are good and which ones are useless or harmful, learning perfect pitch, outlining, etc. Has a chapter on piano tuning for the amateur, explains the chromatic scale

and tempering. Go to the above web site and click on "CONTENTS" link to download the 2nd edition free; it is an updated and expanded version of the 1st edition. **A MUST READ.**

Eigeldinger, Jean-Jacques "Chopin, pianist and teacher as seen by his pupils". 1986, 324 pp., references.

The most scholarly and complete compilation of relevant material on Chopin concerning teaching, technique, interpretation, and history. Because of a lack of direct documentation in Chopin's time, practically all the material is anecdotal. Yet the accuracy seems unquestionable because of the exhaustive documentation, lack of any detectable bias, and the obvious fact that such deep understanding could only have come from Chopin himself — the results are in uncanny agreement with the best material available today. Eigeldinger has arranged the subjects into helpful groupings (technique, interpretation, quotes, annotated scores and fingerings, Chopin's style). I certainly wish that there were more practice methods, but we must all realize that the lack of documentation in Chopin's time has resulted in the loss of a large fraction of what he taught. In the case of F. Liszt, the situation is far worse.

The technical teachings are presented concisely on pages 23–64. These teachings are in almost complete agreement with those of all the best sources, from Liszt and Whiteside to Fink, Sandor, Suzuki, and this book (Chang). The presentation is in stark contrast to Whiteside; here it is authoritative (Whiteside sometimes retracts her own findings), brief (only 41 pages compared to 350 pages for Whiteside!), organized, and clear, while covering a similar range of topics. The second part, pages 65–89, covers interpretation and therefore contains much less information on technique, but is just as informative as the first section. It touches (very!) briefly on how to interpret each of his major compositions. The remaining 200 pages are dedicated to documentation, illustrations, Chopin's annotations on his own compositions and fingerings, and a 10 page "sketch" of basic material to teach beginners.

Notes on technique: Chopin was self-taught; there is little known about how he learned when young except that he was taught by his mother, an accomplished pianist. Chopin didn't believe in drills and exercises (he recommended no more than 3 hr practice/day). Chopin's methods are not as contrary to Liszt's as they might appear at first, although Liszt frequently practiced over 10 hours a day and recommended exercises "to exhaustion". Chopin, like Liszt, wrote etudes and Liszt's "exercises" were not mindless repetitions but specific methods of technique acquisition.

Learn to make music *before* learning technique. The whole body must be involved, and use of arm weight (gravity drop) is a key element of technique. He taught thumb over (especially when the passed note is black!!) as well as thumb under, and in fact allowed any finger to roll over any other whenever it was advantageous — the thumb was not unique and had to be "free". However, every finger was different. Thumb over (as well as other fingers) was especially useful in double chromatic scales (thirds, etc.). To Chopin, the piano had to speak and sing; to Liszt, it was an orchestra. Since C major scale is more difficult, he used B major to teach relaxation and legato; ironically it is better to start learning scales staccato, to eliminate the difficult legato problems although, in the end, he always came back to his specialty — legato. Wide arpeggios require a supple hand more than a wide reach. Rubato is one in which the rhythm is strictly held while time is borrowed and returned in the melody. [My opinion is that this definition is often misquoted and misunderstood; just because he said that a few times, it does not mean that he applied it to every-

thing. This definition of rubato applied specifically to the situation in which the RH plays rubato while the LH keeps strict time. Chopin certainly also allowed that rubato was a freedom from strict tempo for the sake of expression.] Chopin preferred the Pleyel, a piano with very light action. His music is definitely harder to play on modern instruments, especially the pianissimo and legato. **A MUST READ.**

Fink, Seymour "Mastering Piano Technique", 1992, 187 pp., excellent list of references; video also available.

Most scholarly of all books listed here, as befits the work of a university professor. Scientific treatise using correct terminology (in contrast to Whiteside who was frequently unaware of standard terminology), easy to understand, starts with human anatomy and its relation to the piano, followed by a list of movements involved in playing, including pedal. Scale must not be played thumb under, but thumb under is an important movement (p. 115). Illustrates each movement and the corresponding piano exercises. Good description of gravity drop. Strictly mechanical approach, but this book emphasizes production of richer tone and playing with emotion. The motions are difficult to decipher from diagrams, making it desirable to purchase the video. You must read either Fink or Sandor; preferably both since they approach similar subjects from different points of view. Some readers may love one and hate the other. Fink is based on exercises, Sandor is based more on examples from classical compositions.

The first half is a treatment of all the basic motions and exercises for these motions. These include: pronation, supination, abduction, adduction, hand positions (extended, palm, claw), finger strokes, motions of the forearm, upper arm, shoulder (push, pull, cycling), etc. The second section applies these motions to examples from famous classics, from Ravel, Debussy, and Rachmaninoff, to Chopin, Beethoven, Mozart, and many others. **MUST READ** either this or Sandor.

Hofman, Josef "Piano Playing, With Piano Questions Answered", 1909, 183 pp., no references.

Teaching lineage: Moszkowki, Rubinstein.

The first half deals with very useful general rules and the second half is in question and answer form. Most of the book discusses general concepts; not much detailed technical instruction. Not an essential book for technique, but makes nice side reading.

Gieseking, Walter, and Leimer, Karl "Piano Technique", 2 books in one, 1972, no references.

Teaching lineage: Leimer-Gieseking.

First book: Gieseking, 77 pp. Importance of listening, "whole body" method (à la arm weight school), concentration, precise practice, attention to detail. Excellent treatment of how to analyze a composition for practicing and memorizing. This book is representative of most books written by these great performers. Typical advice on technique is, "Concentration, precise practice, and attention to detail will automatically lead to technique" or "Use your ear" or "All notes of a chord must sound together" without any advice on how to actually acquire each particular skill.

Takes you through how to practice Bach's Invention in C major (#1), Three Part Invention in C major (#1) and Beethoven's Sonata #1, but more from analysis and interpretation than technical skill points of view. He guides you through the first 3 movements of this Sonata, then dismisses the most technically demanding 4th movement as "presenting no new problems"! Note that this last movement requires a strong, difficult, and very fast 5, 2, 4 fingering followed by a thumb-over descending arpeggio in the LH and rapid and accurate large chord jumps in the RH. These are where we would have wanted some advice from Gieseking. Chang's book plugs up this hole by providing the missing guidance in section 1.3.8. Worth reading even just for the specific guidance on the above pieces.

Second book: Leimer, 56 pp. Importance of rhythm, counting, accurate timing, phrasing. Excellent section on pedaling. Contains some specific information that is difficult to find elsewhere.

Lhevine, Josef "Basic Principles in Piano Playing", 1972, 48 pp., no references.

Excellent treatment of how to produce good tone. Brief discussions of: basic knowledge of keys, scales, etc., rhythm, ear training, soft & loud, accuracy, staccato, legato, memorizing, practice time, velocity, pedal. Mostly superficial — book is too short. Good general summary, but lacks specific details and does not contain material you cannot find elsewhere.

Green, Barry, and Gallwey, Timothy "The Inner Game of Music", 1986, 225 pp., no references.

Mental approach to music; relaxation, awareness, trust. Almost no technical piano playing instruction. Only for those who think that mental attitude is the key to playing piano. Those interested in specific recipes for practice will find little useful information.

Prokop, Richard "Piano Power, a Breakthrough Approach to Improving your Technique", 1999, 108 pp., just a very references.

The Introduction reads like this is the book everyone's been looking for. However, the more you read, the more you get disillusioned. This author, pianist, piano teacher, and composer, started learning piano using the "intuitive method" and his teachings still consist of 50% intuitive methods (see section 1.1 of Chang for "intuitive method"). For example, he does not know the thumb over method, and therefore encounters many "problems". The teachings consist of "Theorems" that he "proves". Reading through just a few such theorems demonstrates that in piano technique, you can't prove theorems like you can in math, thus invalidating basically the entire book. He does bring up a few useful ideas. (1) importance of extensor muscles (lifting fingers); accurate lifting of fingers (and pedals) is just as important as accurate key drop. He provides exercises for lifting each finger, and gives the best description of the bones, tendons, and muscles of the finger/hand/arm and how/what motions are controlled by each. (2) detailed analysis of the advantages/disadvantages of small, medium, and large hands. Since good ideas are mixed with wrong ones, this book can mislead/confuse the less informed students. There are no "Breakthrough"s (see title); recommended reading only for those who can separate the useful ideas from the wrong ones.

Richman, Howard "Super Sight-Reading Secrets", 1986, 48 pp., no references.

This it is the best book on sight reading. It contains all the fundamentals; they are described in complete detail, teaching us all the correct terminology and methodologies. It starts from how to read music, for the beginner, and advances logically all the way to advanced sight reading levels; it is especially helpful for the beginner. It is also concise, so you should read the whole book once before starting any actual drills/exercises. Starts with how to psychologically approach sight reading. Basic components of sight reading are Pitch, Rhythm, and Fingering. After an excellent introduction to music notations, appropriate drills are given. Then the sight reading process is broken down into its component steps of visual, neural, muscular, and aural processes that start with the music score and end up as music. This is followed by drills for learning "keyboard orientation" (finding the notes without looking at the keyboard) and "visual perception" (instantly recognizing what to play). Depending on the person, it may take from 3 months to 4 years to learn; should practice every day. Finally, about one page of ideas on advanced sight reading. **A MUST READ.**

Sandor, Gyorgy "On Piano Playing", 1995, 240 pp., no references.

Teaching lineage: Bartok-Kodaly-Sandor.

The most complete, scholarly, and expensive book. Contains most of the material in Fink, stresses arm weight methods. Discusses: free fall, scale (thumb-over method; has most detailed description of scale and arpeggio playing, pp. 52–78), rotation, staccato, thrust, pedals, tone, practicing, memorization, performance. Takes you through learning the entire Waldstein Sonata (Beethoven).

Numerous examples on how to apply the principles of the book to compositions from Chopin, Bach, Liszt, Beethoven, Haydn, Brahms, Schumann, many others. This book is very complete; it covers subjects from the effect of music on emotions to discussions of the piano, human anatomy, and basic playing motions, to performing and recording; however, many topics are not treated in sufficient detail. **A MUST READ**, but Fink will give you similar information at lower cost.

Sherman, Russell "Piano Pieces", 1997, no references.

Consists of five sections dealing with playing, teaching, cultural issues, musical scores, and "everything else". The contents are arranged in no particular order, with no real solutions or conclusions. Discusses the politics of art (music), opinions, judgments, and observations that pianists can relate with; whether non-pianists can understand these musings is questionable but will provide insight. Seating position, thumb serves as momentum balance. Fingers = troops, but body = supply line, support, carrier ship, and manufacturing. Fingers vs. body = sales vs. CEO; thus controlling fingers does not result in music. Easy pieces are valuable for learning to make music. What is the value of learning piano? It is not even a good career, financially. Should you slide the finger? What is involved in beauty or character of piano sound? How important are quality pianos and good tuners? Pros and cons of competitions (mostly cons): preparing for competitions is not making music and often becomes more like an athletic competition; is the stress and effort worth it?; judging is never perfect.

Deals with issues faced by pianists, teachers and parents; describes many of the major problems but presents few solutions. This book touches on numerous issues, but is as aimless as its title. Read it only if you have time to burn.

Suzuki, Shinichi (et al) two books (there are more):

"The Suzuki Concept: An Introduction to a Successful Method for Early Music Education", 1973, 216 pp., no references, has large, excellent bibliography.

Mostly for violin education starting at an early age. One small chapter (7 pages) on piano teaching methods.

"How to Teach Suzuki Piano", 1993, 21 pp., no references.

A brief, general outline of the Suzuki Piano methods. The methods described by Chang are in general agreement with the Suzuki methods. Let baby listen; no Beyer, Czerny, Hanon or etudes (even Chopin!); must perform; teachers must have uniform teaching methods and open discussions (research groups); balance memory and reading, but memorizing is more important. Teachers are given a small set of graded music on which to base their lessons. Suzuki is a centrally controlled teaching school; as such, it has many of the advantages of the faculties of established music universities and colleges, but the academic level is, in general, lower. Suzuki teachers are at least one notch above the average private teacher because they must meet certain minimum standards. Describes many general approaches to teaching, but few specifics on how to practice piano for technique. Classic example of how an authoritarian system can eliminate bad teachers by imposing minimum standards.

Walker, Alan "Franz Liszt, The Virtuoso Years, 1811–1847", 1983, 481 pp., references.

This is the first of 3 books; it covers the period from Liszt's birth until the time he decided to stop performing at age 36. The second book covers the years 1848–1861, when he mainly devoted himself to composing. The third book covers the years 1861–1886, his final years. I review only the first book here.

Liszt is known as the greatest pianist of all time. Therefore, we would expect to learn the most about how to acquire technique from him. Unfortunately, every book written about Liszt is an absolute disappointment from that point of view. My guess is that technique was like a "trade secret" in Liszt's time and his lessons were never documented. Paganini practiced in complete secrecy, and even covertly tuned his violin differently in order attain results no one else could. Chopin, on the other hand, was a composer and professional teacher — those were his sources of income, and there are numerous accounts of his lessons. Liszt's claim to fame was his performances. His success in this regard is reflected in the fact that practically every book on Liszt is an endless and repetitive chronicle of his incredible performances. My guess about this secrecy would explain why so many pianists of the time claim to have been students of Liszt yet they seldom describe Liszt's teaching methods in any useful detail. However, when these details are probed among today's teachers of the "Liszt school", they are found to use similar methods (hands separate, shorten difficult passages, chord attack, etc.). Whatever the real reasons, Liszt's teaching methods were never adequately documented. One legacy that Liszt did leave us is the well-chronicled fact that the kinds of feats he performed are humanly possible. This is important, because it means that we can all do similar things if we can rediscover how he did it. Many pianists have, and I hope that my book is a step in the right direction for producing a written documentation of the best known piano practice methods.

Walker's book is typical of other books on Liszt that I have read, and is basically a chronicle of Liszt's life, not a textbook on how to learn piano. As such, it is one of the best Listz biographies and contains numerous discussions on particular compositions with specific pianistic demands and difficulties. Unfortunately, a description of an impossible passage "that was executed with the greatest of ease" does not teach us how to do it. This lack of technical teaching information is surprising in view of the fact that bibliographical accounts of Liszt number well over ten thousand! In fact, any useful technical information we might glean from this book must be deduced from the contents using our own knowledge of piano (see the "relaxation" example below). The section entitled "Liszt and the Keyboard" (pp. 285–318) contains a few pointers on how to play. As in all three books, Liszt is revered as a demi-god who can do no wrong, even endowed with super hands somehow configured ideally for the piano — he could reach a tenth easily. This bias reduces credibility and the incessant, repetitive accounts of superhuman performances create a boredom that detracts from the vast amount of revealing and fascinating historical details in these books.

From the point of view of piano technique, perhaps the most interesting point is that Liszt was a thin, sickly man from early youth. In fact, at age three, he was given up for dead after an illness and they even ordered a coffin. He did not start piano until age six and didn't even have a decent practice piano until seven, because his family was so poor. He was taught by his father, a talented musician and passable pianist, and was steeped in music since birth. Czerny was his first "real" teacher, at age 11, and Czerny claims to have taught Franz all of his fundamental skills. However, he acknowledges that Franz was already an obvious prodigy when they were first introduced — which seems suspiciously contradictory. Franz actually rebelled at Czerny's drills, but nevertheless used exercises extensively for his technical developments. The things he practiced were the fundamentals: runs, jumps, repeat notes. My interpretation is that these were not mindless repetitions for building muscle but skill exercises with specific objectives in mind, and once the objectives were achieved, he would move on to new ones.

But how does a frail person perform "impossible" exercises to exhaustion? By relaxing! Liszt may have been the world's greatest expert on relaxing, out of necessity. Concerning relaxation, it may not be a coincidence that Paganini was also a sickly man. By the time he became famous, in his thirties, Paganini had syphilis, and his health further deteriorated because of an addiction to gambling and contraction of tuberculosis. Yet, these two men of poor health were the two greatest masters over their instruments. The fact that both were physically weak indicates that the energy for superhuman performances does not come from athletic muscle power but, rather, from complete mastery over relaxation. Chopin was also on the frail side, and contracted tuberculosis. A sad historical note, in addition to Paganini's poor health and the grotesque consequences of the primitive surgical attempts of that time, is the circumstances of his ghastly death, as there was a delay in his burial and he was left to rot in a concrete cistern.

Another notable teacher of Liszt was Saliery who taught him composition and theory. By then Saliery was over 70 years old and, for years, had been suffering under the suspicion of having poisoned Mozart out of jealousy. Liszt was still improving at age 19. His feats are credited with popularizing the piano. He is credited with inventing the piano recital (by bring it out of the salon and into the concert hall). One of his devices was the use of many pianos, as well as many pianists. He even played multi-piano concerts with Chopin and other luminaries of his time. This climaxed in extravaganzas with up to 6 pianos, advertised as a "concert of 60 fingers". In one stretch of 10 weeks, he played 21 concerts and 80 works, 50 from memory. That he could so enthrall his audiences was the more surprising because adequate pianos (Steinway, Bechstein) were not available until the 1860s, almost 20 years after he stopped concertizing.

I read this book with the intention of extracting information on how to practice the piano. As you can see, there is almost nothing we can learn today about how to practice piano from the greatest pianist of all time, although his life story makes fascinating reading.

Werner, Kenney "Effortless Mastery", 191 pp., plus meditation CD, a few references and lots of suggested listening material.

Mental/spiritual approach to making music; almost no descriptions of the mechanics of playing, emphasis on meditation. Book is like an autobiography, and the lessons are taught as he learned them during his life. In the same category as Green and Gallwey, but a different approach.

Whiteside, Abby "On Piano Playing", 2 books in one, 1997, no references.

This is a re-publication of "Indispensables of Piano Playing" (1955), and "Mastering Chopin Etudes and Other Essays" (1969).

Teaching lineage: Ganz-Whiteside.

First book: "Indispensables of Piano Playing", 155 pp.

Uses non-standard English, convoluted logic, biblical phraseology, unnecessarily long winded. Contents are excellent, but the terrible write-up makes learning unproductive. Many of the ideas she describes appear in other books but she may have originated (or rediscovered) most of them. Although I had difficulty reading this book, others have claimed that it is easier to understand if you can read it rapidly. This is partly because she is repetitious and often takes a paragraph or even a page to describe something that can be written in one sentence.

Almost the entire book is like this (p. 54): "Q: Can Weight — an inert pressure — help develop facility? A: It is exactly the inert pressure of weight which cannot be used for speed. Words are important in teaching. Words of action are needed to suggest the coordination for speed. Weight does not suggest the muscular activity which moves the weight of the arm. It does suggest an inert pressure." I did not pick this section because it was particularly convoluted — it was picked at random by opening the book with my eyes closed.

Contents: Must follow her methods religiously; why rhythm is important, the body-arms-hand-finger combination has infinite possibilities of which we are mostly unaware; thumb under scale is reviled; functions of each part of anatomy for playing piano (horizontal, in-out, vertical motions); discussions on creating emotion, memorizing, pedaling, phrasing, trills, scales, octaves, teaching methods. Points out importance of rhythm to music and how to attain this using outlining (p. 141). Czerny and Hanon are useless or worse.

The following is her attack on passing thumb-under for playing scales (in understandable language!), excerpted from over two pages; the ( ) are my clarifications:

"*Passing.* Here we are faced with a welter of stress in traditional teaching concerning the exact movements that should take place with finger and thumbs. . . . . If I could blast these concepts right out of existence I would not hesitate to do so. That is how faulty and pernicious I think they are. They can literally cripple a pianist . . . . . If it (playing perfect scales) seems quite hopelessly impossible and you have no glimmer of an idea as to how it can be accomplished, then you are trying with a coordination which actually makes a scale an impossible feat. It means thumb snapping under the palm and reaching for position; and fingers trying to reach over the thumb and seeking a legato key connection. It doesn't matter if the performer achieving the swift and beautiful scales and arpeggios tells you he does just that (thumb under)

— it isn't true. No suggestion is meant that he is lying, but simply that he was successful in discarding the coordination that he was taught when the occasion arose which made it inadequate . . . . They (thumb under players) have to be re-educated physically to a new pattern of coordination; and that re-education can mean a period of wretched misery to them. . . . . . Action (for thumb over passing) can be taken through the shoulder joint in any direction. The top arm can move so that the elbow end of the humerus can describe a segment of a circle, up or down, in and out, back and forth, or around and about . . (etc., an entire page of this type of instruction on how to play thumb over). . . . . With control from center the entire coordination operates to make it easy to have a finger available at the moment it is needed . . . . The best proof of this statement is a beautiful scale or arpeggio played with complete disregard for any conventional fingering. This often happens with a gifted, untaught pianist . . . . For passing (thumb over), the top arm acts as fulcrum for all the "other techniques" involving the forearm and hand; flexion and extension at elbow, rotary action, and lateral hand action at wrist, and last and least, lateral action of fingers and thumb. . . . . Between rotary action and alternating action, passing is made as easy as it looks when the expert does it."

Second book: "Mastering the Chopin Etudes and Other Essays", 206 pp.

Compendium of edited Whiteside manuscripts; much more readable because they were edited by her students, and contains most of the ideas of the first book, based on the playing of the Chopin etudes which were chosen for their unequaled musical content as much as for their technical challenge. This is like a catechism to the above bible; may be a good idea to read this book before reading the first book above. Describes outlining in some detail: pp. 54–61 basic description, and pp. 191–193 basic definition, with more examples on pp. 105–107 and pp. 193–196. Although outlining can be used to overcome technical difficulties, it is more valuable for learning, or learning to play, the musical concept of the composition.

These two books *are* a diamond mine of practical ideas; but like a diamond mine, you must dig deep and you never know where it's buried. The use of the Chopin Etudes here turns out not to be a random pick; most of Whiteside's basic tenets were already taught by Chopin (see Eigeldinger); however, Eigeldinger's book was written long after Whiteside's book and she was probably unaware of many of Chopin's methods.

There is no middle ground — you will either love Whiteside for the treasure trove of information or hate it because it is unreadable, repetitive, and unorganized.

Scientific American Jan., 1979, pp. 118–127, *The Coupled Motions of Piano Strings*, by G. Weinreich

This is a good article on motions of piano strings if you need to learn the very basics. However, the article is not well written and the experiments were not well conducted; but we should be cognizant of the limited resources that the author probably had. Even more advanced research had surely been conducted long before 1979 by piano manufacturers and acoustics scientists. I will discuss below some of the deficiencies that I have found in this article in the hope that the awareness of these deficiencies will enable the reader to glean more helpful information from this publication and avoid being misled.

There is no information at all on the specific frequencies of the notes that were investigated. Since the behavior of piano strings is so frequency dependent, this is a vital piece of information that is missing. Keep this in mind as you read the article, as many of the results will be difficult to interpret without knowing the frequency at which the experiments were conducted and therefore become of questionable value.

The center plot in the lower row of figures on p. 121 (there are no figure numbers anywhere in this article!) is not adequately explained. The article, later on, proposes that the vertical modes produce the prompt sound. The figure therefore might be interpreted as showing the sustain of a single string. I know of no note on a grand piano having a single string sustain of less than 5 seconds as suggested by the figure. The left hand figure of the upper row of plots from a single string shows a sustain of over 15 seconds, in agreement with my cursory measurements on an actual grand. Thus the two plots from single strings appear to be contradictory. The upper plot measured sound pressure whereas the lower one measured string displacement, so that they may not be strictly comparable, but we would have liked the author to at least provide some explanation of this apparent discrepancy. I suspect that strings with very different frequencies were used for the two plots.

In reference to these figures, there is this sentence: "I used a sensitive electronic probe to separately measure the vertical and horizontal motions of a single string," with no further information. Now any investigator in this field would be very interested in how the author did it. In proper scientific reporting, it is normal (generally *required*) practice to identify the equipment (usually including the manufacturer and model numbers) and even how it was operated. The resultant data are some of the few new information presented in this paper and are therefore of utmost importance in this article. Future investigators will probably have to follow up along this line of study by measuring string displacements in greater detail and will need this information on instrumentation.

The four figures on page 122 are not referenced anywhere in the article. Thus it is left to us to guess about which parts of the article pertain to them. Also, my guess is that the lower two plots showing oscillations are just schematics and do not represent anything close to actual data. Otherwise, the prompt sound would be over in about 1/40th of a second, according to these plots. The curves plotted in these two lower figures are purely imaginary in addition to being schematic. There are no data to back them up. In fact the article presents no other new data and the discussions on the ensuing 5 pages (out of an 8 page article) are basically a review of known acoustical principles. As such, the descriptions of the springy, massive, and resistive terminations, as well as the sympathetic vibrations, should be qualitatively valid.

The major thesis of this article is that the piano is unique because it has an after sound and that the proper tuning of the after sound is the essence of good tuning and creates the unique piano music. My difficulty with this thesis is that the prompt sound typically lasts over 5 seconds. Very few piano notes are played for that long. Therefore, essentially all of piano music is played using only the prompt sound. In fact, piano tuners use mainly the prompt sound (as defined here) to tune. In addition, the after sound is at least 30 db less in power; that is only a few percent of the initial sound. It will be completely drowned out by all the other notes in any piece of music. What is happening in reality is that whatever is controlling the quality of the piano sound controls both the prompt and after sounds, and what we need is a treatise that sheds light on this mechanism.

Finally, we need a publication with proper references so that we can know what has or has not been previously investigated (in defense of the author, Scientific American does not allow any references except references to previously published articles in Scientific American. This makes it necessary to write articles that are "self-contained", which this article is not. According to Reblitz [p. 14], there is a 1965 Scientific American article on "The Physics of the Piano", but that article is not referenced in this report.).

Five Lectures on the Acoustics of the Piano `http://www.speech.kth.se/music/5_lectures/contents.html`

A most modern series of lectures on how the piano produces its sound. The Introduction gives the history of the piano and presents the terminology and background information needed to understand the lectures.

The first lecture discusses piano design factors that influence tone and acoustical performance. Hammers, soundboards, case, plate, strings, tuning pins, and how they work together. Tuners tune the transverse vibrational modes of the string, but the longitudinal modes are fixed by the string and scale design and cannot be controlled by the tuner, yet have audible effects.

The second lecture focuses on the piano tone. The hammer has two bending modes, a shank flex mode and a faster vibrational mode. The first is caused by the rapid acceleration of the hammer, much like the flex of the golf club. The second is most pronounced when the hammer bounces back from the strings, but can also be excited on its way towards the strings. Clearly, the backcheck is an important tool the pianist can use to reduce or control these extraneous hammer motions, and thereby control the tone. The actual time dependent string motion is totally unlike the motion of vibrating strings shown in text books with fundamentals and harmonics that are integral fractional wavelengths that fit neatly between the fixed ends of the string. It is actually a set of traveling waves launched by the hammer towards the bridge and towards the agraffe. These travel so fast that the hammer is "stuck" on the strings for quite a few passes back and forth, and it is the force of one of these waves hitting the hammer that eventually throws it back towards the backcheck. Then, how are the fundamentals and partials created? Simple — they are just the Fourier components of the traveling waves! In non-math terms, what this means is that the only traveling waves possible in this system are waves that contain mostly the fundamentals and partials because the system is constrained by the fixed ends. The sustain and harmonic distribution are extremely sensitive to the exact properties of the hammer, such as size, weight, shape, hardness, etc.

The strings transfer their vibrations to the soundboard (SB) via the bridge and the efficiency of this process can be determined by measuring the acoustical impedance match. This energy transfer is complicated by the resonances in the SB produced by its normal modes of vibration because the resonances produce peaks and valleys in the impedance/frequency curve. The efficiency of sound production is low at low frequency because the air can make an "end run" around the piano so that a compressive wave above the SB can cancel the vacuum underneath it when the SB is vibrating up (and vice versa when moving down). At high frequency, the SB vibrations create numerous small areas moving in opposite directions. Because of their proximity, compressed air in one area can cancel an adjacent vacuum area, resulting in less sound. This explains why a small increase in piano size can greatly increase sound production, especially for the low frequencies. These complications make it clear that matching the acoustical efficiencies across all the notes of the piano is a monumental task, and explains why good pianos are so expensive.

The above is my attempt at a brief translation of highly technical material, and is probably not 100% correct. My main purpose is to give the reader some idea of the contents of the lectures. Clearly, this web site contains very educational material.

Web Sites, Books, Videos

General

`http://www.chopin.pl/`

`http://www.faqs.org/faqs/music/piano/general-faq/` (rec.music.makers.piano newsgroup FAQ locator page; excellent piano info source)

Bie, Oscar, *The History of the Pianoforte and Pianoforte Players*, Da Capo Press, NY (1966)

Gerig, Reginald R., *Famous Pianists and Their Technique*, Robert B. Luce, Inc., NY (1974).

Harvard Dictionary of Music, by Willi Apel.

Mach, Elyse, *The Liszt Studies*, Associated Music Publishers, 1973.

Schonberg, H. C., *The Great Pianists from Mozart to the Present*, Simon & Schuster, Inc. NY (1987).

Sites with Free Sheet Music and Other Goodies

`http://www.geocities.com/Vienna/Strasse/8840/free.html`

`http://www.kjos.com/`

`http://www.rainmusic.com/pianomusic/piano.htm` (Pianist Resource Center)

Piano Instruction (Classical), Teachers, Schools

`http://alexandertechnique.com/`

`http://library.thinkquest.org/15060/index.html`

`http://musicstaff.com/`

`http://www.taubman.com/`

`http://www.cco.caltech.edu/~boyk/piano.htm`

`http://www.cvc-usa.com`

`http://www.feldenkrais.com/`

`http://www.KenFoster.com/`

`http://www.musicplay.com/`

`http://staff.mwsc.edu/~bhugh/piano-practice.html`

`http://www.pianoteachers.com/`

`http://www.serve.com/marbeth/piano.html`

`http://www.Suzuki-Music.com/`

`http://pianoeducation.org/` (Piano Education page)

`http://www.wannalearn.com/Fine_Arts/Music/Instruments/Piano/`

A Dozen A Day, by Edna-Mae Burnam.

A History of Pianoforte Pedalling, by David Rowland.

A Music Learning Theory for Newborn and Young Children, Edwin Gordon, 1997.

All-in-One, by Alfred.

Beethoven on Beethoven: Playing his Piano Music his Way, by William S. Newman, 1988.

Chopin: Pianist and Teacher as Seen by his Pupils, by Jean-Jacques Eigeldinger, 1986.

Chopin Playing, from the Composer to the Present, by James Mathuen-Campbell, 1981.

Comprehensive Guide for Piano Teachers and Piano Auditions Syllabus, published by THE MUSIC EDUCATION LEAGUE, INC., 119 West 57th St., New York 19, NY, (1963).

Debussy, by Marguerite Long.

Faber and Faber Piano Adventures, by ? and ? Faber.

Franz Liszt, the Man and the Musician, by Ronald Taylor, 1986.

Franz Liszt, The Virtuoso Years, 1811–1847, by Alan Walker, 1988.

Franz Liszt, The Weimar Years, 1848–1861, by Alan Walker, 1993.

Franz Liszt, The Final Years, 1861–1886, by Alan Walker, 1997.

Freeing the Caged Bird, video, by Barbara Lister-Sink, `http://www.freeingthecagedbird.com/`.

Golden Age of the Piano, video.

Good Music, Brighter Children: Simple and Practical Ideas to Help Transform Your Child's Life Through the Power of Music, by Sharlene Habermeyer.

Great Pianists on Piano Playing, by James Francis Cooke.

Guide to the Pianist Repertoire, by Maurice Hinson.

How to Play the Piano — Despite Years of Lessons, by Ward Cannel and Fred Marx.

Keeping Mozart in Mind, by Gordon Shaw, 1999.

Learning Sequences in Music, Skill, Content and Patterns, A Music Learning Theory, by Edwin Gordon, 1997.

Living with Liszt. From the Diary Notes of Carl Lachmund, by Alan Walker.

Making Music for the Joy of It, by Stephanie Judy.

Mikrokosmos, by Bartok.

Music for the Older Beginner, by J. Bastien.

Music magazines:

American Music Teacher, Clavier, Classics, Piano and Keyboard. Musicianship for the Older Beginner, by J. Bastien.

On the Sensations of Tone, by Hermann Helmholtz.

Ornamentation, by Valery Lloyd-Watt, Carole Bigler, 1995.

Pedaling the Modern Pianoforte, by York Bowen.

Playing the Piano for Pleasure, by Charles Cooke.

Pianists at Play, by Dean Elder.

Pianists' Guide to Progressive Finger Fitness, by Jana S. and Richard L. Bobo.

Piano for Quitters, video, by Mark Almond.

Piano Lessons, by Noah Adams.

Piano Pieces, by Russell Sherman.

Principles of Piano Technique and Interpretation, by Kendall Taylor.

Raising Musical Kids, by Patrick Kavanaugh.

Second Time Around, by J. Bastien.

Sight Reading at the Keyboard, Schirmer.

Studies in technique, also *Daily Technical Studies*, by Oscar Beringer.

Teaching Music in the Twentieth Century, by R. Abramson, L. Choksy, A. E. Gillespie, D. Woods.

The Art of Piano Fingering, by Penelope Roskell.

The Art of Piano Playing, by Heinrich Neuhaus, 1973.

The Art of Piano Playing: a Scientific Approach, by George Kochevitsky.

The Complete Pianoforte Technique Book, by the Royal Conservatory, Toronto, Canada.

The Listening Book, by W. A. Matthieu.

The Literature of the Piano, by Ernest Hutchison.

The Music Tree, by Frances Clark.

The Musicians' Guide to Reading and Writing Music, by Dave Stewart.

The Pianist's Guide to Pedaling, by Joseph Banowetz.

The Pianist's Problems, by William S. Newman.

The Piano Masterclasses of Franz Liszt 1884–1886. Diary Notes of August Goellerich.

The Technique of Piano Playing, by J. F. Gat.

The Visible and Invisible in Pianoforte Technique, by Matthay, Tobias.

The Well-Tempered Keyboard Teacher, by Uszler, Gordon, Mach.

The Wonders of the Piano, by Cathy Bielefeldt.

Tone Deaf and All Thumbs, by Frank R. Wilson.

With Your Own Two Hands, by Seymour Bernstein.

20 Lessons in Keyboard Choreography, by Seymour Bernstein.

Piano Technology, Tuning, Parts, Manufacturers

http://musicyellowpages.com/ (Links and addresses of practically every piano parts supplier in US and Canada; must do your own search))

http://www.americanpiano.com/

http://www.balaams-ass.com/piano/piano.htm

http://www.globetrotter.net/gt/usagers/roule/accord.htm (Examples of temperaments)

http://www.ptg.org/ (Piano Tuners' Gild web site)

Five Lectures on the Acoustics of the Piano, ed. By Anders Askenfelt, 1990.

Piano Servicing, Tuning, and Rebuilding, by Arthur Reblitz, 2nd Ed., 1993.

The Piano Book, by Larry Fine.

The Piano, its Acoustics, by W. V. McFerrin.

Tuning, by Owen H. Jorgensen.

Injury from Piano Practice

http://eeshop.unl.edu/music.html

Musicians' Injuries: A guide to their Understanding and Prevention, by Nicola Culf, 1998.

Jazz, Chords, Theory, Instruction (Popular Music)

http://www.homespuntapes.com/

An Understandable Guide to Music Theory: The Most Useful Aspects of Theory for Rock, Jazz & Blues Musicians, by Chaz Bufe.

Basic Materials in Music Theory: A Programmed Course, by Paul O. Harder, Greg A. Steinke, 1995.

Blues, Jazz & Rock Riffs for Keyboards, by William Eveleth.

Composing at the Keys, by Sue Shannon.

Elementary Harmony, by William J. Mitchell.

Exploring Basic Blues for Keyboards, by Bill Boyd.

Harmony Book for Beginners, Preston Wade Orem, 1907.

How to Play ... Blues and Boogie Piano Styles, by Aaron Blumenfeld.

How to Play from a Fake Book, by Michael Esterowitz.

How to Use a Fake Book, by Ann Collins.

Lead Lines and Chord Changes, by Ann Collins.

Keyboard Musician, by Summy-Birchard, Inc.

Keyboard Musician for the Adult Beginner, by Frances Clark.

Music Theory for the Music Professional, by Richard Sorce.

Scales and Arpeggios for the Jazz Pianist, by Graham Williams.

The AB Guide to Music Theory.

The Jazz Piano Book, by Mark Levine.

The 20-minute Chords and Harmony Workout, by Stuart Isacoff.

Sheet Music, Video, CD, Book, Stores

`http://musicbooksplus.com/`

`http://www.alfredpub.com/`

`http://www.bookshop.blackwell.co.uk/`

`http://www.burtnco.com/`

`http://www.chappellofbondstreet.co.uk/`

`http://www.jumpmusic.com/`

`http://www.sheetmusic1.com/` (Also sells piano parts)

Appendix B

List of Abbreviations

ET = equal temperament

FI = Fantaisie Impromptu op. 66, by Chopin (1.3.2)

FFP = Flat Finger Position (1.3.4.2)

FPD = Fast Play Degradation (1.2.25, near end)

HS = Hands Separate (1.2.7)

HT = Hands Together (1.2.25)

HsT = historical temperament

K-II = Kirnberger II

LH = Left Hand

NG = Nucleation Growth (1.3.15)

PPI = Post Practice Improvement (1.2.15)

RH = Right Hand

TO = Thumb Over (1.3.5)

TU = Thumb Under (1.3.5)

WT = Well Temperament

Index