THE UNIVERSITY OF ALBERTA

THE PIANIST'S WRIST: ITS USE, "DIS-USE" AND MIS-USE

WITH ILLUSTRATIONS FROM BEETHOVEN'S BAGATELLES

by

(C) LILLIAN UPRIGHT

A PAPER

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Lillian Upright
(Student's signature)

5 Yate Ave.
St. Albert, Alberta

(Student's permanent address)

Date: Oct. 15, 1988

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a paper entitled "The Pianist's Wrist: Its Use, "Dis-use" and Mis-use with Illustrations from Beethoven's Bagatelles," submitted by Lillian Upright in partial fulfilment of the requirements for the degree of Doctor of Music in Applied Music (Piano).

A. Ailey
....
Chairman

Ernesto B. Lejano
....
Supervisor

....

....

B. L. Harris
....

....

....

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To

ROBERT STANGELAND

Musician, Mentor
Much-valued Friend

ABSTRACT

The anatomy, physiology and kinesiology of the pianist's wrist and their implications for piano pedagogy are discussed. Wrist pain and disability is seen to arise out of overuse which includes the components both of repetition and high tensile loading. It is seen that an understanding of the physical structures and how they work can lead the pianist to healthy approaches regarding the use of coordinated blends of movements rather than isolated ones, the handling of stretches, and the choice of various finger coordinations. An explication of all the various wrist attitudes and how these affect the pianist's tone is followed by illustrations of these attitudes in excerpts from Beethoven's Bagatelles.

ACKNOWLEDGEMENTS

I am grateful to the Department of Music, University of Alberta, who, in 1976, took on a middle-aged lady pursuing an undergraduate degree in psychology, with music as her minor. The knowledge and expertise, the support and nurturing I have received in the [illegible] have brought me, some twelve years later, to the threshold of a doctoral degree in piano performance.

I should like, in particular, to express my appreciation to my mentor of many years, Dr. R.A. Stangeland, Professor Emeritus and former department chairman, whose keen interest in, and understanding of, the physical approach to the piano have been so stimulating and instructive; and to Dr. Ernesto Lejano whose extraordinary sensitivity to musical sound has opened my ears and enhanced my desire to produce the broadest possible palette of expressive tone color.

I should also like to acknowledge my gratitude to three other people for their specific assistance to me in the preparation of this paper: Dr. David Reid, orthopaedic surgeon and Associate Professor in the Faculty of Rehabilitation Medicine, University of Alberta, for his valued consultation and advice; Pamela Mustard, Diploma in Physiotherapy, in whose kitchen I hammered out my understanding of things anatomical, physiological and kinesiological; and May Kates, photographer and artist, for her significant contribution to this document.

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INTRODUCTION

The idea of writing a research paper on the wrist was born one day in the studio of Dr. Robert Stangeland at the University of Alberta, Edmonton. As he demonstrated at the piano, I heard an arresting tone quality. Watching his physical approach, I saw that he was playing from his elbow hinge with fixed wrist and fingers, the latter having simply become the end of the forearm. In more than four decades of teaching and learning about piano playing, I had somehow never become fully aware of that particular stroke in piano technique.

At about that same time, however, I was becoming more aware of the incidence of what was referred to as tendinitis among young pianists studying at the University. Often the complaint seemed to center around pain in the wrist region, and I pondered the involvement of wrist and finger fixation in this regard.

And as I did my own piano teaching and performing, I was becoming more and more intrigued with the vital role of the wrist in tone production: when it was high; when it was low; when its deliberate up-and-down motions were prime movers in the production of tone; when its lack of fixation merely allowed it free sway between the fingers at one end and the shoulder at the other; when it was stabilized; or, how its motions, be they up-and-down, left-to-right, or circular, helped to deliver the fingers to their appropriate destinations.

This paper is an attempt to speak to all these issues regarding the wrist and piano playing. Although the problems of wrist ailments must be addressed, the focus is on the healthy functioning of the wrist, and its myriad attitudes which facilitate the broadest and most expressive tone palette and the greatest possible physical ease in producing those tone colors.

PHYSIOLOGICAL ASPECTS OF THE WRIST AND ASSOCIATED PHYSICAL STRUCTURES AND THEIR IMPLICATIONS FOR PIANO PEDAGOGY

"An articulation (joint) may be defined as an area of junction between two lines in the body or an area of junction between a bone and a cartilage in the body."[1] The wrist joint, besides its interesting complexity of articulating surfaces (see below) comprises several other elements: the ligaments (short bands of tough, yet flexible fibrous tissue that bind the bones together sufficiently tightly to prevent dislocation, yet allow enough laxity to permit a certain range of movement at the joint); [2] the muscles (terminating in tendons which attach to the bone),[3] whose contractions serve to move the bones;[4] and a sleeve of "capsular ligaments [that] surround the joint,"[5] sometimes referred to as a joint capsule.[6]

The anatomical wrist is that articulation between the complex of two rows of bones known as the carpal arch of the hand, and the radius/ulna bones of the forearm (see illustration 1, p. 2). More strictly speaking, the articulation is between the proximal row (that row nearest to the center of the body) of carpal bones (scaphoid, lunate and triquetrum), and the radius/ulna plus the triangular ligament (a fibrocartilage/ligament complex that joins them).[7]

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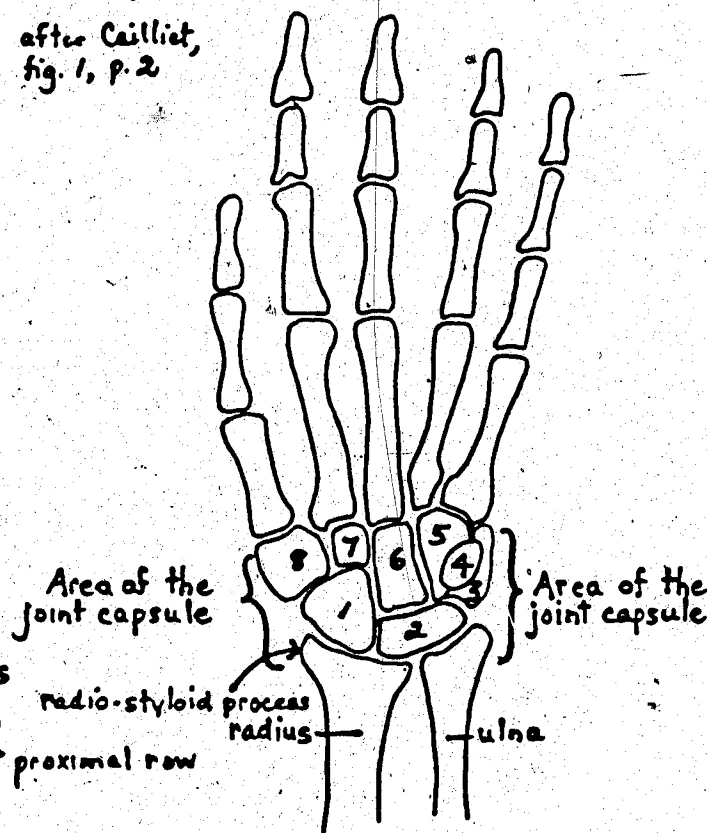
[1] J. Robert McClintic, Human Anatomy (St. Louis: The C.V. Mosby Company, 1983), p. 147.
[2] This description of the ligaments was summarized in conversation by Pamela Mustard, Physiotherapist, Liberton Physio Therapy, St. Albert, Alberta.
[3] T. Duckworth, Lecture Notes on Orthopaedics and Fractures, 2nd ed. (Oxford: Blackwell Scientific Publications, 1984), p. 12.
[4] McClintic, Human Anatomy, p. 183.
[5] Ibid., p. 158.
[6] The term "joint capsule" was introduced to me by Pamela Mustard.
[7] René Cailliet, Hand Pain and Impairment, 2nd ed. (Philadelphia: Davis, 1975), p. 7.

Bones of the Hand and Wrist

(Palmar View)



Carpal Bones

1. scaphoid
2. lunate
3. triquetrum
4. pisiform

} proximal row

5. hamate
6. capitate
7. trapezoid
8. trapezium

} distal row

Illustration 1

The functional wrist includes not only the radiocarpal joint as described above, but also all the accessory movements or joint play that takes place between the carpal rows (the mid-carpal joint), and between the articulating surfaces of all the carpal bones (the intercarpal joint).[8]

The wrist, one of the synovial joints, is characterized by the

i) it has great mobility;

ii) its smooth, articulating surfaces are lined with hyaline

iii) it is surrounded by a sleeve of capsular ligaments;

iv) its joint capsule is lined with a vascular synovial membrane, secreting a synovial fluid which has lubricating and nutritive properties;[9] and,

v) it is "open to a great deal of pathology."[10]

The wrist joint is stabilized by several sets of ligaments:

i) the transverse carpal ligament (also known as the *flexor retinaculum*) which is in two bands, spanning the two rows of carpal bones; it roofs the concavity of the carpal arch that is known as the carpal tunnel; through this tunnel pass the long finger, thumb and wrist flexors, and the median nerve;[11]

ii) the ulnar collateral and radial collateral ligaments (see illustration 2, p. 5) that work cooperatively in wrist abduction (movement away from the center of the body) and adduction

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[8] David C. Reid, Functional Anatomy and Joint Mobilization: A Manual of Kinesiology (Edmonton: School of Rehabilitation Medicine, University of Alberta, 1970), pp. 253-54.

[9] The foregoing paragraph, beginning, "The wrist," is compiled from McClintic, Human Anatomy, pp. 149 and 151.

[10] Reid, Functional Anatomy, p. 257.

[11] Cailliet, Hand Pain, p. 11.

(movement toward the center of the body);[12] to avoid any confusion, it is necessary to keep in mind that these are palms-up movements which are being diagrammed and described in the sources;

iii) the transverse and oblique ligaments which are located on the palm and the back of the hand; the palmar ligaments maintain the carpal arch";[13] and,

iv). the intercarpal ligaments (see illustration 3, p. 6) which include many transverse connections that permit movement of the carpal bones.[14]

WRIST MOVEMENT

As a joint the wrist may be likened to a universal joint in machinery because of its capacity to allow movement in many directions.

i) Abduction and Adduction

Abduction of the wrist occurs within an average range of 20°,[15] and takes place mainly at the midcarpal joint.[16] Most of the movement involved in adduction occurs at the radiocarpal joint;[17] the average range of adduction is 30°.[18] During abduction/adduction the carpal row glides across the radial surface, given an elastic joint capsule and sufficiently lax ligaments.[19] Intercarpal joint play is also

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12 Ibid., p. 5.
13 Ibid., p. 5.
14 Ibid., p. 7.
15 Ibid., p. 3.
16 Reid, Functional Anatomy, p. 255.
17 Ibid.
18 Cailliet, Hand Pain, p. 3.
19 Ibid., p. 5.

Ligaments of the Wrist

after Cailliet, fig. 7, p. 6

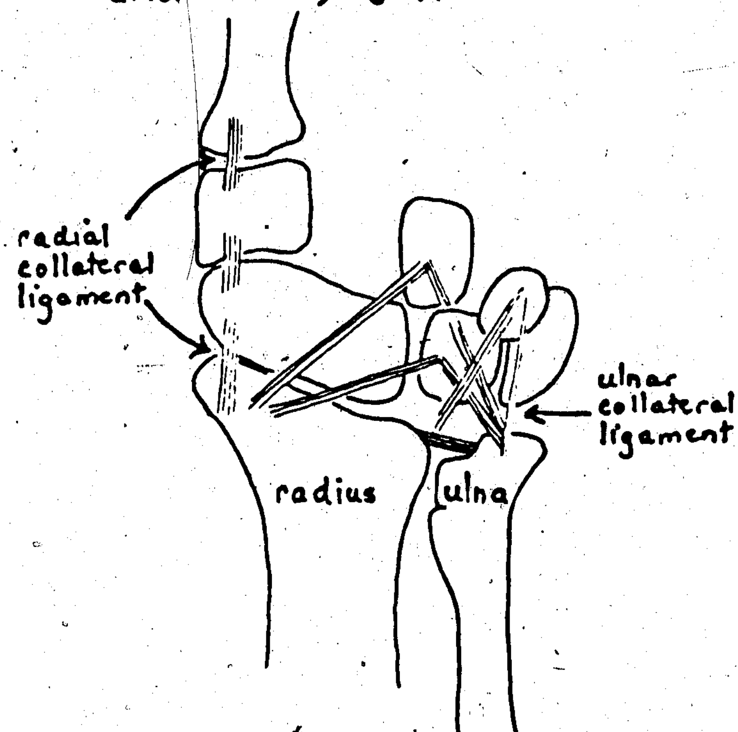

Illustration 2

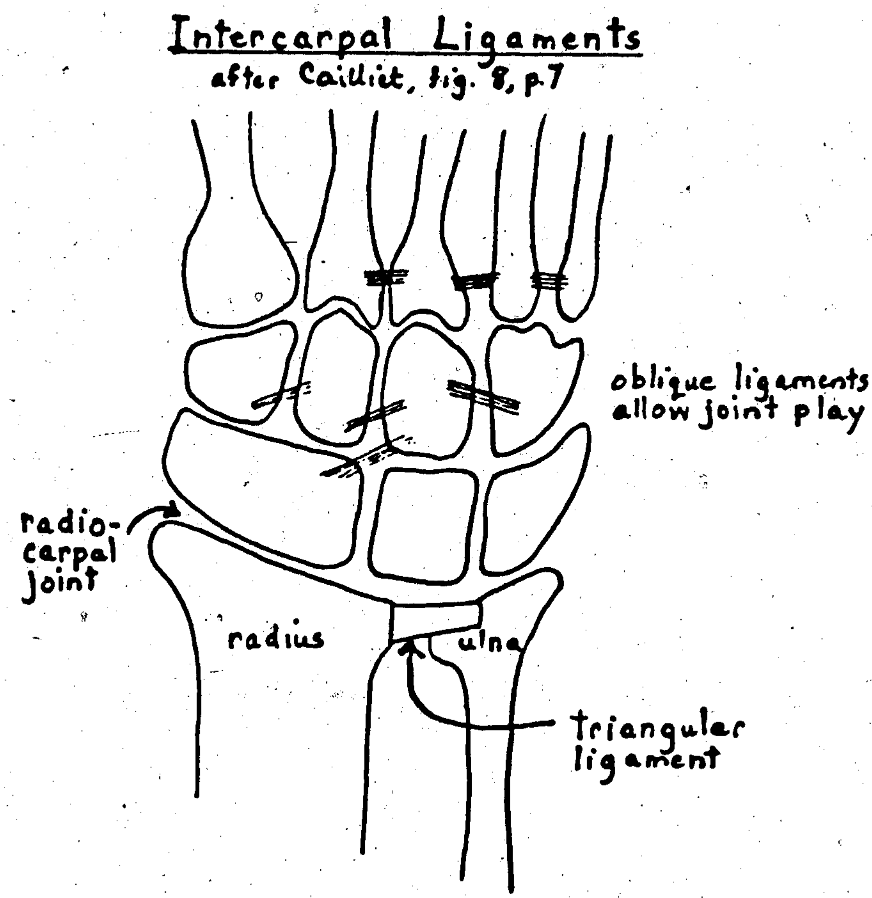

Illustration 3

involved in abduction/adduction, and these many small movements allow for the full range.[20]

ii) Flexion and Extension

Wrist extension (the bending backward of the hand) occurs in a range averaging 70°, while the range of wrist flexion (the curling under of the hand) is 80°.[21] These articulations at the wrist are brought about by sets of so-called "antagonist" muscles, working in pairs. When the extensor muscles of the wrist contract to lift the hand, the corresponding flexor muscles relax; conversely, the opposite combination of contraction/relaxation occurs to produce hand flexion.[22] Extension/flexion also take place at the midcarpal joint. Indeed, it is here that flexion mainly occurs, while extension occurs mainly at the radiocarpal joint.[23] Flexion/extension of the wrist is easier when the fingers are somewhat extended. This is easily verified by putting the hand into a fist and bending the wrist back and forth. There is a relative lack of ease in comparison to the same movement made when the fingers are allowed to extend, a restraint which is particularly noticeable in wrist flexion.

iii) Circumduction[24]

The combination of wrist abduction/adduction with flexion/extension constitutes the movement known as circumduction, the range of which depends on the length of the

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[20] Reid, Functional Anatomy, p. 253.

[21] Calliet, Hand Pain, p. 3.

[22] Arnold Schultz, The Riddle of the Pianist's Finger and its Relationship to a Touch-Scheme (New York: Carl Fischer Inc., 1936), pp. 16-17.

[24] The term circumduction and my of it understanding arose in discussion with Pamela Mustard.

THE WRIST IN EXTENSION/FLEXION

THE WRIST IN EXTENSION

THE WRIST IN FLEXION

THE WRIST IN ABDUCTION/ADDUCTION

THE WRIST IN ABDUCTION

THE WRIST IN ADDUCTION

extended hand.[25] Circumduction involves the complex interplay of all three wrist joints: the radiocarpal; the midcarpal; and the intercarpal.

WRIST IMMOBILIZATION

Opposed to these variants of wrist articulations are the assorted means of stabilizing or fixating the wrist (seemingly "dis-using" it) in order to disallow its movement:

i) when the forearm is raised to the piano keys, the wrist extensors act to stabilize the hand at an angle of 20°-30°; this lines up hand, wrist and elbow level with the keyboard, the normal playing position; such a degree of extension, providing the optimum functional position for the finger muscles, is known as the position of function;[26]

ii) gravity (in conjunction with ligamentous integrity and muscle action) acts on the forearm to help stabilize the wrist in its desired position when the hand is supported by the keyboard;[27]

iii) activity in the thumb has an important influence on wrist mobility/immobility; some of the muscles controlling the thumb's horizontal movements (abduction/adduction) and vertical movements (flexion/extension) originate in the forearm and pass over the wrist for attachment to the thumb bones;[28] since "tendons control the

---

[25] This variable range can be empirically observed when the wrist is circumducted first while the short, extended fifth finger sustains a note, and next when the long, extended third finger sustains a note. The circle described in the latter case is noticeably wider.

[26] Ibid., p. 257.

[27] Igor Hmelnitsky; Nigel Nettheim, "Weight-bearing Manipulation: A Neglected Area of Medical Science Relative to Piano Playing and Overuse Syndrome," Medical Hypotheses, 23 (1987), p. 210.

[28] Lucille Daniels; Catherine Worthingham, Muscle Testing, 3rd ed. (Toronto: W.B. Saunders Company, 1972), pp. 128, 130, 132.

joints they traverse,"[29] the stronger the contraction of these muscles, the greater will be the fixation of the wrist joint;

iv) the simultaneous contraction of wrist extensors/flexors produces a degree of fixation proportional to the strength of the contractions,[30] since these muscles, too, control the joint they cross; and,

v) three sets of muscles serve to manipulate the fingers: two sets of intrinsic muscles which both originate and insert below the wrist (interossei and lumbricales),[31] and the antagonist pairs of long finger extensors/flexors which originate in the forearm and cross the wrist joint to insert into the finger bones;[32] it is these extrinsic muscles, traversing the wrist joint as they do, which are implicated in wrist fixation; of particular importance is the so-called "stiff-finger coordination,"[33] in which both flexors and extensors are contracted simultaneously; it is easy to observe, empirically, that such a coordination inevitably tightens the thumb as well, producing significant stiffening at the wrist joint.

Certain truths are common knowledge in the fields of kinesiology and physiology:

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29 Cailliet, Hand Pain, p. 5.

30 This direct relationship between the strength of contractions and the degree of fixation was verified in a conversation with Pamela Mustard.

31 Daniels and Worthingham, Muscle Testing, pp. 118, 124, 126.

32 Ibid., pp. 120, 122.

33 Schultz, Riddle Pianist's Finger, p. 107.

Tendons Passing Over the Wrist

after Cailliet, fig. 15, p. 93

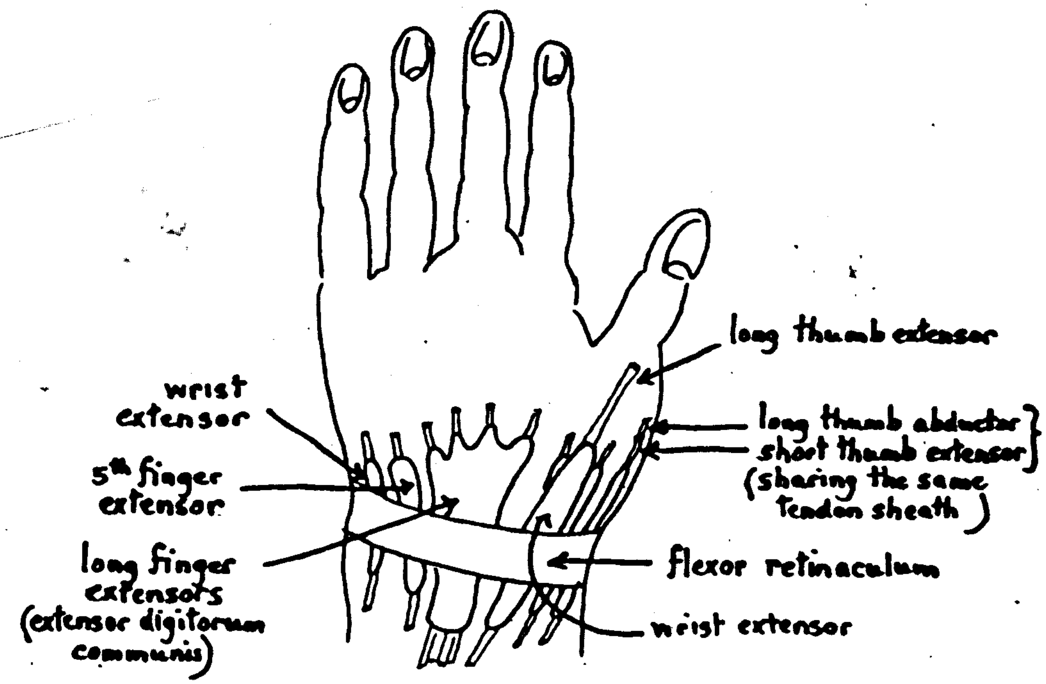

Illustration 5

i) with all physical movements "the physiologically best movement is the one permitting motion near the middle of range of the joints involved";[34]

ii) simple common sense dictates that the most efficient and coordinated movement forms are those in which the minimum amount of contraction necessary to accomplish the task is exerted for the minimum possible time span;[35]

iii) more than one set of muscles combining in a cooperative action to accomplish the movement is healthier, physiologically, than the over-burdening of a single, small set of muscles;[36] and,

iv) tendons which pass over bony joint structures are subject to extra wear and tear, especially when the tendons are in a stretched state;[37] additionally, the strain of a long, thin tendon under pressure is naturally much more acute than when the stretch is distributed along the length of a short, broader tendon.[38]

Bearing in mind these facts, and armed with an understanding of the structures involved in wrist mobilization/immobilization, the pedagogue can arrive at three important conclusions for piano performers.

Firstly, there is a danger in the cultivation of a hand *staccato* which seeks to limit the action to the wrist joint. The tendency

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[34] Otto Ortmann, The Physiological Mechanics of Piano Technique (New York: E.P. Dutton & Co., Inc., 1929), p. 33.

[35] This statement corroborated in consultation with Dr. David C. Reid, Associate Professor of Rehabilitation Medicine, University of Alberta, Edmonton.

[36] Ibid.

[37] Duckworth, Notes Orthopaedics Fractures, p. 12.

[38] Sandra Curwin; William Stanish, Tendinitis: Its Etiology and Treatment (Toronto: D.C. Heath & Co., 1984), p. 8.

then arises (especially when a substantial sound is called for) to overflex the wrist beyond its healthy mid-range of motion in order to attain the speed of attack that a longer stroke will accomplish. When the upper arm is the initiator and the fingers are also playing an active role, the forearm muscles are relieved of their exclusive burden.

Secondly, there is a need to be aware of the various finger coordinations and how they implicate the long finger extensors/flexors.

"Play with curved fingers" is still the prime injunction of many piano pedagogues, and such a directive can easily evoke the previously-mentioned "stiff-finger" coordination, described by Arnold Schultz in The Riddle of the Pianist's Finger. Schultz writes of this coordination:

> . . . the long [finger] flexors and the extensor contract simultaneously to stiffen the finger, the long flexors then contracting in excess [my emphasis] of the fixation to move the finger downward.[39]

While such a coordination does have advantages for the wide range of intensity it allows, it puts a big work-load on the tendons involved, and impedes all the helpful movements of wrist abduction/adduction, flexion/extension and circumduction.

In a second type of "stiff-finger" coordination described by Schultz, there is, again, the simultaneous contraction of the long finger flexors/extensors, but this time it is the intrinsic hand muscles that propel the finger into the key. Here excessive flexor

[39] Schultz, Riddle Pianist's Finger, p. 107.

fixation is avoided, but wrist movement is still impaired. Advantages for velocity are greater than in the first coordination, but the range of intensity is less.

Schultz's seminal contribution to finger coordination is his focus on the mid-joint of the finger and its "breaking" so that the finger can be propelled into the key from the knuckle joint, largely by the lumbricales, and without the simultaneous fixation of the long finger tendons. Empirical observation proves that substantially curved fingers absolutely mitigate against this coordination, which, while it is limited in its range of intensity, is the *sine qua non* of velocity.[40]

Where velocity is not a consideration, but *cantabile* tone is, there is a coordination involving the intrinsic hand muscles in maintaining firmly flexed fingers at the keys while a flexible wrist with free arm behind it transmits the desired weight to the keys. Here the long finger tendons are relatively out of work.

The same relative unemployment of the long finger extensors/flexors is experienced when the playing unit is fixed from elbow to finger-tips in detached touch forms.

An example of over-employment of the long finger extensors/flexors is humorously described by Gyorgy Sandor in On Piano Playing, in which he cites a particular type of finger exercise where certain notes are sustained while others are forcefully executed to achieve finger independence. He writes:

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[40] Schultz, Riddle Pianist's Finger, pp. 130-134.

> The victim, or student, is supposed to press down four notes, raise the finger that plays, and repeat the down-and-up motion until he feels considerable tension and stiffness in the forearm. He then proceeds to the next finger and lets the previously active one join the others in pressing down the keys. During the entire procedure the arm and wrist are supposed to be held immobile in a fixed position by tightening up both the flexor and extensor muscles of the forearm. . . . If we insist on continuing this masochistic pastime, we will indeed develop chronic tendinitis--which becomes the "coup de grâce" that will liberate us from any further undue suffering. We will then have to give up the piano completely![41]

The adaptation of such an exercise to include the flexion/extension of the wrist in a coordinated, blended action can, on the other hand, transform it into a highly useful technical tool.

The third important conclusion for the pianist involves his thumb. Because tightness at the thumb mitigates against wrist flexibility, there must be a focused awareness on how the thumb feels. When the thumb is not in use, its gravitational weight is easily supported by the keyboard. Alternatively, it can be allowed simply to hang loosely, rather than be held in a certain position by the unnecessary simultaneous contractions of its flexors/extensors. Of great importance, too, is the way in which the taking of a span, (say, an octave) is handled. Excellent advice in cultivating a healthy hand extension comes from Abby Whiteside, who proposes that the feeling of extension be in the palm of the hand rather than at the tips of the fingers. She writes:

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[41] Gyorgy Sandor, On Piano Playing: Motion, Sound and Expression (New York: Macmillan, 1981), p. 159.

> The faulty span is one which reaches and holds at the <u>tips</u> of the thumb and finger. All that is needed to cure that habit is to achieve the holding of the span between the hand knuckles of the finger and the second joint of the thumb. That means opening the palm instead of stretching the fingers.
>
> Learn to abduct the thumb with the palm segment. It is quite easy to localize this control if the thumb is flexed at the first and second joints. . . . The result should be a kind of diagonal pull from hand knuckle joint of finger to second joint of thumb. When this is achieved, then extend the fingers and thumb.[42]

Such a span maintains the integrity of the carpal arch, and prevents an undue stretch of the thumb abductor, and of the radial collateral ligament, with the result that wrist flexibility is less impinged upon.

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[42] Abby Whiteside, <u>Indispensables of Piano Playing</u>, 2nd ed. (New York: Coleman-Ross Co. Inc., 1955), p. 98-99.

WRIST AILMENTS AND THEIR MANAGEMENT

A review of the medical literature on wrist ailments in general and among pianists in particular leads not only into a terminological maze, but also to a perplexing quandary regarding conflicting approaches to diagnosis and treatment.

In an attempt to clarify this confusion, the definition, etiology and treatment programs for these various ailments will first be outlined.

I i) Synovitis--inflammation of a synovial membrane.[1]

ii) Tendinitis--inflammation of a tendon.[2] The tendons implicated in wrist movement (those of wrist flexors/extensors, long finger flexors/extensors, and thumb abductors and extensors)[3] which pass under the *flexor retinaculum* (see illustration 5, p. 12), are encased in synovial sheaths,[4] and usually tendinitis occurs simultaneously with inflammation of the synovial sheath of the tendon.[5]

iii) Tenosynovitis--inflammation of a tendon and its synovial sheath.[6]

iv) Tenovaginitis--technically the correct term for that pathology of an inflamed tendon sheath whose stenosis (narrowing)

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[1] Joan Luckmann and Karen Creason Sorensen, Medical-Surgical Nursing: A Psychophysiologic Approach, 2nd ed. (Toronto: W.B. Saunders Company, 1980), p. 1704.

[2] Ibid.

[3] Daniels and Worthingham, Muscle Testing, pp. 114, 116, 120, 122, 128, 130, 132.

[4] Sandra Curwin and William Stanish, Tendinitis: Its Etiology and Treatment (Toronto: D.C. Heath & Co., 1984), p. 8.

[5] Robert Berkow, Ed., The Merck Manual of Diagnosis and Therapy, 14th ed. (Rahway, N.J.: Merck Sharp & Dohme Research Laboratories, 1982), p. 1225.

[6] Luckmann and Sorensen, Medical-Surgical Nursing, p. 1704.

Schematic Tendon Sheath

after Cailliet, fig. 30, p. 29

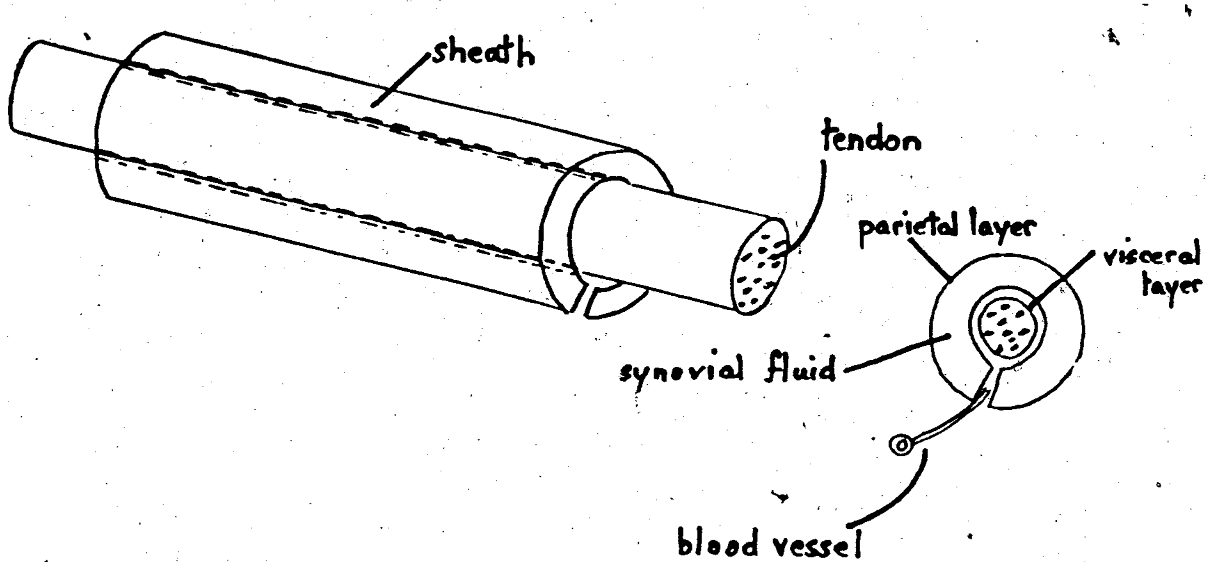

Illustration 4

causes friction, restriction, and painful movement of the tendon it encloses.[7]

Etiology[8]

1. excessive, repetitive use; and,
2. strain during use.

Symptoms and Signs[9]

1. possibly visible swelling of the sheath because of edema and inflammation, or

2. sheath containing a certain amount of fluid can elicit friction rubs that can be felt as the tendon moves in its sheath, or heard with a stethoscope;

3. variable localized tenderness; when tenderness is severe, movement can cause disabling pain, in which case movement is restricted; and,

4. x-ray may (rarely) show calcium deposits in the tendon and sheath.

Recommended Treatment[10]

1. rest, including use of splints;[11]
2. heat/cold;
3. ultra-sound;
4. analgesic agents locally;

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[7] This definition arose out of a consultation with Dr. David C. Reid, Associate Professor of Rehabilitation Medicine, University of Alberta.

[8] Curwin and Stanish, Tendinitis, p. 142.

[9] Berkow, Merck Manual, p. 1225.

[10] Ibid., p. 1226.

[11] Fred H. Hochberg et al., "Hand Difficulties Among Musicians," Journal of the American Medical Association, 249 (1983), p. 1872.

5. non-steroidal and anti-inflammatory agents systemically and/or locally;

6. cortico-steroid injection into tendon and sheath to reduce pain and inflammation;

7. in persistent cases, surgical decompression and removal of inflamed and calcific deposits; and,

8. graded movement program and rehabilitation.

II De Quervain's Syndrome (also referred to as stenosing tenosynovitis, tendovaginitis and tenovaginitis).

First described by Swiss surgeon F. de Quervain in 1895, this ailment involves the short thumb extensor and long thumb abductor.[12] They share the same synovial sheath in their passage along a bony groove behind the styloid process of the radius (see illustration 5, p. 12), through an angulation of as much as 105° en route to insertion on the thumb.[13] Synovitis is a result of the friction set up between the tendon, its sheath, the bony radio-styloid process, and the *extensor retinaculum* under which these structures lie.[14]

Etiology[15]

1. excessive, repetitive wrist movements; and,

2. pressure on tendons passing under the *extensor retinaculum*.

[12] Cailliet, Hand Pain, p. 92.
[13] Ibid.
[14] Curwin and Stanish, Tendinitis, p. 142.
[15] Ibid.

Symptoms and Signs[16]

1. a feeling of "aching discomfort over the [radio-styloid] process," which is exacerbated with wrist and thumb activity;

2. pain when tendons are stretched;

3. pain upon resisted abduction of the thumb; and,

4. a thickened sheath which may increase to two to four times its normal size due to increased vascularity and edema.[17]

Recommended Treatment[18]

1. immobilization;[19]

2. local application of ice;

3. anti-inflammatory drugs; and,

4. "physio-therapy (usually ultrasound in water)."

These measures are usually successful. More resistant cases might require:

5. steroid injections into the sheath; and,

6. surgical decompression by slitting the sheath.[20]

III Carpal Tunnel Syndrome--compression of the median nerve as it passes under the wrist through the tunnel between the carpal arch and the *flexor retinaculum* (transverse carpal ligament).[21]

Etiology

1. Excessive, repetitive wrist flexion/extension in combination with simultaneous finger flexion.[22]

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16 Ibid., excluding item 4.
17 Cailliet, Hand Pain, p. 93.
18 Curwin and Stanish, Tendinitis, p. 142, excluding items 1 and 6.
19 Cailliet, Hand Pain, p. 93.
20 Ibid.
21 Ibid., p. 68.
22 Ibid., p. 71.

Contents of the Carpal Tunnel

after Cailliet, fig. 26, p. 25

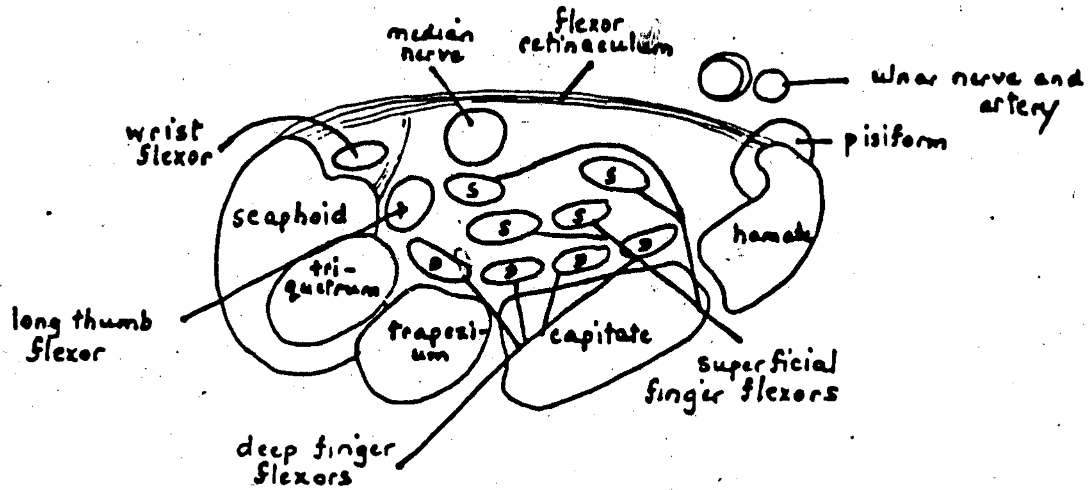

Illustration 6

George S. Phalen writes, "I still believe that thickening or fibrosis of the *flexor synovialis* within the carpal tunnel is the most common cause of the syndrome." He cites statistics of histologic examinations which reveal chronic fibrosis in 55%, chronic inflamation in 31% and no pathological change in 14% of a group of 148 patients.[23]

Symptoms and Signs[24]

1. numbness, burning, tingling, itching of the thumb, index and third fingers;

2. pain ascending into the arm at night;

3. clumsiness, weakness, dropping of objects;

4. impaired sensation to a pin prick in the first three fingers; and,

5. ultimately, thenar atrophy (the affected muscles being the short thumb abductor and the *opponens pollicis*,[25] that muscle which enables the thumb to touch the pad of the little finger).[26]

Recommended Treatment[27]

1. rest, including the use of splints;

2. steroid injection into the tunnel may give some temporary relief, but its value is mainly as a diagnostic tool; and,

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[23] George S. Phalen, "Reflections on 21 Years' Experience With the Carpal-Tunnel Syndrome," Journal of the American Medical Association, 212 (1970), p. 1366.

[24] Cailliet, Hand Pain, p. 69, excluding item 6.

[25] Phalen, "Reflections Carpal Tunnel Syndrome," p. 1366.

[26] Daniels and Worthingham, Muscle Testing, p. 136.

[27] Cailliet, Hand Pain, p. 71.

3. surgical decompression involving severing the entire width of the *flexor retinaculum* and the removal of the synovium if thickened; while sensory return is usual, motor return is variable.

IV Overuse (Injury) Syndrome--Tenderness and pain in the joint ligaments and muscles of the upper limb,[28] advanced cases being characterized by weakness, impaired agility and speed, and a loss of response and control.[29]

Etiology

1. Overuse of the structures involved, both in terms of repetition and intensity.[30]

Signs and Symptoms[31]

1. demonstrable tenderness in intrinsic hand muscles;

2. demonstrable tenderness in joint ligaments of the radial side of the wrist and the carpometacarpal joint of the thumb;

3. swelling over the affected muscles, ligaments;

4. spread of pain proximally and distally;

5. subtle, difficult-to-describe sensory changes in the skin over the affected areas;

6. loss of coordination/strength;

7. depression -- H.J.H. Fry, a leading Australian researcher, writes: "The patients invariably felt depressed";[32] and,

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28 Hunter J.H. Fry, "Overuse Syndrome, alias Tenosynovitis Tendinitis: The Terminological Hoax," Plastic and Reconstructive Surgery, 78 (1986), p. 414.

29 Ibid., p. 415.

30 Hunter J.H. Fry, "Physical Signs in the Hand and Wrist Seen in the Overuse Syndrome of the Upper Limb" Australian and New Zealand Journal of Surgery, 56 (1986), p. 47.

31 Idem, "Overuse Syndrome Terminological Hoax," p. 415.

32 Idem, "Overuse Syndrome of the Upper Limb in Musicians," Medical Journal of Australia, 144 (1986), p. 183.

8. infrequently, symptoms suggesting median/ulnar nerve involvement; Fry attributes this effect to "the direct action of pharmacologically active substances produced by the affected muscle groups through which the nerve trunks pass in the forearm."[33]

Recommended Treatment

1. most severe cases: radical rest, meaning "the total avoidance of all pain-inducing activities";[34] and,

2. least severe cases: some modification of technique, practise habits,[35] and the teaching of body awareness control.[36]

V Repetition Strain Injury--a term coined in Australia in 1981-82 (for legal purposes, by the Workmen's Compensation Board) to supersede "tenosynovitis," and later extended to embrace virtually all painful conditions of the upper limb, including those listed previously, apart from the exclusion of the "overuse syndrome" as a separate entity.[37]

It is interesting to speculate just who among those young pianists with wrist splints at the University of Alberta really was suffering from tendinitis (or tenosynovitis). Certainly, the research of the American team of Doctors F.H. Hochberg, L.D. Leffert, M.D.

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[33] Idem, "Overuse Syndrome Terminological Hoax," p. 415.
[34] Ibid., p. 416.
[35] Idem, "Overuse Syndrome Upper Limb," p. 183.
[36] Earl R. Owen, "Instrumental Musicians and Repetition Strain Injuries," Journal of Occupational Health and Safety - Australia and New Zealand, pp. 183-39.
[37] Fry, "Overuse Syndrome Terminological Hoax," p. 414.

Heller, and L. Merriman emphasizes the diagnosis and treatment of "inflammatory disorders of tendon or joint.[38] Their findings[39] are based on studies of 100 musicians (75 of them pianists who played an average of five to six hours daily). Forty-nine of the total population were examined by the team; other data were obtained through correspondence. Of that total population, 45% were reported to have inflammatory diseases of the tendon/joint. The examinations by Hochberg and his associates included serological work to determine the presence/absence of inflammatory conditions. Many of these subjects had been previously and correctly (according to Hochberg) diagnosed as having tendinitis or carpal tunnel syndrome.

Of those 49 examined, 36% were diagnosed as having tendinitis/tenosynovitis, occurring mainly in the lumbricales and the long finger extensors of the right hand, with the hand and wrist flexors being least affected.

As for specific involvement of the wrist joint itself, of the total population, only 4% cited the wrist (3% right wrist, 1% left wrist) as the focus of their difficulty, although a further 11.5% complained of unspecified hand difficulties, and 5.5% cited thumb problems.

Hochberg speculates tentatively that the genesis of tendinitis lies in the stretching of the hand and fixing of the thumb (say, to cover an octave span), coupled with the execution of rapid, powerful strokes. Examination reveals a bogginess in the tendon and a feeling

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[38] Hochberg, "Hand Difficulties," p. 1869.
[39] Ibid., pp. 1869-72, summarized in the five paragraphs that follow.

of discomfort localized around the forearm's extensor sheath. He further notes less common sites of tendinitis including the *flexor retinaculum* and the thumb extensors.

As for treatment, Hochberg prescribes rest (including the use of wrist splints) for three to six weeks, followed by physical therapy. He questions the efficacy of anti-inflammatory drugs. Such a treatment program allows 60% to return to work. Unfortunately, recurrences are common. Hochberg comments on the musicians' lack of a medical vocabulary with regard to symptomology, and advocates a medical-musical collaboration to research cause and prevention.

Fry, on the other hand, plumps for a diagnostic terminology (overuse syndrome) that accentuates the cause of the ailment.[40] He questions the tacit acceptance of an inflammatory etiology despite "total absence of proof of this highly verifiable pathology."[41] He cites operations by Howard at Stanford University demonstrating "tendon sheaths of patients with the overuse condition were normal to the naked eye," and which, on the basis of biopsy evidence, showed the real lesions to be in the muscle. Furthermore, "secondary inflammatory changes seen outside the muscle sheath were presumably due to diffusion of products from muscle damage."[42]

Fry's findings are based on the "personal experience of a study of 650 musicians" (as well as 1300 patients from other

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[40] However, since the purpose of a diagnosis is to define a pathology which can then issue in a course of treatment, Fry's "overuse syndrome" can hardly be termed a diagnosis.

[41] Fry, "Overuse Syndrome Terminological Hoax," p. 414.

[42] Ibid., pp. 414-15.

occupations), and his conclusions are that the overuse syndrome among musicians is of the same order as that of marathon runners who suffer muscle fiber necrosis during long runs, and of polio victims who tend to over-use their surviving muscle fibre later in life. There are muscle biopsy studies documenting overuse in both these populations,[43] but thus far musicians' muscles have not been made available for scientific research! Fry proclaims:

> Operations on the tendons and tendon sheaths in such patients [musicians who may practise or rehearse some 3-10 hours a day] have not furnished histological proof of the diagnosis nor has any clinical effect been reported.[44]

Fry further cites the lack of improvement in the condition of patients having undergone tenosynovectomies and carpal tunnel operations,[45] and concludes: "Indications for surgical intervention in patients with overuse syndrome must be immaculate, since overuse syndrome mimics or may even coexist with other conditions."[46]

Where does all this conflicting information and opinion leave the piano pedagogue and performer?

The common ground ~~seems to~~ center around the fact that repeated movements coupled with intensity demanding high loading of the physical structures involved can lead to pain and put the

43 Ibid., p. 416.
44 Idem, "Overuse Syndrome Upper Limb," p. 182.
45 Ibid., p. 183.
46 Idem, "Overuse Syndrome Terminological Hoax," pp. 416-17.

pianist at risk. It would seem that he can better care for himself by implementing the following measures:

1. acquiring a knowledge of his physical anatomy as it applies to piano playing, and a repertoire of healthy, coordinated physical movements; i.e. those which require the minimum loading for the minimum duration to produce the desired tone;

2. developing an increasing awareness of how his body feels as he plays: when and where is there tension, stretching, contraction; or, conversely, when and where is there a feeling of looseness, lightness, relaxation;

3. developing a sensible practice regimen; Fry suggests 25-minute periods, followed by 5-minute breaks to allow the recovery of muscles involved;[47]

4. heeding the warning signal of pain; Fry reports that all too often afflicted pianists not only continue but intensify their practice schedule with the onset of pain;[48] there must be open communication among musicians, their mentors, and the medical profession; and,

5. realizing that there seems to be a genetic factor involved in the physical capacity to withstand repetitive movement: some are simply more robust than others;[49] each performer must tune into what his body is telling him, and learn its healthy limitations; sheer physical size is another variable, and performers and their teachers must be realistic about choice of repertoire and the

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[47] Idem, "Prevalence of Overuse (Injury) Syndrome in Australian Music Schools," British Journal of Industrial Medicine, 44 (1987), p. 39.

[48] Ibid., p. 38.

[49] Ibid., p. 39.

avoidance of prolonged extension; Owen suggests, too, the need for awareness by teachers of a child's growth spurts, "where rapid bone growth completely unbalances their muscle-tendon-hand-finger combinations and leads to very rapid onset of RSI symptoms."[50]

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50 Owen, "Instrumental Musicians," p. 138.

TONE PRODUCTION AND THE WRIST

The desire to produce a certain sound at the piano causes the pianist to find ways and means to recreate that aural image. While a satisfying tone production can be achieved empirically, a knowledge of what causes variations in piano tone, and how (for the specific purposes of this paper) the wrist is implicated, may help to bring about the achievement of the desired tone more quickly and easily.

Abhorrent as it may be to the sensitive souls of some performers, the scientific fact is that piano tone "quality" hinges on the speed with which the hammer hits the string, and this, in turn, is a product of the mass of the body and the speed of that body in producing the key descent.[1]

Six ancillary factors governing (perceived) tonal variations are:

i. percussive noises in the actions of the particular instrument, as well as those made by the contact of the finger with the key surface;[2]

ii. the inter-relationship of one sound to what precedes and follows it: piano tone is heard not as discrete sounds, but rather as a continuum in which the subtle inter-relationships among the sounds bear upon the listener's sensing of the tone itself;[3]

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[1] Ortmann, Physiological Mechanics, ~~4, 337~~.
[2] Ibid., p. 342.
[3] Ibid., pp. 337, 355.

iii. the failure of the listener to dissociate what is heard from what is seen; for example, seeing an abrupt physical motion can cause the listener to imagine that he hears an accent;[4]

iv. the performer's use of the pedals;[5]

v. the tonal capacity of the instrument being played: simply compare the resources of any nine-foot grand piano with a bottom-of-the-line upright;[6] and

vi. the acoustical properties of the space in which the piano is being heard.[7]

Following are the ways in which the wrist is an agent in producing piano tones.

I. THE WRIST IN EXTENSION/FLEXION

A. Perhaps the most obvious wrist stroke is its alternate extension and flexion, the vertical up-and-down motion that the pianist makes in executing what is variously known as wrist or hand *staccato*.

B. i) Wrist extension and flexion facilitates the execution of the two-note phrase, and the very movement-complex (the active down-stroke followed by the relaxation of the whole hand on the up-stroke of the wrist) is congruent with the musical expression usually

[4] Ibid., p. 355.

[5] Sandor, Piano Playing, p. 161.

[6] Wilmer T. Bartholomew, Acoustics of Music (Englewood Cliffs, New Jersey: Prentice-Hall, 1942), p. 14.

[7] Ibid., pp. 65, 67, 71, 74.

implied in such a figuration (the "sigh" of the Baroque appoggiatura comes to mind).

ii) This principle can well be extended to phrases containing more than two notes, where the initiating gesture is one of wrist extension, and the termination that of wrist flexion. (The two-note or two-note-plus phrase is not universally executed using wrist extension/flexion. For an application employing a stabilized wrist as part of the forearm stroke, see p. 49).

C. i) The undulating motion of wrist flexion and extension facilitates the *quasi-legato* repetition of repeated notes. Flexion of the wrist allows the raising of the key to that crucial point, not so high as to cause the cessation of sound, yet sufficiently high to allow the ensuing key-depression with an action that includes wrist extension.

ii) This vertical up-and-down wrist motion is also part of a coordinated action used in playing a series of rapidly repeating notes with changing fingers. The wrist accommodates the different finger lengths with its undulation, and it is the constantly changing pull on muscles that furnishes the required endurance.

D. It is principally the wrist in flexion/extension (although many small horizontal adjustments may also be taking place) that helps to deliver the fingers to their keys in the playing of polyphonic passages. Here, the undulation, providing a relaxation at the wrist joint, is helpful in the prevention of fatigue.

E. Flexion and extension of the wrist in a single-voice melodic line adds the power and control of a bigger lever to the fingers in their key descent, thus increasing the quantity of sound. This active stroke, elaborated upon exhaustively by Robert D. Schick in The Vengerova System of Piano Playing, constitutes the thrust of Isabella Vengerova's technical system, namely, "wrist accents."[8]

II. THE RELAXING WRIST

A. In contrast to this direct role of the wrist in producing the sound is the wrist as a passive agent behind the activity of the fingers at the keys. Otto Ortmann's description of this phenomenon offers indisputable scientific verification of the raising of the wrist when the finger has fully depressed the key, and the wrist's fall as the finger rises.[9]

In contemplating the distinction between the active and passive roles of the wrist just elaborated above, the question of proximal (near to the centre of the body) versus distal (peripheral, or away from the centre of the body) control arises. As the arresting folk saying asks, "Does the dog wag the tail or the tail wag the dog?" Abby Whiteside, writing in The Indispensables of Piano Playing, makes a compelling case for central control by the upper arm, arguing that the fine control to be exercised in the removal of a sliver from the eye would come not from the finger-tips, but rather "with an action that involved a coordination from head to toe."[10]

Arguing for the disto-proximal theory of motion, that is, control of motion by the distal finger joints of the more proximal joints above them, are Igor Hmelnitsky and Nigel Nettheim. They describe the raising of the finger to play a single note:

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[8] Robert D. Schick, The Vengerova System of Piano Playing (University Park: Pennsylvania State University Press, 1982), p. 12.

[9] Ortmann, Physiological Mechanics, p. 85.

[10] Whiteside, Indispensables, p. 49.

> This does not use the extensors, as would be naively supposed. Instead, the finger which is presently playing is strongly flexed: this action provides a force tending to raise the hand (and with it the forearm), while the non-playing fingers appear to be raised (perhaps about 15 degrees extension at the metacarpo-phalangeal MCP joint) with scarcely any work of their own. The arm also will be displaced to some extent or tossed around in a ballistic manner by this activity so that the observer might mistakenly think that the arm is being "used;" its movements are instead passive.
>
> Thus the hand, wrist and arm are controlled from the distal end, using the small muscles of the hand, and not from the proximal end.[11]

Substantiating their theory, Hmelnitsky and Nettheim invoke the research of Carol Loria on the relationship of proximal and distal function in motor development. Loria concludes that "proximal development is not a pre-requisite for distal motor development" and claims that her findings "tend to support the theory of a dual motor control mechanism in the developing human infant."[12]

B. In delivering an unprepared key attack, the player stabilizes the wrist for the application of power. At the moment just before the keybed resistance is felt, a relaxation of the wrist joint retards the playing mechanism, thus diminishing the thud against the keybed. The amount of relaxation determines the speed with which the hammer will be delivered to the string, thus determining the tone "quality." This "cushioning" by the wrist is one of its prime functions in tone control.

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[11] Hmelnitsky and Nettheim, "Weight-bearing Manipulation," p. 210.

[12] Carol Loria, "Relationship of Proximal and Distal Function in Motor Development," Physical Therapy 60 (1980), p. 171.

III. THE WRIST IN EXTENSION

In an unprepared key attack for a single tone, extension of the wrist (a low wrist) retards the delivery of power, thus producing a tone subjectively judged to be less harsh because its ratio of fundamental vibration is high in comparison to the vibrations of the string's upper partials.[13]

IV. THE WRIST IN FLEXION

A. The powerful flexion of the wrist, in combination with strong movement at the elbow and upper arm has been found by the writer to be efficacious in producing the big sound associated, say, with the opening chords of Tchaikowsky's first piano concerto.

B. Similarly, strong wrist flexion is effective in the emphatic delivery of single notes.

V. THE WRIST IN ABDUCTION/ADDUCTION/CIRCUMDUCTION

The piano keys descend vertically, and, therefore, the most efficient stroke in delivering the power is a stroke at right angles to the key.[14] Since the fingers are varied in length, it is the abduction, adduction and circumduction of the hand (all accomplished by means of a flexible wrist joint) which delivers the fingers to this efficient perpendicular relationship to the keys.

VI. THE STABILIZED WRIST

A. The title of Tobias Matthay's book, The Visible and Invisible in Piano Technique,[15] presents a very important concept for the

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[13] Bartholomew, Acoustics, p. 13.

[14] Sandor, Piano Playing, pp. 22.

[15] Tobias Matthay, The Visible and Invisible in Piano Technique (London: Oxford University Press, 1932).

consideration of piano practitioners: not everything that goes on in the playing mechanism can be seen. In the stabilization of the wrist for the forearm stroke from the elbow hinge, it is the unseen, simultaneous contraction of wrist flexors and extensors (as well as the fixation of knuckle and finger joints) which allows the power to go directly to the tips of the fingers without being distributed along the way. The use of the longer lever provides optimal control of attack and release.

B. Stabilization of the wrist is also required in the use of forearm rotation at the piano. Like most of the moves a pianist makes, this one is common to everyday living: it accomplishes the turning of a door-knob. Describing forearm rotation, Gyorgy Sandor writes: "The wrist functions only as an inactive connecting joint."[16] Yet, in order for that wrist to be "inactive," its extensors must be contracted to disallow any independent movement and twisting.

C. In order to achieve the maximum mechanical advantage with the minimum muscular contraction, it is advantageous to line up the mass of the playing mechanism bone-on-bone. In this case, the body will lean backward so that the arm can be lined up from the shoulder through to the elbow and wrist in a relatively straight line, as it angles down towards the fingers fixed at the keys. In this attitude the wrist is elevated well above the keyboard level.

VII. THE TOTALLY LOOSE WRIST

When the arm is at the side of the body, simply suspended from the shoulder, the hand hangs from a totally loose wrist in which there is

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[16] Sandor, Piano Playing, p. 85.

no stabilization. Such a hanging hand allows the pianist to cover distances with speed and accuracy in taking leaps. Abby Whiteside writes:

> There has been much discussion concerning a "loose wrist." The wrist is only effectively "loose" when it allows an action farther back in the arm to propel the hand through an arc of distance. Then its "looseness" is of the utmost importance.[17]

While this wrist attitude is not directly involved in the actual production of the tone, it enables the pianist to get where he wants to be with optimum speed, accuracy and grace, in order to produce the next sounds.

[17] Whiteside, Indispensables, p. 40.

WRIST ATTITUDES ILLUSTRATED IN EXCERPTS FROM BEETHOVEN'S BAGATELLES

I. THE WRIST IN EXTENSION/FLEXION

A. Alternate extension/flexion of the wrist constitutes wrist (hand) *staccato*.

Bagatelle Opus 33/2, Trio mm. 51-52.

Here is the trouble-spot for most students in this Bagatelle, probably for two reasons: inefficient organization of the double-note fingering, and unnecessary physical fixations. The hand must feel as it does when a person is seated with the hand resting, palm-up, on the knee: there is no excessive contraction of the long finger extensors to interfere with the wrist's mobility. The wrist alternately extends and flexes within an easy mid-range of motion, throwing the fingers into the keys and then quickly rebounding. The intrinsic finger muscles (whose activity does not bear upon wrist mobility) guide the fingers accurately to their destinations. Napier, describing the lumbricales and interossei writes:

> These short muscles are extremely well-endowed with special nerve endings which provide them with a positional sense that has no equal elsewhere in the body.[1]

[1] J. Napier, Hands (London: Allen & Unwin, 1980), p. 65, cited in Hmelnitsky, "Weight-bearing Manipulation," p. 210, n. 17.

The elbow is the joint against which the wrist plays, and because of this, reactive motion can be noted in the upper arm. Thus, although the wrist motion is of paramount importance, the total action is a blended coordination, involving much more of the playing mechanism.

B. i) Wrist extension/flexion accommodates the execution of the two-note phrase.

Bagatelle Opus 126/6, mm. 42-44.

In this succession of two-note phrases the down-stroke of the wrist (extension) with its compaction of muscle and bone provides the emphasis required on the initiating notes; and the relaxation of the hand as the wrist rises (flexion) produces the quieter release of the terminating notes, as well as preparing the hand for the next down-stroke.

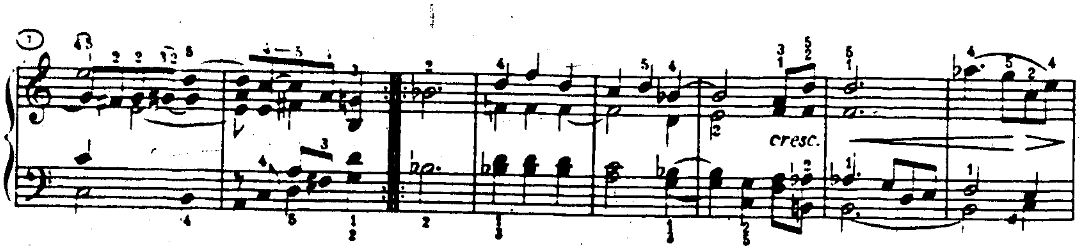
ii) Wrist extension/flexion facilitates extensions of the two-note phrase.

Bagatelle Opus 119/2, mm. 1-12.

The seven-note roulades in the left hand are initiated by the wrist in a low position, and terminated with a high wrist and hanging hand, providing healthy fluidity in wrist movement, and a physical gesture congruent with the musical expression.

C. An undulating wrist action (flexion/extension) facilitates the *quasi-legato* repetition of repeated notes.

Bagatelle Opus 119/8, m. 10.



The simplest and most apparent solution to Beethoven's *molto ligato* (sic) directive is the use of the damper pedal (and its disuse is by no means being advocated here). However, there is a psychological value to the pianist in maintaining intimate key contact, and thereby sensing, physically, the continuity of the three repeated chords. Wrist flexion allows the raising of the keys for the lower three voices to that point where the sound still continues, yet from which the keys can be re-pressed, using wrist extension to initiate this repetition.

D. An undulating wrist action facilitates *legato* in polyphonic textures.

Bagatelle Opus 33/4, m. 43.

Given the alto fingering suggested in m. 43, it must be assumed that the soprano fingering would be 5, 5, 3, 4, 5 since covering C#-A with the second and fourth fingers would be an impossible extension. A second fingering possibility is to use the thumb everywhere in the alto voice (in which case the soprano fingering would be 5, 4, 3, 4, 5)., Whichever solution is chosen, alternating wrist flexion and extension is a *sine qua non.* If the pianist chooses to use 1 and 2 alternately in the alto, a fluctuating wrist eases the tension put on the joint when the thumb and fingers are in abduction. The second option, to use the thumb everywhere, demands the raising of the wrist while maintaining key contact, and its lowering as the thumb flops to each subsequent note. (Chopin's Etude in D-flat, Opus 25 number 8, is the ultimate challenge for this particular pedagogical problem, and the pianist choosing the latter fingering solution must have a facile thumb, indeed).

E. Wrist flexion and extension in a single-voice melodic line adds the increased power and control of a longer lever.

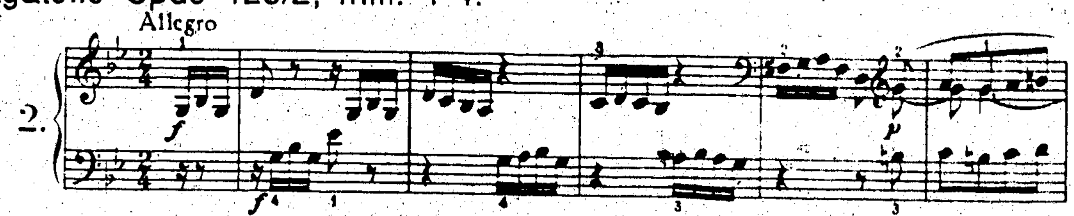
Bagatelle Opus 33/4, mm. 16-24.

Simply using the active wrist stroke in executing the left-hand progression helps not only to focus the performer's attention on that melodic line, but also to project it more clearly and expressively.

II. THE RELAXING WRIST

A. The wrist acts as a passive agent behind the activity of the fingers at the keys.

Bagatelle Opus 126/2, mm. 1-4.



This energetic opening requires more muscle power than fingers alone can provide, yet the tempo disallows the active stroke of wrist flexion/extension. A relaxation at the wrist joint, however, allows the transmission of arm weight through to the strongly flexed fingers. This kind of weight playing is gravity-assisted, in that the force of gravity ("the unseen muscle," "the only inexhaustible source of energy")[2] is acting on the forearm.

B. Resilience at the wrist joint just before the moment of keybed resistance "cushions" the resultant tone, serving both to retard the hammer speed and diminish the noise of the piano's action.

Bagatelle Op. 33/1, m. 9, etc.

[2] M.A. McConnail and J.V. Basmajian, Muscles and Movements (New York: Kreiger, 1977), pp. 206, 171, cited in Hmelnitsky, "Weight-bearing Manipulation," p. 211, n. 1.

The wrist has been well labelled "the transmitter," mediating as it does between the muscle and bone of arm and finger. For the drop into the *sf* chord the wrist is stabilized. Its loosening just before arrival at the key-bed is both physiologically healthy and tonally efficacious, preventing as it does both hard tone and undue noises in the piano's action.

III. THE WRIST IN EXTENSION

The wrist in extension, with the arm behind it, delivering the power for a single note, produces a full, but not harsh sound.

Bagatelle Opus 33/2, mm. 55-58.

Experimenting with the level of the wrist in executing these *sf* sounds produces interesting tonal differences. A high wrist position allows its alignment in a straight line with the fingers for a direct delivery of the power, while the lowered wrist (as in the proposed wrist extension) retards the delivery and yields a sound richer in fundamental vibrations. The latter position is a healthier one physiologically, since the sound can be sustained while the hand rests against the board of the piano underneath the keys.

IV. THE WRIST IN FLEXION

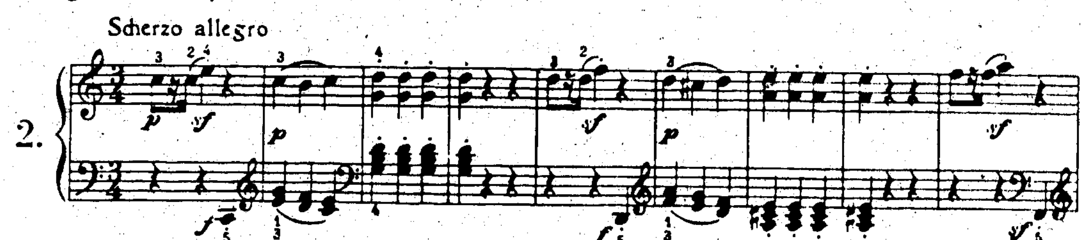
A. Powerful wrist flexion (combined with strong movement at the elbow and upper arm) produces substantial-sounding, detached chords.

Bagatelle Opus 126/6, mm. 73 and 74.

The strong upward jerk of the wrist is the prime mover in the coordinated action used to play the exciting flourish of tonic chords with which Beethoven begins and ends this final Bagatelle.

B. Powerful wrist flexion is also efficacious in the emphatic delivery of single notes.

Bagatelle Opus 33/2, m. 1, etc.

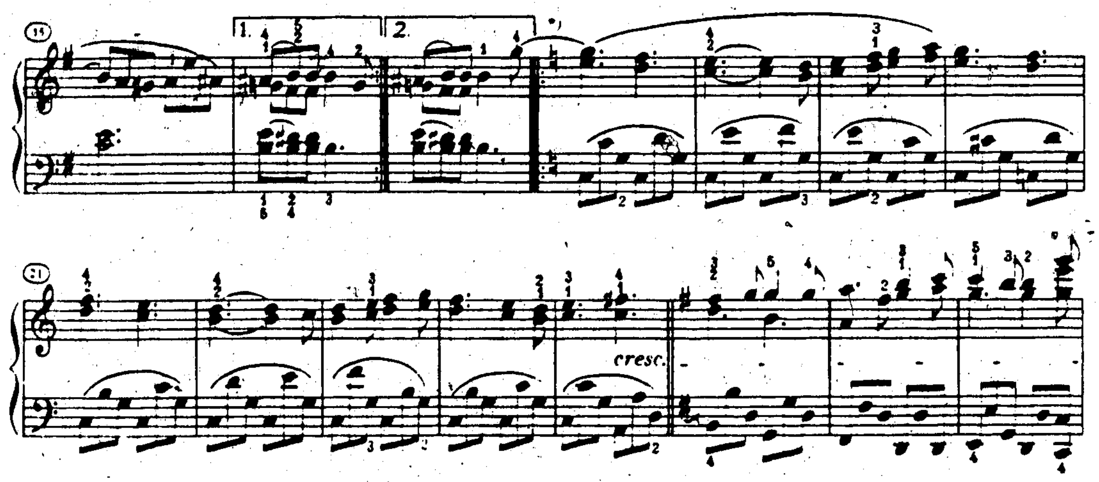


The sudden upward jerk of the wrist as the right hand plays the *sf* e" not only provides the added muscle and bone needed to supplement the sound. The visual effect of such a motion adds to its auditory impact.

V. THE WRIST IN ABDUCTION, ADDUCTION AND CIRCUMDUCTION

A. The wrist in circumduction helps to deliver the fingers to their key destinations with a physical gesture that is congruent with the musical content.

Bagatelle Opus 126/5, mm. 17-32.



The smooth execution of this angular left hand accompanying figure is greatly eased by a circular wrist motion which enables the performer to simulate the *legato* touch that Beethoven calls for. The particular stroke constitutes a physical gesture that is congruent, musically, with the rhythmic organization of 6/8 time.

B. The wrist in abduction accommodates the playing of notes so placed that the arm must reach across in front of the body.

Bagatelle Opus 33/6, mm. 78-85.

The capacity of the wrist to deviate to the left of its central axis facilitates the execution the closing chords of this Bagatelle. (Another solution would be to displace the torso to the left).

C. A combination of wrist <u>adduction/abduction</u> teams synergistically with finger muscles in executing a repetitive ascending and descending broken chord figure.

Bagatelle Opus 33/2, mm. 31-32.

In comparing a "fingers-only" approach to this figure with its execution using the wrist in adduction/abduction, the latter seems entirely effortless. Prolonged repetition of such a figure using the former coordination, however, leads to fatigue in the thumb extensor/flexor, and consequent stiffening in the wrist joint.

VI. THE STABILIZED WRIST

A. i) The stabilization of the wrist allows for a stroke to be made directly from the elbow hinge to the fixed fingers, utilizing what William Newman describes as the forearm's "power cum accuracy."[3]

Bagatelle Op. 119/5, mm. 1-7, etc.

The *risoluto* character of this Bagatelle can be best achieved with a playing unit that begins at the elbow hinge and ends at the finger-tips, allowing speed of delivery as well as bringing to bear all the compacted mass of bone and muscle between elbow and finger-tips. Thus, instead of the over-taxing of small finger muscles to produce the substantial tone required, the fingers' bony structures support the power of the arm. Each of the left-hand chords, as well as each right-hand note (apart from the ornaments), gets its own individual stroke from the elbow hinge. It is interesting to compare the difference, tonally, of this approach with one in which the wrist relaxes on each note. The fixed wrist and finger joints allow great

[3] William S. Newman, The Pianist's Problems (New York: Harper Bros., 1956), p. 47.

precision in the attack and release of notes, which also contributes to the over-all tonal impression.

ii) The stabilized wrist accommodates a forearm stroke that is effective in achieving a precise attack and release of two-note phrases.

Bagatelle Op. 119/1, mm. 44-47.

The fixing of the right wrist and the use of a forearm stroke on each beat of these measures allows for great accuracy in the timing of attacks and releases. It might be generalized that wrist extension/flexion accommodates expressive two-note phrases in slower tempi, while the forearm stroke with a stabilized wrist is more efficient in quicker tempi where rhythm rather than lyricism is the operative.

B. A fixed wrist provides the stability necessary for the stroke of forearm rotation.

Bagatelle Opus. 119/3, mm. 17-22.

While this left-hand passage can be played from the fingers only, or with the undulation of the wrist in flexion/extension, the use of the larger structures involved in forearm rotation is both healthier, physiologically, and more effective, musically. The repeated thumb notes are passive, merely "tucked in" between the active throwing of the outer fingers into the keys by way of forearm rotation. The more exaggerated the range of motion, the greater a hammer speed can be attained, and the stronger must be the stabilization of the wrist.

C. The elevated wrist is lined up, in a relatively straight line with the rest of the playing mechanism as it angles down in a fixed line from shoulder to finger tips.

Bagatelle Opus 33/7, mm. 141-144.

The massive sound called for in these *fortissimo* chords demands the maximum mass of compacted bone and muscle to be applied to the keys. The body must lean back to accommodate the alignment of shoulder, elbow, wrist and hand as they line up to deliver the power. Such a bone-on-bone alignment reduces muscular involvement.

D. The stabilized wrist acts as a fulcrum against which the finger coordination employing finger movement (with broken mid-joints) from the big knuckles can take place.

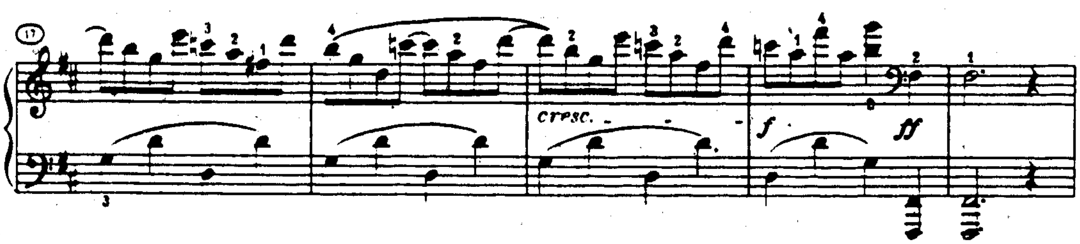
THE STABILIZED AND ELEVATED WRIST

Bagatelle Op. 33/1, m. 79.

Fitting in all the right-hand notes without slowing the beat is an exercise in velocity for which Arnold Schultz's previously-discussed touch-form (see p. 14) is an effective solution. The fingers need the stability of a fixed wrist against which their action can take place.

VII. THE TOTALLY LOOSE WRIST

The unstabilized, loose wrist, with hanging hand, accommodates the swiftest arc of motion initiated by the upper arm in taking leaps. Bagatelle Opus 126/4, mm. 20-21.



Both hands have a considerable leap to cover in attaining the F-sharps at a *presto* tempo. A relaxed wrist and elbow provide less resistance in making this move. Physiologically, this is a healthy attitude, providing, as it does, the opportunity for the muscles to return to their original length before a subsequent contraction is undertaken.

CONCLUSION

Because of the myriad ways in which the wrist can and does affect the pianist's tone production, it is difficult to make any sweeping generalizations in conclusion. Nonetheless, a summing-up must be attempted.

Immediately paradoxes arise. Movement at the wrist can both <u>retard</u> the hammer's journey to the string (as in the "cushioning" effect when the wrist destabilizes a split second before the moment of key-bedding), and <u>accelerate</u> the hammer attack (as in the str[illegible] wrist flexion used to produce massive chordal sonorities). Stability at the wrist can be both the means of achieving lightness (as when the fingers play from the big knuckle joints against the stability of the fixed wrist as fulcrum), and the means of producing a sturdy sound (when the fixed wrist becomes part of a playing unit operating from the elbow hinge). A resilient, "giving" wrist can be the means of achieving both a weighty tone (as the weight from torso, shoulder, upper arm and forearm is transmitted through the wrist to the finger-tips), and the most gentle of releases (as the wrist flexes and the hand floats off the keys at a phrase-end).

The importance to the pianist of muscular awareness has already been noted at the conclusion of Chapter Two. Visual cues are also helpful, although, as Matthay has pointed out, much of what goes on in physical movement is unseen.

It would seem, thus, that the pianist and pedagogue's greatest ally must surely be his ears. After all, music _is_ sound (John Cage's _4'33"_ notwithstanding), and the more discriminating student and teacher become, the more they will delight in discovering the vital and versatile roles the wrist plays in tone production.

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