Looking Inside the Art of Piano Performance

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Where Do We Begin?

We've all learned different techniques through our lives – no one technique is perfect. When we look inside the performer through physiologic monitoring and biofeedback we have a tool to look deeper into issues and see what works best for each individual. Let's go into this together as an exploration. Exploring what we cannot see with the naked eye: tension has three sources: physical, mental, emotional. Regardless of the starting point, all three manifest physiologically in the body and we see this through the monitoring of muscle activity. We can literally see and analyze how our muscles are involved in playing and learn efficiency of muscle use.

Through simultaneous recording and playback on a MIDI instrument we become aware of what we often don't hear while we are playing: harsh tone and notes that "stick out." Seeing the piano roll notation on the screen allows us to analyze how our fingers interact with each other – are they playing independently or do certain fingers overlap? Looking at this along with the video windows and graphs of muscle activity, are there correlations between hand position and muscle activity and finger interaction?

How Things Work

Let's back up a bit and have a closer look at some basics of physiology. Our muscles respond to produce the intended movements. Muscles have a tendency to "brace" in response to certain movements and misperceptions of movements. No muscle is completely relaxed, even during sleep.

The amount of muscle activity present in the muscle is simply muscle tone. Too much relaxation results in movements that are too loose and not controlled affecting the sounds produced.

What can we learn from tennis? The follow-through - this movement allows the arm, wrist and hand to move freely, preparing for the next shot, causing the muscles involved to relax. However, there is still an amount of tension present – the racket doesn't fall out of the player's hand.

There is a delicate balance. Too much relaxation is not a good thing. The completely relaxed muscle needs time to take up the slack. The slightly contracted muscle can transmit its pull to the bone immediately. But, how much is enough?

The key word is optimal. Muscle tone is not a constant force. It is usually greatest following a period of activity, least following inactivity, and changing with varying degrees of emotional excitement or everyday stress. There are optimal levels of muscle tone or activity for each movement. Muscle fatigue can occur without you being aware of the onset. Periods of **rest** are important as they allow waste products to be removed from the muscles and for the muscles to be refueled.

Monitoring muscle activity can give us a tremendous amount of information. Through this process, coupled with real time video windows of how our hands and bodies are moving provide a rich source of biofeedback that speaks to our bodies.

A Simple Anatomy Lesson

This is a wonderful illustration from Gray's Anatomy depicting some of the most important muscles in the back:

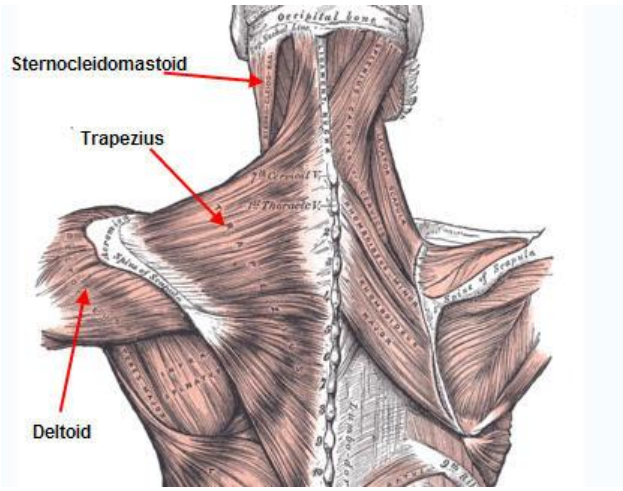


Figure 1. Some important muscles in the back

Understanding the muscles of the hand

We have several sets of powerful muscles that operate our fingers. The **extrinsic** muscles, exterior to the hand, start at the elbow or forearm. They run down the forearm and cross the wrist and hand. The smallest muscles that originate in the wrist and hand are called the **intrinsic** muscles. The intrinsic muscles guide the fine motions of the fingers by getting the fingers positioned and holding them steady during hand activities. Some control only the bending or straightening of the wrist. Others influence the movement of the fingers or thumb. Many of these muscles help position and hold the wrist and hand while the thumb and fingers perform fine motor skills.

Finger movements are largely controlled by two muscle systems. The Flexor Digitorum system consists of: the Flexors Digitorum Profundus, which run from the elbow along the lower arm, through the carpal tunnel under the wrist, to the 1st finger joint (nearest the finger tip) of each finger; the lumbricals branch off from the Flexors Digitorum Profundus at a point within the hand palm and run to each knuckle joint. The Flexors Digitorum Superficialis, also run from the elbow, along the forearm, under the wrist, to the 2nd finger joint of each finger. This group of muscles closes and curves the

fingers. Another set of muscles, the **Flexor & Extensor Carpi**, hold the wrist firm, counterbalancing the Flexor Digitorum muscles.

Now we come to the "powerhouse muscles" – the muscles *inside* the hand. The Interossei lie on either side of the hand between the knuckles. Their primary function is in opening and closing of the fingers and to contribute to fine motor control. We rely on the Lumbricals to do most of the knuckle movements throughout our daily activities, including our finger actions on the keyboard. In piano playing we must strengthen the Interossei muscles to flex the fingers from the knuckle joints. This leaves the wrists relaxed and flexible. Both the Lumbricals and Interossei assist in maintaining the natural arch of the hand by supporting the main metacarpals as the fingers play.

The thumb has its own sets of "powerhouse muscles" both intrinsically and extrinsically. The muscles for the fifth finger are all intrinsic – the "digiti minimi" group. These are most often neglected and underdeveloped in pianists.

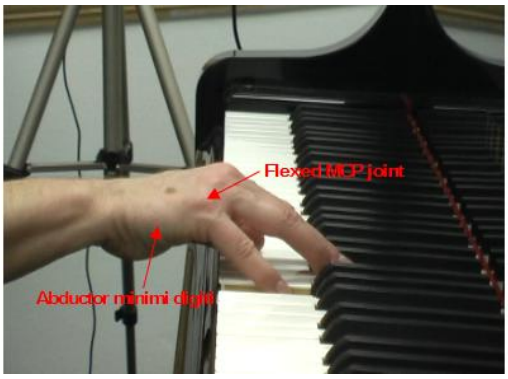


Figure 2. Intrinsic muscles of fifth finger

What is biofeedback?

Biofeedback is a physiological control technique. It incorporates the use of monitoring devices that display information about the operation of a bodily function that is not normally consciously controlled, heart rate or blood pressure for example. Biofeedback helps a person to learn to control the function or movement consciously.

What is sEMG?

sEMG stands for **Surface Electromyography**. It is a device that measures the amount of electrical activity your muscles release when they are contracting, more commonly known as muscle tension. It is similar in function to an EKG which measures heart muscle activity.

How does this relate to piano playing?

Many pianists are unaware of their hand and finger position. Even those with a good technique often play with high levels of muscle activity that they are unaware of and therefore do not always release properly. In piano playing the large muscles of our arms assist the fine muscles in our hands and fingers. Using only tiny finger muscles can cause unnecessary strain that can result in tendonitis and other problems. Common complaints among pianists are pain or discomfort and excess tension in the neck and shoulders, back, elbow, forearm, wrist or hand, and tiredness.

Let's break down the components of the physiomonitoring methodology and see what we can learn.

Video Analysis

Figure 3

Video capture allows us an up close view of hand position that we never see for ourselves when we are playing or for us as teachers when we are teaching because we are monitoring so many things at once. Let's take a look at the next couple of slides of the same person as they play a scale:

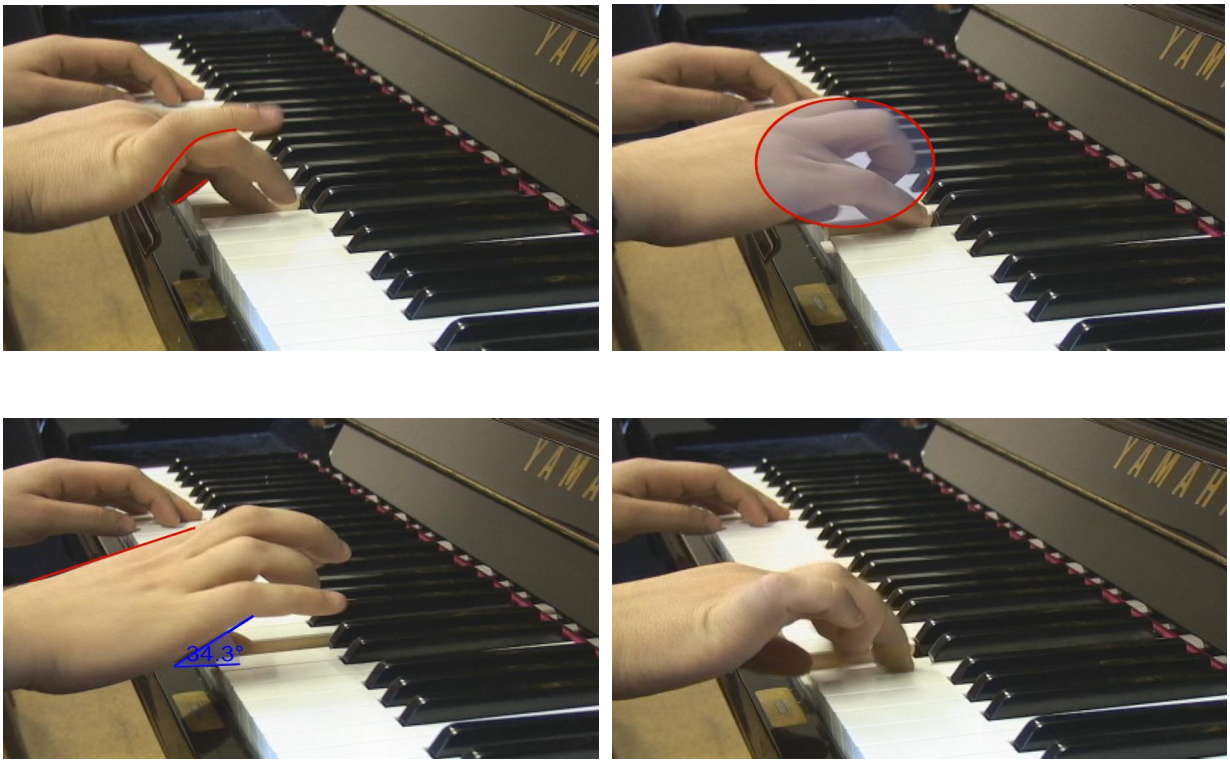


Figure 4

The power of MIDI

MIDI is a data interface that is designed to communicate musical messages. MIDI instruments describe the variables of a performance by reading and emitting a constant stream of messages. Used as a feedback tool the performance score generated by a sequencer as a piano roll graph can be understood as a translation of the timing and dynamics of the performance. The precise measurements of timing are seen on the piano roll and the dynamics are heard in playback and presented in bands of color on the graph.

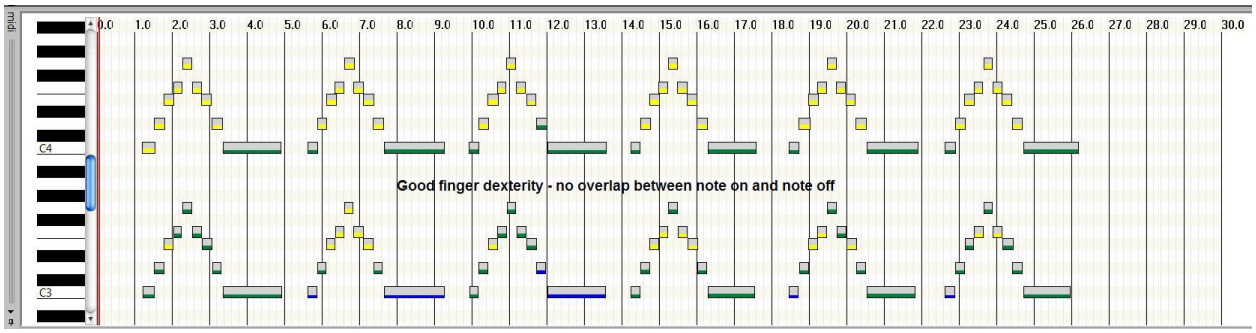


Figure 5. Ideal piano roll graph

The bars (boxes) on the graph depict specific notes played in relation to vertical keyboard display on left. Colors reflect velocity levels.

Establishing Correlations

Over the last 10 years I have worked with hundreds of pianists as well as other musicians, some to correct problems, but, in many workshops and master classes, many come simply for assessment. There are several factors that can clearly be seen as possible roads to injury, or, in many cases, just the cause of faulty technical approaches to passages. I have said for years that a picture is worth a thousand

words. And now that we can clearly see hand position along with readings of muscle tension I can establish validity for my arguments. Remember the picture of the correct hand position? The fingers fall naturally from the large knuckles. Here are some pictures taken from the participants at our symposium. The spikes in muscle activity clearly correlate with raised wrist, raised fingers and collapsed knuckles.

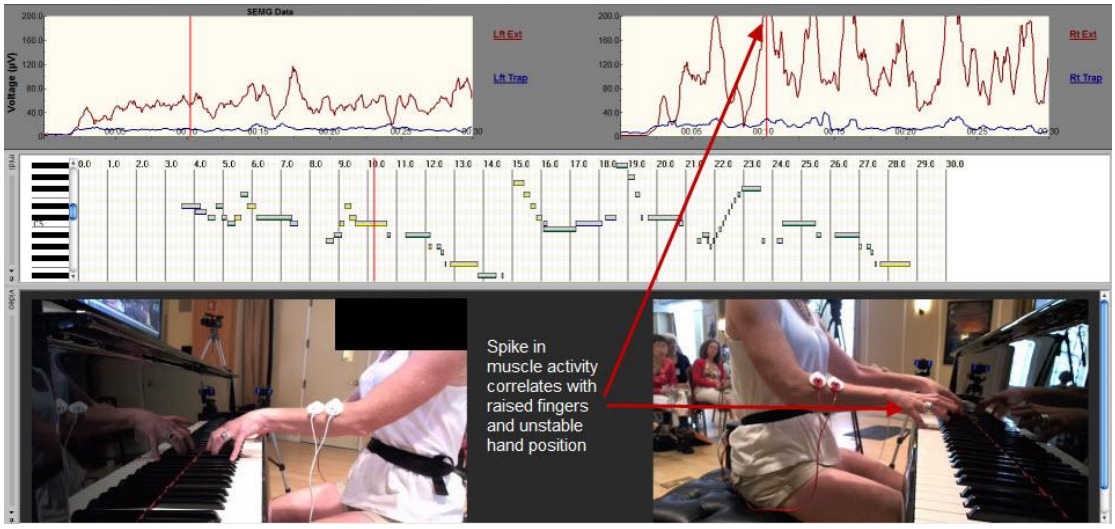


Figure 6

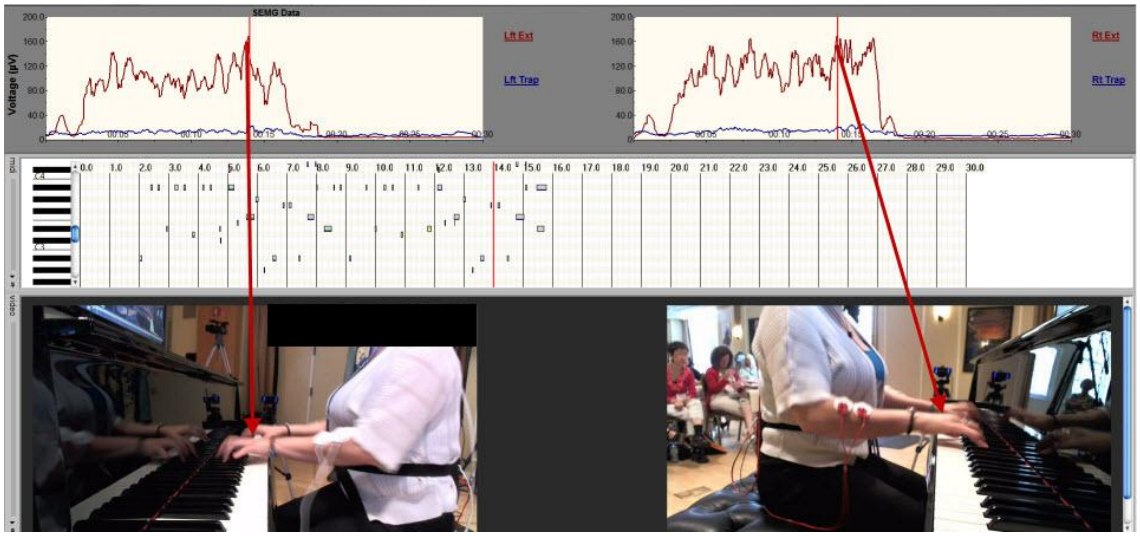


Figure 7

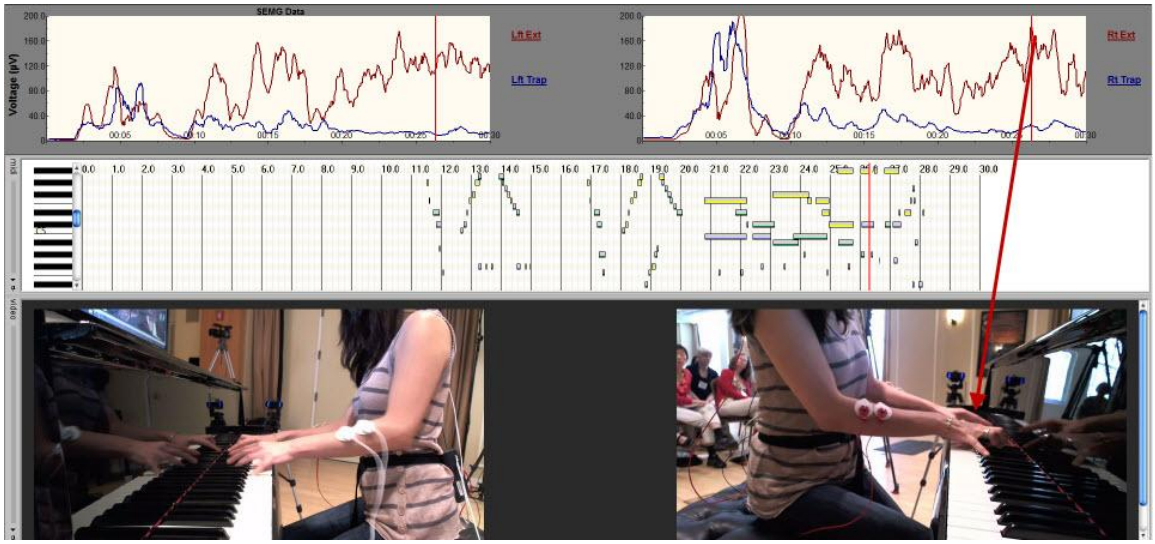


Figure 8

Used as a student assessment tool, we can help bring awareness to students even at the beginning level. The next picture is of a beginning student who had had about eight months of lessons. Luckily she was not playing much and so in a relatively short period of time, the bad habits learned could be corrected.

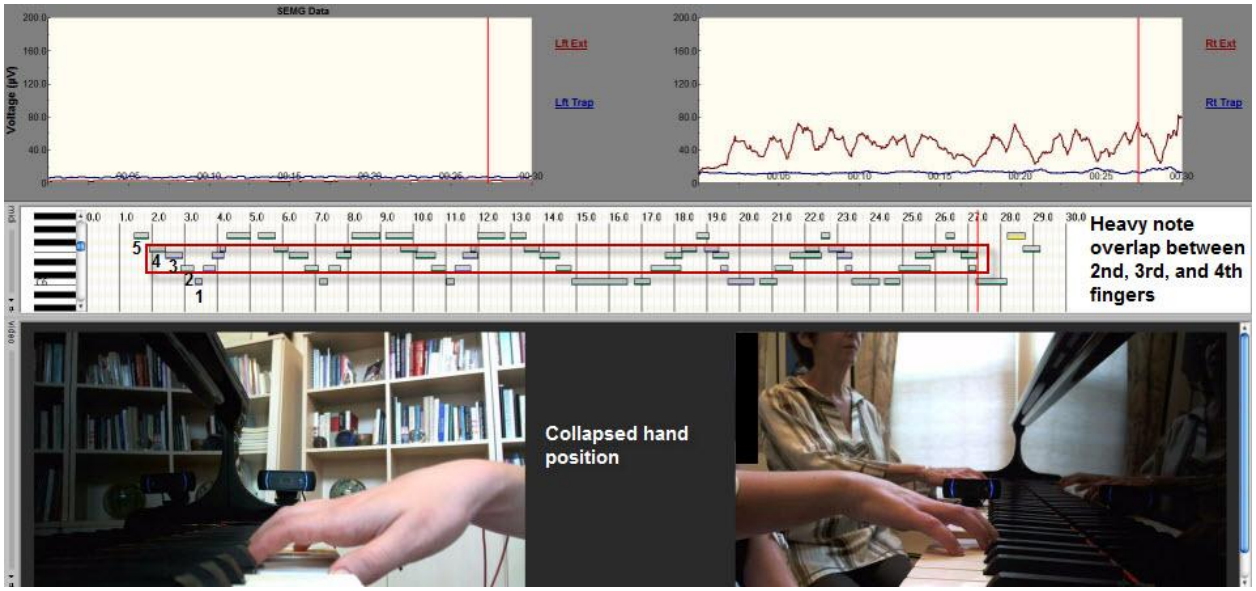


Figure 9. Student assessment

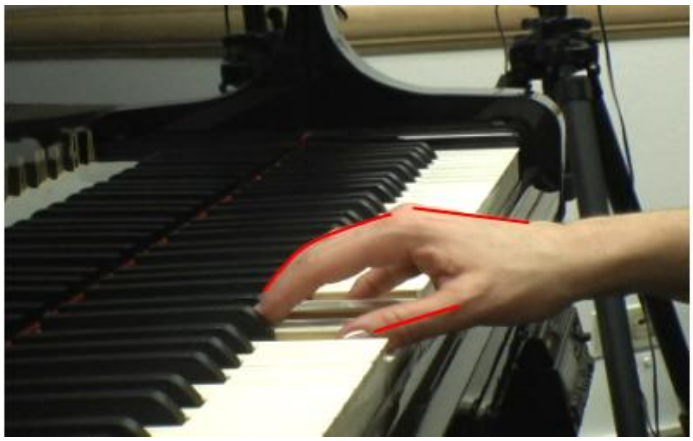
The power of the piano roll notation allowed me to also see weaknesses in finger independence. The note bars should not overlap as seen in Figure 9.

Over the last eight years of research and teaching with video and sEMG monitoring, what has struck me most is the compensatory patterns musicians develop because of an improper hand position. We use our hands in many different ways – for functionality of daily living, work, high level skills such as piano playing, and, while we don't often realize it, for emotional expression. One of my colleagues expresses everything through gestures with her hands as she speaks. But hands and fingers often tell a deeper story – at the piano when a student is unsure of the notes of a piece, or the technical difficulty is beyond his or her grasp, the hand position is filled with trepidation which simply manifests as muscle tension.

I am also amazed at how many musicians play the piano with the collapsed position shown in the last figure – a completely non-functional shaping of the hand where the fingers cannot operate without strain on the forearm. I would like to discuss hand position further as it is so very important to what we do.

Defining Proper Hand Position

As pedagogues, we know that there is a natural shape to the hand. The large knuckles of the hand form a very powerful arch – they are the "powerhouse" of the hand and of piano technique. There are three sets of muscles inside the hand that are situated around the large knuckles or main metacarpals as they are called. These muscles are responsible for the fine motor movements our fingers make. The natural arch of the hand looks like this:



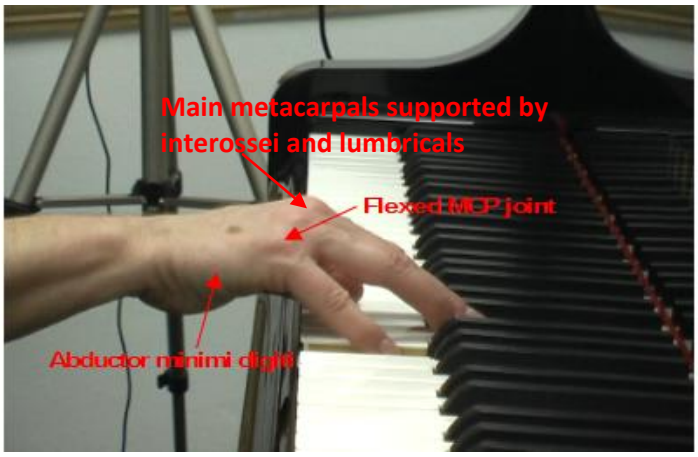


Figure 10

The hand position on the keyboard should resemble the hand in a relaxed position: the thumb hanging at the side of the hand and the other fingers extending downward in a gentle curve from the main knuckle (metacarpal joints). These four knuckles are the bridge which forms an arch on the top of the hand. The bridge of the hand is the powerhouse behind the fingers.

1. The finger that plays should be in a straight line with its flexor and extensor muscles.

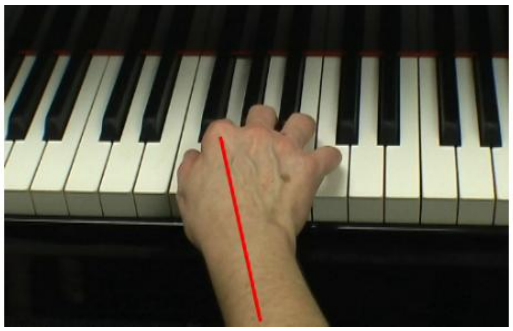


Figure 11

2. The hand, wrist and arm adjust slightly both vertically and horizontally to place each finger in the position where its muscles can contract effectively and where the hand and arm are balanced over the finger that plays.
3. This slight change of position eliminates any tension in the joints and muscles and guarantees their readiness to play again.
4. Any change of position enables the hand and arm to transmit a throw to the fingers, resulting in an increase in speed and power.

The knuckles and wrist should be level and the joints should not collapse or buckle under when a finger depresses a key, forming a “box” on the top of the hand. It is also important to not collapse the last joint of the finger while depressing the key. This position is often difficult for beginning students, especially children. Many of the muscles needed to maintain this position are not strong enough yet.

Figure 12

It is best to emphasize the position of the hand away from the keyboard as well. By beginning to shape the hand correctly, students are using many of the small muscles within the hand to do so. It is important to begin to do this without strain. Emphasize the same position of the hand resting on the keys: fingers falling gently from the knuckles. See the arch across knuckles, forming the "box" of the hand. There is a straight line from the wrist to the knuckles.

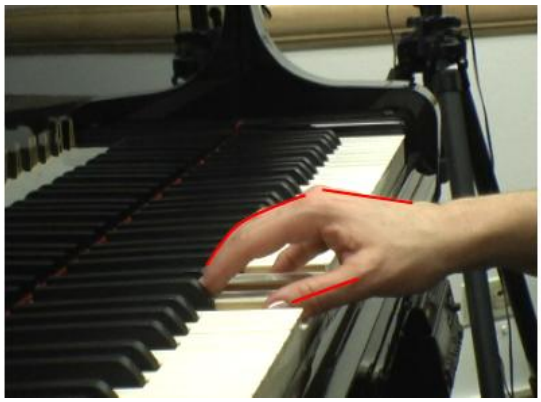


Figure 13

The Fingers

As Gyorgy Sandor observed, true finger independence can be achieved only with the assistance of the forearm and upper arm muscles and not by maintaining a fixed hand (or wrist) position that causes the fingers to move in a forced, unnatural position. In the long run these fixed positions will cause tension, fatigue, pain, and acute or chronic ailments.

There are two very important adjusting movements of the arm and wrist that enable them to collaborate with each of the fingers: both vertically and horizontally. Since we want to place the fingers in line with their respective forearm muscles (the flexors and extensors), there will be a slight horizontal change in the position of the wrist and forearm for each finger.

Figure 14

The fingers are spread apart, assisting the stability of the hand; the curvature of the finger is very important. The open, relaxed position of the thumb is important for the stability of all arches in hand. The correct position of the arch forms a "C" between thumb and forefinger.

Velocity is an important factor to consider here. Since we refer to velocity in piano playing as the speed of a succession of notes, the speed of the release of each key back to its original position effects a succeeding key strike. I refer to this as an active release. The instinct of the untrained student is to "muscle" the passages demanding velocity, incorporating powerful

contractions. However, this type of contraction brings a reactionary movement of a larger arm unit. For example a powerful movement of the finger at the knuckle joint is not possible without incorporating part of the arm.

Concluding Thoughts

So, in conclusion, physiologic monitoring and biofeedback enable us as teachers to look inside ourselves and our students. The power of biofeedback helps students make changes that are lasting. When there is irrefutable proof from the lines on the screen that a correct hand and finger position and body alignment significantly decrease the amount of muscle activity and it is easier to play a passage, there are no arguments from students, only willingness and an understanding of what needs to be corrected and why.

Proper posture and body alignment are essential. Careful repertoire selection is a must – the piece must fit the student, technically, emotionally and ergonomically. If a student has small hands some pieces will simply be off the list of choices unless you are willing to take out notes. Have students spend more time in the intermediate repertoire. This repertoire is rich with building blocks for style and technical development. Once students have a solid foundation here it is more easily transferred to the advanced repertoire.

Proper development of the muscles in the hand is important. In children these are not developed. Maintaining a proper hand and finger position automatically engages these muscles and they begin to strengthen. When the hand is in a collapsed position, these muscles do not engage.

Musicians must begin to think of themselves as athletes of finger dexterity. We need to take the same amount of careful training of the body as athletes do to insure healthy development and prevent technical problems and injuries.