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Editorial Perspective

Begin Where the Wheel Touches the Ground

By Ed Sutton, RPT
Journal Editor

The yearly NAMM show in Anaheim is brash and loud, high-pressured and self-important. Visiting the event as editor of this magazine presents a challenge in a tough environment. How can I return with something of value for our members? Retail is tough. Companies and people shift, twist, struggle to survive and often disappear. I don’t want to just survive—I want to thrive, joyfully as possible. I want to be ready for change, and I want to deliver reasonable visions of our business future to our members, so that we can all think ahead and not just ride our waves until we fall off.

So, well ahead of time, I sent some questions to the people I expected to see at NAMM, and a few other piano people as well.

1. What is your company’s vision of the piano in the United States and the world over the next six years?
2. How does your product demonstrate and serve that role?
3. How do you envision an ideal technician for your pianos over the next six years? What skills and knowledge will be needed to service your pianos well by the year 2020?
4. Does your company offer training programs, internships, seminars or classes for piano technicians?

You can read the replies I received in the NAMM report. NAMM may be the center of things, but the replies to my questions eventually led me back to my quiet home, and the homes of my customers. The center is where the pressure is greatest, but the rim is where the wheel touches the ground. As piano technicians, as members of the craft and musical communities, we live our careers in the place where the wheel touches the ground, and I believe it is a wonderful place to be. We are in a place to know why people have pianos in their homes and in their lives, and we are there to help carry the message forward.

See it as job insurance. See it as your purpose. Or even better, see it as both.
Letters to the Editor

In the November 2013 issue of the Journal, page 11, Paul Williams states, “My tuning fork’s pitch varies with temperature. Its pitch is perfect at 65 degrees.” I am not questioning this statement. Then he says, “The fork goes sharp in a warmer room.” Unless he has a fork made of a strange material, that statement is not correct. As metal cools, it gets stiffer. Therefore, the frequency of vibration and pitch go up. As the metal warms up, it becomes less stiff and the pitch goes down.

I did a quick experiment to test this theory. I checked my 523.3-Hz fork with G# 24 on my piano. It yielded about seven beats per second. Then I put the fork in the freezer until its temperature was about 32 degrees and I checked it against the piano. It yielded about nine or ten beats per second. Next, I heated the fork with a heat gun until it was a bit too uncomfortable to hold in my hand. This time it was beating only about three beats per second.

Since G# to C is a wide interval (that is, the wider it is, the faster it beats), this is proof positive that the pitch of the fork and its temperature move in opposite directions. As the temperature goes down, the pitch goes up; as the temperature goes up, the pitch goes down.

James B. Geiger, RPT
Heart of Texas Chapter
Editor

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Correction:
On p. 31 of the February issue, Masayuki Takaku was misidentified in a photo caption.

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Photo by Katsufumi Seki, International Chapter, Okinawa, Japan

Please submit tuning and technical articles, Tuner’s Life/Tuner’s Health stories and queries to:
Ed Sutton, Editor
4001 Brookview Dr, Charlotte NC 28205
E-mail: editor@ptg.org

Please submit tips for TT&T to:
John Parham, Assistant Editor
1322 36th Ave NE, Hickory NC 28601
E-mail: TTT@ptg.org
Where are We Going?

If you have ever planned a trip or event, you have asked a form of the question, “Where are we going?” The counterpoint to this question is, “If you aim at nothing, you will hit it every time.” All of our U.S. members are well aware that on the 15th of this month taxes are due. Without planning we can find ourselves short and owing money to the IRS. Business planning is an important part of each of our lives.

Likewise, planning is part of what the board of directors is charged with doing in order to help PTG perform its duties. The board is charged with the development of the budget that is presented and approved by Council at the PTG convention each year. A budget in its basic form is a spending plan. While there are certain fixed spending categories for which PTG is basically committed each year, there are categories onto which focus can be shifted and priorities can be emphasized. Balancing all the demands from each category and moving forward is but one of the challenges facing your PTG board each year. Not only do we need to anticipate needs in the short term, but we must also look at the long-term focus of PTG.

During the midyear board meeting, we spent the first day reviewing the various long-range plans that have been provided to the PTG membership over the last almost 20 years. We began with a YouTube clip of a performance from the Ed Sullivan show, where a gentleman named Eric Brenn was featured spinning plates on small flexible rods. At one point in the clip he is busy twirling one of the rods to help a plate maintain its spinning energy. Unfortunately, he has been so preoccupied that he hasn’t taken the time to actually load a plate on this particular rod.

Before we laugh too loudly, we might ask ourselves how many times we have been guilty of the same thing in our personal lives or with the corporate life of PTG. We may be busy devoting resources to a program or committee that has lost its focus or purpose, but because of tradition, we continue to twirl a rod that has no plate.

Deciding on priorities is a challenge for the board. Reviewing the various long-range plans that have been adopted over the years helps us to get the flavor of what our membership expects. There have been several proposals over the years to strengthen our marketing of the RPT, both to the public and to Associates, by encouraging opportunities to become an RPT and for making the public aware of the value of using an RPT for piano service. There are also statements challenging us to provide opportunities for professional development and avenues for continuing education. A commitment was made to maintain our facilities in a sufficient manner to provide for present and future programs.

A list of the long-range planning goals that were last affirmed by Council can be found on the ptg.org Web site in the member area under Forms and Documents. I would encourage each of you to visit this document and see how your chapter can incorporate this year’s technical programs to reflect these goals.

We are committed as your board of directors to make sure that we use the resources at hand to keep us on track with our long-range plans and keep PTG moving forward.
Baby Powder to Prevent Rust

Perspiration from our hands can cause steel strings and copper alloy windings on bass strings to rust. I use baby powder when I restring a piano (Photo 1). I’ve never experienced any oxidation or corrosion damage as a result of stringing with a light coating of baby powder on my hands. I learned this tip from Ed Howard.

Linn L. Roath, RPT
Austin TX Chapter

Mark Block Positions

Have you ever finished a two-hour, last-minute, 100-cent pitch raise on an 1897 Estey grand with rusty strings on Christmas Eve morning, and as guests are filing in for lunch, you’re trying to find the right spot for those small blocks attached to the back of top front panels on old uprights, cursing all the while? Save yourself the headache. Before unscrewing them, trace two sides that meet at a corner as an alignment guide (Photo 2). Reassembly will be much easier.

Cy Shuster, RPT
New Mexico Chapter

Oiler Tips

I’ve used a hypo-oiler for many years to apply CLP to flanges. Over time, the tips tend to break—at least they do in my tool bag. Also, the bottle occasionally capsizes inside my tool kit and the liquid drips out, leaving me with an empty bottle the next time I need to lubricate some flanges.

This nice kit in Photo 3 solves several of these issues. It comes with three different gauges of needles for applying liquid in different volumes, and it has a clear plastic tube to protect the metal tip. It also includes a small black plastic cap so you can quickly remove the needle and screw on the cap for a leak-free bottle in the tool kit.

You can order this inexpensive kit online at www.precisionoilerplus.com.

Trevor Nelson, RPT
Boulder CO Chapter
Yield to Proper Grammar and Spelling

The September 2012 issue of the Rhode Island chapter newsletter Good Vibrations had a great business tip from Janet Kyle Altman, the marketing principal for the firm Kaufman, Rossin & Company. Janet Altman said, “Treat your blog like journalism, not marketing. Pretend the editor at The New York Times is going to fact-check you.” The same goes for grammar. Don’t overlook the importance of using proper grammar in business situations.

Sharon Eliza Nichols’s book entitled I Judge You When You Use Poor Grammar is full of public examples that contain obvious spelling and grammatical mistakes (Photo 4). That book was a good reminder of how important it is to proof the words we present to the world. Checking your Web site, blog, newsletter, and e-mail posts for obvious mistakes is a good business reminder for us all.

John Parham, RPT
Charlotte NC Chapter
[Photo used with permission from Sharon Eliza Nichols.]

FloatPins® for Strike Weight Reduction

Cell phone and tablet makers have been tucking these nifty little pins into their products for the past few years to lighten them up a bit. They’re made from a lithium alloy with an open crystal structure in which atoms of helium are trapped, making them buoyant in air. Recently, I’ve found that they’re ideal for reducing strike weight, too.

I buy vials of 100 of the 2 mm x 9 mm size, which fit snugly in a 5/64” hole, from www.floatpins.com for $95. Each pin tips the scale at minus 0.17 g. For easier handling, they come attached to weighted strips, which you peel off before installation. To be on the safe side, though, I work under an umbrella, to catch any strays.

I like the results I’ve been getting so much that at this point, I’ve pretty much stopped shaving off wood and felt from hammers. (See Photos 6 and 7 for typical results.) Taking off material reduces mass as well as weight, which, to my ears at least, robs a hammer of power. Now that I can reduce strike weight without reducing mass, I find I can lower an action’s balance weight and still keep the tone of the piano nice and full.

Graham Waites, iRPT
Lightweight Chapter

String Hook

You can easily make a string hook using just a screwdriver. Grind the tip to the shape in Photo 5. It is narrow enough to press through even the most narrow of spaces. For very close wires, you can turn the tool 90 degrees to easily remove.

Jon Page
Boston MA Chapter

Please submit tips for TT&T to: John Parham,
1322 36th Ave NE, Hickory NC 28601
e-mail: TTT@ptg.org
A Look Back

Some readers might assume that a monthly Journal feature such as Q&A Roundtable is a relatively modern development. Not so. Columns in technical publications for piano technicians featuring discussion and a question-answer format predate the formation of PTG.

Below are excerpts from a monthly feature called “The Trouble Shooter,” compiled and written by Nels C. Boe and published in The Tuners Journal by the National Association of Piano Tuners, one of the ancestors of the Piano Technicians Guild. This column appeared in April of 1922, 92 years ago this month.

Journal issues dating back more than a century are available for viewing online at my.ptg’s Tuner Technician Magazine Archives community.

Caveat: Procedures and materials discussed below should not necessarily be considered as recommendations for present-day piano technicians.

The TROUBLE SHOOTER

Loose Tuning Pins Again.

Dear Editor:

Each month when I receive the TUNERS JOURNAL I read it through with pleasure and a great deal of interest, as there are always such splendid articles in it. It is so educational, and can’t be anything but interesting, and I will do all I can to get new members, although the field here is rather a poor one in which to work.

In the November and December issues I noticed several articles about “Loose Tuning Pin” difficulties. One brother suggested bushing with sandpaper, and that seemed to end the discussion, of which I didn’t quite approve, as there is still a better way in my estimation, especially if there are many loose pins.

I know of one case where a certain tuner bushed the whole middle section of the treble on a Chickering grand, and the result wasn’t a bit satisfactory. He went to a great deal of trouble—loosening all the strings, and then three or four tunings to get it back in nice shape, from a tuning standpoint; and it surely took a lot of tuning, as I remember I tuned it several times myself. Right here is where the discrepancy came in. The “pins” were hard to SET, which made it difficult to do fine, accurate tuning.

Why not make a long story short and get the best results by just replacing the old, original SMALL tuning pin, with a LARGER SIZE PIN? The large pin will be firm, it will tune up much better, and be more satisfactory all around.

I hear some critical brother say, “Yes, but how about the coils? They might break in replacing the old pin with a larger one.” Not if one is careful in removing the old pin. Often one can just take a pair of pliers, pull out the pin from pin block, after tension is off, and then easily remove pin from the string coil. I have often done it in this way and with the best results.

Now back to bushing. In a pinch—when we haven’t any more large tuning pins in our kit, when we have pounded the tuning pin in to (the hilt) where the coil nearly touches the pin block—or plate, if it happens to be a full metal plate—(and by the way, always use a pin punch, so as not to batter up the pin nor the adjoining pin) and the pin still refuses to remain firm and tight, and we must bush the hole—then try a small strip of fine emery cloth, not sandpaper, as the sandpaper sometimes cracks, and then our troubles start all over again,
especially if we tune that particular piano at regular periods, say twice a year. Of course it is understood that if emery cloth is inserted as a bushing that the cloth side must be against the pin, the same as if sandpaper were used. Every tuner should carry a piece of emery cloth in his kit, as it comes in so handy for many things. I am not entirely denouncing sandpaper, as now and then a tuner is so far away from a town that sandpaper is the best he can get. In that case do the best you can. I only wanted to suggest my experiences, and the result.

Hoping this will be of some use to some one, I am, 

Very respectfully,
D. B. KRUGER, 
Spokane, Wash.

Answer: Thanks, Brother Kruger. Your point is very well taken. Why tuners insist upon using sandpaper, piano strings and diverse other things as remedies for loose tuning pins, when pins of larger size will be better and make a permanent job, we do not quite understand, particularly when entire sections are found loose. Other expedients undoubtedly are all right with one or two pins and when away from easy communication with a supply house, but when it comes to entire sections we agree with you that the new, larger size pin is the only proper and permanent remedy.

Coal Oil on “Centers.”

Dear Editor:

Some months ago the question was asked through one of the columns of the JOURNAL, “What is the most effective way to remedy sticking centers in a piano action?”

For the benefit of young tuners [I] will say: By tight centers is meant the swelling of the flanges, which become so tight as to prevent the center from working. This is particularly the case with the hammer flanges. Both the wood and felt bushing swell from dampness, and the hammer will not fall back toward the hammer rail. I have always lived near Philadelphia, not far from the Atlantic Ocean and from rivers. The climate is naturally quite damp at times.

I have met hundreds of pianos where the keys would not strike the second time. This is particularly the case where pianos are in stone houses. Now let us be practical. We go into a home to tune piano. We find at once that a number of the hammers will not strike the second time owing to the hammer flanges being affected by dampness. We say to the people, “A number of these flanges need repinning.” The reply is, “We cannot afford to pay for any extra work,” and they ask if there is anything that can be done as a temporary relief, as the piano must be used at once. Now this is what gets any tuner, as no one can afford to do this extra work without extra pay.

In my early days I was taught to use coal oil on the flanges. It almost ruined a number of pianos. The first time it is used the result is instantaneous, and you can see no bad results. But soon a sediment is left on the felt and center pins, and in a short time they are useless.

I must confess that so far I have not found any harmful results from benzine or refined gasoline. I quite often use it, and the keys work perfectly freely. Even this is not permanent.

I wish to mention another thing. Several times I have cured a sticky action by standing it in the hot sun all day, or close to a stove or heater. Of course it will stick again, when exposed to dampness. The most effectual and lasting thing that can be done is to repin.

Last month I repinned an action, completely ruined by coal oil, took out each flange and with a center pin punch, dipped in “Graphitoleo,” reamed out the felt, and by inserting new pins, the job was complete.

So my advice is never use coal oil. Use benzine, if absolutely necessary. Always repin the action, if you can get enough to pay for the job. In repinning make it just free enough to work right. If too free, the action may rattle or sound loose.

In writing this it is with the hope of preventing, once for all, the use of coal oil for sticking hammer flanges.

HOWARD W. PYLE, 
Drexel Hill, Pa.

Answer: Thanks, Brother Pyle. We join you in the wish that your article will banish forever from the tuner’s grip and temptation this most destructive agent of all suggested remedies for tight flange pins—coal oil.

Raising Pitch and Oil.

Dear Editor:

Not having all of last year’s JOURNALS, I have a suggestion for the cause of breaking strings, and why I find so many in old uprights.

If tuners only would use a brush and a little Three-In-One oil on the upper bridge next to the pins they would not need to fear breaking the string when pulling up to 440-A or 435-A. The tension is so great at this point that a little Three-In-One oil will remove the strain.

Yours respectfully,
E. E. COMBS, 
Ypsilanti, Mich.
The theory that buildings, bridges and similar structures can be wrecked or made to crumble by being brought into sympathetic vibration with musical instruments dates back to the earliest history of man.

The belief possibly originated in the old legend about one of history’s earliest kings, who in an effort to impress upon his subjects his mastery of bridge construction, erected a most magnificent structure across one of the country’s largest rivers.

The finishing touches were barely completed when, to the great surprise of the ruler and his subjects, the bridge began to crumble.

The king, himself, unable to determine the cause of its rapid destruction, sent his soldiers to investigate. The mystery was solved, apparently, when under the bridge and close to one of its main supports, was discovered an old man playing his violin, imparting with one note of his violin a sympathetic vibration on the support, creating a rhythmic vibratory force sufficient for its destruction.

Naturally, no violin made by mortal hands could do it, but if the energy of vibration could be magnified in the same proportion, as must have been those of Joshua’s wall-shattering trumpets at Jericho, of which the Bible tells us, then perhaps a skyscraper, or Knickerbocker Theatre, could be made to crumble by the bow of a Paganini or the voice of a Caruso.

It is a known fact that bridges often are set into perceptible vibration by the traffic crossing them, and care is taken to prevent the resulting rhythmic vibratory force from destroying them by signs requesting that traffic pass slowly.

It is also known that marching soldiers break step in crossing a long bridge, lest the regular recurrence of the blow of their feet should create a dangerous oscillation.

The theory that the Knickerbocker disaster may have been caused by sympathetic vibration is, therefore, sound, but in its practical application one must consider the relative magnitude of force to resistance. It may be that the structure was weakened to the point of collapse by the weight of the snow and that the vibratory force imparted by one of the theatre’s large organ pipes acted as a contributing factor.

Answer: The fear of breaking strings is the greatest contributing factor to the timidity exhibited by tuners in raising pitch of old pianos; much greater, we believe, than that of laziness or the don’t-care attitude, because every tuner who is concerned about the quality of his work dislikes to leave a piano below the pitch for which it was designed and at which pitch alone it can give the proper tonal effects. Yet the probability of breaking strings may be avoided or, at least, considerably lessened, as our correspondent says, by the use of a little Three-In-One oil, or similar lubricant, on the upper bridge pin or plate bridge.

A little oil at these points tends to destroy the artificial joint formed through rust between the string and the upper plate bridge, or pin, considerably lowering the chances of a fracture at the junction of string and tuning pin, that is, the coil, where breaks most frequently occur.

Naturally, the utmost care must be employed in using the oil; otherwise it will, especially in the bass section, penetrate down to the winding of the string, and, with an accumulation of dust become a factor in the cause of “dead” strings.

Another method which invariably works well on an old, rusty piano is to raise in pitch, it is to give each tuning pin a firm blow with a hammer. Of course this brings the strings far below original pitch, but a piano so treated usually may be brought to international, or even philharmonic pitch without much danger of breaking the strings.

---

**Striking of Certain Note by Musician May Have Caused Knickerbocker Theatre Collapse.**

A correspondent has sent us the following very interesting “clipping,” requesting that we pass some comment upon it:

“Vibration caused by musical instruments abetted by the weighty snow, is being considered by scientists as a contributing cause for the disastrous collapse of the Knickerbocker Theatre roof at Washington recently.

“Slight swayings, which may have been caused by certain notes struck by the orchestra or the huge pipe organ, possibly assisted in making the supports insecure, according to several noted scientists and experts upon sound action.

“In view of these developments it is now suggested that music may be utilized in the construction of buildings to assure their stability in advance.

“Although I cannot say what key it was, I believe that there was one on the Knickerbocker organ which was in harmony with the vibration of the theatre building, said a member of the Musicians’ Union.

“He stated that he had played the organ in the ill-fated theatre on several occasions, and he recalled the time that the organ used at the St. Louis Exposition was installed in a music hall in the East, and upon the striking of a certain note the skylight was shattered. After an investigation the removal of the large foot-stops on the organ was ordered.”

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Answer: Possibly the fear of breaking strings is the greatest contributing factor to the timidity exhibited by tuners in raising pitch of old pianos; much greater, we believe, than that of laziness or the don’t-care attitude, because every tuner who is concerned about the quality of his work dislikes to leave a piano below the pitch for which it was designed and at which pitch alone it can give the proper tonal effects. Yet the probability of breaking strings may be avoided or, at least, considerably lessened, as our correspondent says, by the use of a little Three-In-One oil, or similar lubricant, on the upper bridge pin or plate bridge.

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**Dear Editor:**

Wishing the JOURNAL prosperity and success in passing it on to our readers with a truthful and very interesting short comment.

Yours respectfully,

E. F. STINDE,
2020 Vision: A Visit to NAMM 2014

By Ed Sutton, RPT

Journal Editor

This year the National Association of Music Merchants (NAMM) is one hundred thirteen years old. It’s a long story. In 1901, hoping to control ruthless price manipulation that was giving piano dealers a bad reputation, a group of piano dealers met to form the National Association of Piano Dealers of America (NAPDA), a group that expanded to include wider coverage of the field and became NAMM in 1919. NAMM is a proud organization, and indeed has much to be proud of. A visitor to the NAMM Web site (including the Museum of Making Music Web site) can learn much about the history of musical instruments in the United States. Exploring themes such as “Where were music stores located?” or “Where did people buy musical instruments?” or “How were musical instruments delivered?” can yield stories of changing styles, economics, and demographics.

Sometimes one detail is the harbinger of waves of change. By 1920 most homes in America had electricity, thus signaling the end demand for the wind-up acoustic phonograph and foot-pumped player piano and reed organ, and the readiness of the market for radio and electronically driven instruments. Decade by decade one can document changes in retail driven by new technologies and evolving markets. One does not need to be very old to have witnessed transformations and births and deaths of retail music businesses in one’s hometown.

The preeminence of the piano is evident in cover after cover of music trade magazines over the first decades of the 20th century. As late as the 1960s, music organizations still insisted that every home should have a piano and that every child should have music lessons in school.

Then the Beatles came. A new kind of youth-driven music took hold of recording studios and pop radio stations. Schools did not teach electric guitar; teens learned guitar on their own. They learned to write their own music, and, following the lead of the recording studios, they made popular use of technologically modified sounds. The forces of production, marketing and delivery were ready, and the once-staid business of supplying musical instruments to a public hungry for novelty has never been the same.

This year the theme of NAMM was “Amplify.” Your sales, your profits. The ubiquity of electric amplification is such that few saw any irony in the theme. The overall noise of the show is such that one goes primarily to see the instruments and learn about their sales potential, not necessarily to hear them. Given that many, perhaps most manufacturers have adopted digital technologies as part of a survival strategy, it is inevitable that there will be sonic and ultimately value conflicts on the show floor, as when, for example, two Fazioli pianos are on display next to a ring keyboard in which performers play while dancing to a drum machine, while just around the corner of the display a digitally driven piano plays along with a synthesized orchestra.

I am judging neither the validity of these instruments nor the quest of technology to invent new ways to generate sound and to make money. I am questioning the place of pianos in this venue, wondering what it can tell us (if anything) about the place of pianos in the world, and how piano technicians can best adapt to it all.

The amount of NAMM floor space taken up by pianos is perhaps half what it was five years ago. This reflects many things. Manufacturers must balance the significantly higher NAMM charges and delivery costs with the benefits they expect to receive from showing at NAMM. For a piano manufacturer, the cost of a private room at NAMM could equal the cost of several full-time factory workers. In a time when piano dealers have been closing stores, can a manufacturer expect to pick up enough new dealer business to justify the costs? Seen one way, the cost of NAMM is necessary for the introduction of new products to the marketplace, and is potentially more valuable to piano manufacturers that incorporate new technologies into their product line.

I was not surprised by the overall change of the role of pianos at NAMM. This year was just the continuation of a trajectory that has been evident over the last several years. Instead, I came to NAMM with a new set of questions, hoping to extract from the show a vision for piano technicians who want to stay on top of the wave of change and perhaps even be ready for the next wave, if we can see it coming.

Manufacturers and their representatives come to NAMM to sell pianos to dealers. The showroom is not the best place for extended conversation on other matters. Prior to NAMM I sent a set of questions to piano people I expected to see there, asking them about their companies’ visions for pianos over the next six years. In harvesting their responses I hoped to develop an image of the piano technician of the future—hence this article’s title, “2020 Vision.”
I learned something about the piano business, and in the end gained a helpful image of what the future may hold.

Let’s walk around a bit and visit a few rooms and displays. On the second floor, four manufacturers invested in their own display rooms.

Half of the Kawai room was devoted to digital technologies, and half to Kawai’s fine and well-established lines of pianos. Kawai has upgraded its K series vertical pianos. On display were the K-200, 300, 400 and 500 pianos, which are heavier in construction and look to be a clear step up in quality from the former K-2, 3, 4 and 5 models. Prices will also be a step up.

As one of the better-funded piano builders, Samick is developing a new (if familiar) model for piano dealers. With the acquisition of the Seiler piano company, Samick’s top-line piano is now the German-made Seiler. The Eduard Seiler is the top piano made in the Samick factory in Indonesia, and the Johannes Seiler is the introductory line. These pianos all take the German Seiler as their inspiration, seeking to produce a “German sound.”

The Kawai exhibition hall, I was struck by the immensity of the world music industry is one of the impossible tasks that confront the visitor to NAMM. Crossing the street to visit the Yamaha exhibition hall, I was struck by how one company creates such a
Bösendorfer's rich tradition of piano-making, combined with Yamaha's advanced technology, resulted in a strikingly beautiful and powerful instrument that was both inspiring in its tone and a testament to the craftsmanship that goes into making such a masterpiece.

For the pianist, a Yamaha piano is more than just a tool; it is a tool that allows them to express themselves in a way that is nothing short of magical. Yamaha's commitment to quality and innovation is evident in every aspect of their product line, from the smallest digital keyboards to the grand pianos that are the pride and joy of many concert halls around the world. The success of their Disklavier pianos and remote lessons is a reflection of their ability to meet the changing expectations of today's consumers, who demand not only quality and innovation, but also convenience and affordability.

In conclusion, Yamaha's dedication to the art of piano making is evident in every aspect of their business, from the way they treat their technicians and dealers to the way they design and build their pianos. They are a company that is truly committed to excellence, and it shows in the way that their pianos inspire musicians and audiences alike. Yamaha is a company that is truly committed to the future of piano making, and it is exciting to see what they will do next.
any technician can get this opportunity. Yamaha has also taken the extra step of training instructors for the seminar, as well as providing complete instruction materials and videos. We hope that the contribution is beneficial for all technicians, not only across North America but worldwide. Yamaha is ready for the future and will also start a new Hybrid seminar, to be offered at many dealer locations and at PTG seminars and conventions.’’

What is the world of the piano technician? If we had unlimited resources to put on the biggest, piano technician show ever, what would it be? Would it be a show of lights, banners, drums and wild dancers, the Olympics of piano tuning?

Most piano technicians are introverts, I believe, and though we make noise when there is a reason, and we celebrate together now and then, our deeper strength comes from our instinctive need for quiet work, private values, and focused, self-directed purpose. In a retail culture that does not largely support those values, we need to claim our own world, to discern, support and advance a culture that needs and appreciates our skills. We also must recognize the needs of our customers and serve them in ways that nurture our mutual growth and relation.

At NAMM, unhappiness among all relating to pianos is evident, though its form, viewpoint and expression will vary considerably. A few people remember the days when herds of Kimball and Baldwin spinets and consoles filled row upon row of the showroom floor. They were pianos of minimal quality and price, dressed in costumes of every sort, Queen Anne to Sheraton to Danish modern. It was a time when the middle class ethos required a piano, or something like a piano, and the great American piano makers competed to provide the best decoration at each price point, knowing that research showed that the most pianos would be bought by people who had never played a piano, and had no idea what a piano should be.

Something similar is happening today in China. A piano man whose career spans both eras tells me that neither then nor now has he felt that the directors of the big manufacturers had any real understanding of the inner needs that drive people to play pianos! I believe it is a fair conjecture that most of us who remember the pianos of the 1970s would not treasure a return to such design and quality.

A little more difficult to grasp and accept is a change in the role of the piano in music making, especially in the creation of new music. Piano is no longer the instrument of choice for the composer and arranger unless it is connected to a computer via a digital interface. Digital keyboards of all sorts provide multiple voices and programming capacities. They offer large amounts of sound with little effort, and sometimes with very little skill. Advanced skills do not easily transfer to piano playing. In the popular and commercial music world, the piano is no longer a central or majority instrument.

In one sense, the piano is now a historical instrument, an apparent necessity to play the great literature of the 19th and 20th centuries, which was conceived almost exclusively and perfectly for its capacities. Inherent in this is the nature of the instrument itself. Though it can be used in remarkably powerful and outgoing ways, it is above all an inward-looking instrument, and the great literature almost always expresses an introspective adventure. The piano is an introvert in an extrovert culture. We need to recognize this and (quietly) celebrate it!

If this claim is true, it leads to the question: What, then, should we do? Should we try to make piano become, once again, a majority instrument, or should we value it for what it is, and for the musical needs it can best serve? Can we see in the piano, in our pianist customers, and in each other a certain refuge from a non-stop driving, pressing aggressing culture, and learn to nurture piano culture wherever we meet it? Del Fandrich speaks of how the instrument once known for good reason as the piano became the forte, and he has worked hard to return its full expressive range. We know as technicians that the greatest test of our skills is to regulate and voice an instrument to give a wide range of choices on the quieter side of the dynamic range. When we create this voice in the piano, we create a voice that cannot be synthesized. When we hear this voice and recognize the need for it in our customers and ourselves, we also assert and nurture the validity of this need, this instrument, and our dedication to keep alive the skills and understanding to support it.

Not at NAMM, but in my own home town, I received the following reply from Mark Love, who has just opened the Steinway Piano Gallery:

“The piano will continue to have a place in society; it continues to be an integral part of households. A segment of the population will continue to have a piano available for their children and will provide lessons for their children as part of their upbringing. I believe we have actually bottomed out in terms of the decline in sales of the past three decades. The increase in population and the availability of information from the Internet that promotes music education and champions the benefit of music education will ensure a steady stream of new customers for pianos.

“In our new store we will work actively with our partners in the community to promote active music participation. This community includes piano teachers, piano technicians, symphonies, schools, and arts organizations. We will form collaborative, mutually beneficial partnerships that enhance and increase commitment to active music making. We will be a leader in presenting master classes, workshops, student recital opportunities, and programs designed to educate the educator. We will work to make the music lesson more than a 45-minute session once a week. We will work to make the music lesson a way of being—the lesson, the practice, attending performances, etc.

“The ideal piano technician will be a technician who understands the symbiotic relationship that exists between music educators, piano dealers, and piano technicians. Our health and stability lie in working together to foster
a strong music program. An ideal technician is well trained, well compensated, honest, and a good communicator. An ideal piano technician will recognize when replacement of an instrument is advisable and will communicate this to the consumer, thereby assisting the sale of new pianos in the market.

“Training and providing space and equipment can be a key way that a quality piano retailer supports PTG and its programs. While piano dealers are not large corporations, they can, with creativity and effort, provide support and build relationships with the PTG community. In Philadelphia we often supported PTG with pianos for technical classes, funding for a chapter dinner, scholarships to Steinway technical training and many other programs. In our new location we will endeavor to do the same.

“The new player systems will become a bigger part of the market for one simple fact—the system can operate off the customer’s phone. It is my belief that the previous systems were more or less a novelty, and that when the novelty wore off, the systems were used infrequently. They required that you find the remote, load software, load a CD, etc. Now the consumer can come home, pour a glass of wine, and reach down to a smart phone and turn on the piano. I also believe that the library of music with ensemble background is also a novelty—but the straight solo piano repertoire will continue to grow and be the most utilized part of the library, as solo piano can be incredibly relaxing to listen to.”

A long conversation with Larry Fine, producer of Piano Buyer magazine, and his editor Owen Lovell, assured me that piano technicians are not alone in our experience of pianos! Piano Buyer is the primary source of genuine information about pianos and should be in the reference library of every technician who gives purchase and value advice to customers. Owen offered an uplifting reply: “In the Internet-driven, lowest-price—above-all mentality of our time, pianos are often being put on showroom floors with little to no dealer prep or are delivered directly from the crate. This cost-saving measure “kicks the can down the road,” so to speak, requiring technicians in the field to be proficient in skills beyond tuning to keep and retain happy clients. Speaking of cost savings, a technician who is particularly adept with voicing and regulation has the ability to save a client thousands of dollars by making marked improvements to a current piano instead of the client trading in and buying a more expensive instrument. Ancillaries like exceptional communication skills and an effective Web portal to be discovered by current and potential clients online will continue to be essential to success.”

Thoughts after NAMM 2014
By Del Fandrich, RPT

I do not speak for any company. I have been consulting with Young Chang for the past several years, but these thoughts are my own.

My impressions on leaving this year’s NAMM show are much the same as they were last year. Little has changed. Pearl River introduced a new 180-cm grand bearing the Kaysersburg label. While it is a nicely designed piano and it does represent a significant step forward in terms of build quality for the company, it does not go far enough. Even this effort—impressive as it is—does not begin to address the long-needed advances I described in the article “Where Do We Go From Here?” that I wrote after leaving last year’s NAMM show.

Sadly—at least in my opinion—this is about the brightest news from the entire show. Taken as a whole, it strikes me as being too little and, I fear, too late.

The various European piano makers—at least those who bothered to show up—continue to impress us with their meticulous build quality and their high prices. Mason & Hamlin continues to be the only U.S. piano manufacturer showing its impressive line of high-end and very traditionally designed pianos, along with its revolutionary Wessel, Nickel & Gross action components and its evolutionary PianoDisc reproducing systems.

Pianos from the various Chinese manufacturers (including the redesigned Young Chang product line) continue to show improved build quality. Short pianos from several manufacturers continue to demonstrate improved musical performance.

My personal vision—or desire, and dare I say hope—for the next six years is that someone, somewhere will find the courage and the vision to start a development program that begins to explore potential new markets and stretches the known boundaries of design and construction. In addition to the points I raised in my previous article, I would ask:

• Why do all vertical pianos have to be square or rectangular boxes? Why can we not explore more organic shapes and styles?

• Why can we not have a modern version of a long, flat–strung piano that emulates the performance of the mid-1800s instruments? A modern pianoforte would be superb for certain types of music.

• Why can we not have a modern short grand with an 85–note keyboard? By dropping the bottom three notes, we can make the rest of the bass section sound ever so much better. And we can make it fit into smaller spaces; it can be lighter and easier to move; it can be much better looking; it can be less costly.

• At the other extreme, why do we not have 92–note concert grands? Such a scale can easily be fit into existing concert grand rims with very little modification to the bracing.

Whenever I bring up any of these concepts, I’m greeted with a somewhat derisive, “Don’t be ridiculous! Pianos like that would never sell.” In response I ask, “How do you know they won’t sell? Have you tried any of them? Have you even done the most basic market research? Of course you haven’t, so how do you know they won’t sell?”

Perhaps I can be called an impractical dreamer. But, quoting Proverbs, “Where there is no vision the people perish.” And without vision, companies and industries will also perish.
Stability, Stability, Stability

By Carl Lieberman, RPT
South Bay CA Chapter

What are the three most important aspects of tuning? The answer, which parallels the old real estate saying, is: stability, stability and stability. Most of us have been taught to think of stability as setting the pin or perhaps settling the string. Clearly, it is important to have good hammer technique. It is a given that we should be able to tune a note, pound on it again and again and not have its pitch change appreciably. But there are other ways to conceive of stability.

I started my career as an aural tuner. I believe it is imperative to have refined aural skills to work as a high-level technician. In professional situations, if the accuracy of a note is questioned by a musician, it will not work to pull out an electronic tuning device (ETD) and insist that the note is correctly tuned. We must be able to play the relevant test intervals and correct the note or show that it is properly positioned. In that situation it will still be best to readjust the note aurally back to its original position. However, I believe that a 21st-century piano technician should use a high-level ETD. The bar for stability has been raised, and modern professional ETDs allow for an increased level of stability. Full disclosure: I work for CyberTuner and will use its terminology in this article, but the concepts that I am discussing can be addressed using any of the current professional ETDs.

Every tuning is a pitch correction. I will speak about pitch raises for convenience, but this will also apply to pitch lowering. Even a pitch raise of two cents is non-linear: Every note will not settle exactly the same amount lower. Because there is downbearing, increasing the tension on a string also increases the downward force vector of a string on the bridge. This force distorts the soundboard and causes each string to settle a predictable amount lower than where it was tuned. This means that I approach every tuning as a pitch raise. I used to conceive of a pitch raise as a first tuning that tried to get all of the notes in the ballpark, near the pitches where they would eventually be tuned. I prided myself on doing this first tuning in less than 15 minutes. I would then do the second fine tuning in roughly an hour. I no longer believe in this approach. In order to optimize stability, every tuning should place all of the notes as close as possible to their final position. I now spend most of my time on the first tuning trying to get very close on the first pass. For pitch raises up to 25 cents, a very accurate first “Smart Tuning” is possible. The second pass will be done in “Concert Smart Tune” mode, and every note will settle into a very accurate and stable position. For pitch raises up to 10 cents, only one pass is necessary in “Concert Smart Tune” mode to produce a high quality and stable tuning.

In my practice I have the good fortune of maintaining many pianos that are tuned frequently. I get to follow myself as a tuner and observe how these pianos go out of tune over the course of the seasons. What is notable is that they all go out of tune in exactly the same manner. Most of the time there is almost no change between tunings. I live in California and the weather is fairly benign for pianos compared to the Midwest or East. Our major weather event is the warm dry Santa Ana winds coming in from the desert during the winter. Once there is a change in the weather (temperature/humidity), should I just charge in and retune the pianos so that they are back to their normal tuning? That brings us back to the concept of stability. Another way to think of stability is how much of the time a piano is close enough so as to not offend even trained listeners.

Exactly how do pianos respond to changes in the weather? The most volatile note on the piano is the lowest plain wire string on the long bridge. Think of the long bridge as being hinged at about an octave above the lowest plain wire note. Those 12 notes move up and down with the weather, with the greatest effect at the bottom and the notes above the hinge being relatively stable. There is some movement of the highest two or three bass notes, and some movement of the one or two notes above and below each of the treble plate struts. Given that the piano once was in tune (which it was, since I tuned it six months earlier), then if I methodically put it back into perfect tune, overshooting each note using “Concert Smart Tune” to have these 12 notes drop back to their optimal pitch, I will have actually degraded the stability of the piano’s tuning. Once the weather rebounds, those notes will go out of tune in the opposite direction. Because dryness causes the pitch to drop with the bridge moving down in the same direction of the string downward force vector, the pitch drop will be greater than the subsequent rebound when the normal amount of humidity returns. The bridge will now be moving upwards against the downward force vector of the strings. This is why pianos become flatter over time. Every humidity cycle moves the pitch down more than it returns up.

This is where we can use our ETDs in a non-standard way to increase the long-term stability of the piano. I will tune these 12 lowest plain wire notes on the tenor bridge using “Concert Fine Tune” mode with no overshoot. When I leave the piano, each of these notes will have dropped from its optimal position. The piano will not be in best tune, but will be acceptable to even discriminating ears. If unisons are solidly tuned, there will almost never be a complaint. As the humidity rebounds these notes will move closer into tune, requiring very little adjustment when I return next time. From my point of view the piano
will sound in tune more of the time. Viewed over time, its stability will have been enhanced. Modern electronic tuning devices make these types of “creative mistunings” possible. Pianos breathe in and out of tune on a daily, weekly and monthly basis. Our job is to dampen down those oscillations as much as possible.

Here is another situation where I would not return a note to its optimal position. I’ve tuned a Steinway D for a concert. The artist has rehearsed and is satisfied with the piano. I do my final tuning after the rehearsal. As I play each note, I notice some movement of my spinner. Perhaps some notes are off by as much as one cent, but their unisons are dead on and stable. Should I move those notes to make them better? I don’t think so. A stable unison is more important than perfectly evenly trilling thirds. If there were an interval that was audibly annoying, of course I would correct it. But stability trumps everything else.

I hope this article helps you expand how you think about tuning stability. Use your knowledge and experience to balance many factors and create the most stable tunings possible. □

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The School of Piano Technology for the Blind

By Jeff Lann, Executive Director

Emil Fries, former vocational department chair at the Washington State School for the Blind, founded the School of Piano Technology for the Blind in 1949. Graduates of the School of Piano Technology for the Blind are given the opportunity to embark on a career path that can be financially rewarding, personally satisfying and inspirational. Today we are the only private post-secondary school in the world dedicated to teaching piano tuning and technology to blind and visually impaired students. Since our inception, approximately 70 percent of our graduates have found careers in the piano technology field.

The School is located in beautiful Vancouver, Washington, just ten minutes north of Portland, Oregon. We offer a fully accredited twenty-month course that trains students in the art of piano tuning and technology. Our curriculum covers the ranges of skills and knowledge that piano technicians need to learn to set up an independent business or work in a college or university, music store, church or elsewhere in the music industry. Every student must thoroughly master all aspects of tuning, from unisons through temperament to the entire keyboard, along with basic regulation and repair skills. Students with an interest and aptitude will learn to do considerable rebuilding, including restrunging an entire piano and other repair jobs. In addition to learning to tune and repair pianos, students learn the basics of running their own piano business including developing a business plan, sales, marketing, accounting and customer service.

Entry to the course is by interview and practical tests. Our training is highly individualized, with a maximum of six students attending our school at any one time. We often provide hands-on, one-on-one instruction. Students new to piano technology receive 2,800 hours of instruction. Additionally, we also accept “practiced” technicians that experience vision loss and need assistance in learning how to continue working in the field. These classes are designed to teach specific tasks, such as grand regulation, to veteran technicians and can last from three days to one month.

Understanding the unique challenge of the visually impaired when it comes to learning a trade or occupation is critical. The school is fortunate that all of our instructors can fully appreciate these challenges, as they too are blind and have graduated from our training program. All of our instructors are Registered Piano Technicians.

For information about the School of Piano Technology for the Blind, please visit www.pianotuningschool.org or contact Jeff Lann at jefflann@pianotuningschool.org.

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Mark Burbey came to the School of Piano Technology for the Blind in the fall of 2008 for our two-day evaluative workshop and enrolled beginning the following spring term.

“It was definitely a major commitment to uproot my life in Minnesota and to make the journey out to Washington for the two-year program,” Mark said, “but having access to the individualized, full-time training is really what I was looking for. That was extremely helpful.”

“Way back in high school, I took a two-week summer course in piano tuning offered through a local college workshop, thinking I could get right out there and do it. In reality, they provided us with just enough tools and knowledge to realize that we really didn’t know what we were doing. So, discouraged, I pursued other things professionally.”

Mark obtained a B.A. in communications and worked for companies over the following years, including Jostens, Wells Fargo and Medtronic. However, despite an aptitude for modern computer technology, he found himself still interested in a return to study pianos.

“Well, what happened was that I was turning 40, I was still single and I was tired of sitting behind a computer all day. Now, although I really felt that the types of skills piano servicing actually require were really not my strong suit, and after exploring a number of other options for jobs, I decided to have a nice, quiet, mid-life crisis and prayerfully took the plunge into this line of work.”

Mark graduated from the School of Piano Technology for the Blind program in February 2011, moved back to the Minneapolis-St. Paul area and opened a new business called Keynote Piano Care, LLC four months later.

“I began the business by establishing a good online presence with investing in a professional Web site and online marketing with pay-per-click advertising and SEO (search-engine optimization). I added professional business cards (not done on my home printer!) and carefully chose a few other printed ad channels. I offered initial discounted work rates and paid people for referrals. I hired other professionals to do the things I couldn’t / didn’t want to do and worked with SCORE (the Service Corps of Retired Business Professionals) for input and inspiration. I set up my tiny shop right inside my condo unit and began work. I pursued RPT certification and achieved that in August of the following year. As of this writing, the company services over 160 clients, including several churches, schools, businesses and homes.

“There have been some huge challenges for me in starting this company. First, my personal need for continued education and networking became apparent right away. This is where having the established, professional relationships with the faculty from the full-time training program really shined. Eventually I would also find local, wonderfully helpful technicians through my Guild chapter; but, like most relationships, that took time.

“The second huge hurdle was motivating myself around work to get through the final portion of the RPT certification, which in my case was the bench exam. I had passed the written segment actually before graduating the program, and I passed the tuning part just when my business officially opened. But physically getting myself to repeatedly practice those arduous bench exam tasks was, for me, actually harder than the tasks themselves.

“Finally, those of us with visual impairments must navigate extra hurdles with transportation. In my case, with my current work volume, I burn between 15-25 hours a week dealing with city busses, and I pay drivers just enough for my business to stay competitive and leave something for the technician. But I really do enjoy the work!”
Relate
When people find out what you do, you are met with confusion, indifference and sometimes outright shock. You can’t remember ever seeing your occupation pop up on a standardized check list. Your work is solitary and the experiences that make up most of your day can be difficult to explain to those within your own home. This year you have the opportunity to share, laugh and learn with those who speak your language and fundamentally understand how you make a living. They understand the frustration, the passion, the joy and, ultimately, why you have chosen this unique path. This is why the smiles you see here are so genuine, and they are waiting for you this July in Atlanta.

Validate
You are more than likely your own boss, so how good are you? Are you worth the price you charge your clients? Could you be worth more? After convention you will know exactly what kind of technician you truly are. You will understand your strengths, your weaknesses and in what areas you can grow. You will walk away with new knowledge to make your life better and easier, but most of all, you will walk away with renewed confidence. The next time you give your quote you will do it with pride - knowing you are worth every penny.

Celebrate
This is where we gather to celebrate and foster the close bond of friendship and family we share as members of the guild. We meet old friends and make new ones while honoring the values and traditions we hold dear. This is the 57th year of like-minded individuals gathering to increase the collective quality of piano tuning and technology. This is where we come to respect the past, embrace the present and determine our future.

Educate
When you make your own hours it can be hard to justify taking 5 days away, but with over 100 classes, 95 different instructors and more than 50 exhibitors, you are investing in yourself. You will more than pay yourself back after you have increased your technical and business skills while learning the best methods to keep yourself healthy.

Purchase your tickets now to the 57th Annual Piano Technicians Guild Convention & Technical Institute and we promise you will never have so much fun learning, growing and sharing.

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Weekend Pass: Friday - Sunday
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The Letoff Events “at the Finger”

When a typical piano key is depressed to a certain point in its downstroke, the toe of the jack begins to hit the letoff button. In a grand piano, at around this same time, the top of the balancier begins to hit the drop screw. In a well-regulated piano, these two contacting events should occur at approximately the same time. The point in the downstroke where either of these two events occurs will be referred to herein as the Letoff Start Point of a piano key action (PKA). The region of a PKA’s stroke between the key’s at-rest position and the Letoff Start Point will be known as the “pre letoff” (PLO) region of the piano key’s stroke.

In this same downstroke, if the key is forced to continue sufficiently downward beyond the Letoff Start Point, the jack will eventually rotate far enough—under some amount of built up stress—so that its top “trips” out from beneath the knuckle. In general, the jack is not only rotating, but also bending very slightly as the letoff event proceeds, thus storing up some elastic potential energy. Furthermore, as the stroke progresses, the position of the jack relative to the knuckle becomes less and less conducive to continued contact between the two. At a certain point in the stroke, herein called the Jack Trip Point, the jack rapidly trips out from beneath the knuckle. Of course, this separation is what allows the hammer assembly to traverse the remaining distance to the string in freefall. The Jack Trip Point can be tentatively defined as the point in the downstroke where the jack ends direct contact with the hammer knuckle—or hammer butt, in the case of a vertical piano. It usually occurs at a point fairly close to where the key begins to bottom out on the front punching. The region of a PKA’s stroke between the Letoff Start Point and the Jack Trip Point will be referred to as the “letoff region” of the stroke.

Kinetic Key Leveling

The Key Force One kinetically determines the Bottom-Out Point (BOP) of a downstroke, relative to some home position of the “finger” (Contact). This Home Position will generally correspond to the Contact being well clear of the key. The BOP is the point in the downstroke where a certain amount of ever-increasing resistance is encountered that is unquestionably due to the front punching being compressed by the key. It can be found by examining the resulting reaction forces on the descending Contact for foolproof signs of front punching compression. The vertical distance traversed by the Contact, between its Home Position and the BOP is the Bottom-Out Displacement (BOD).

Starting from this same Home Position, the machine also kinetically determines the at-rest position of the key. By moving the Contact down at a fairly rapid speed, the force-sensing machine detects telltale signs of the inevitable collision between the Contact and key. This gives the so-called Key Collision Distance (KCD)—the clearance between the Contact at Home Position and the at-rest key. The key dip may be found by subtracting the KCD from the BOD. These two innovative routines—and the algorithms for processing the force data—form the heart of the machine’s kinetic key leveling capability.

The Letoff Event: Forces and Locations Along the Downstroke

Once the BOP is found, another downstroke is performed which takes the key all the way to its bottom, generally at a constant speed, while continuously measuring the reaction forces. That is, the well-controlled, force-sensing Contact proceeds so that the key passes fully through its letoff region. If not being done on a workbench, the damper mechanism is fully disengaged. This letoff run provides an additional wealth of information about the PKA. This includes both force and location data: the reaction forces produced by the letoff events, and the important locations in the keystroke where the letoff events occur! Once the KCD is determined, it is often advantageous to begin the letoff runs from a “key adjacent” state. This is the state where the Contact is just barely touching the at-rest key.

![Figure 1: A Typical Letoff Run Motion Profile](image-url)
With the Contact beginning the downstroke from a key-adjacent state, as it passes through the PLO region of the stroke, it experiences forces generally similar in magnitude to the Average Down Force (ADF). This is particularly true if the Contact follows a constant-speed motion profile in this region. After the key has descended at least 5 or 6 mm, the measured forces will begin to increase significantly in magnitude, due to the impact of the jack hitting the letoff button—and/or the balancier hitting the drop screw. Depending on many physical attributes of the particular key action—and various regulation settings—this force increase may proceed for more than 2 mm of travel. This is immediately followed by a sudden decrease in force, occurring when the jack trips from beneath the knuckle/hammer butt. Such an increasing series of forces, followed by a decreasing series of forces, will be called a Letoff Collision String. The beginning of the Letoff Collision String corresponds to the Letoff Start Point. The apex of the string corresponds to the Jack Trip Point. This string is much more apparent in a grand action than in a vertical action.

Figure 1 shows a constant-speed motion profile that may be used for such a letoff run. Positive “y” on the graph is downward on the action. The motion profile gives the displacement of the well-controlled Contact versus elapsed time. The reaction forces are measured every millisecond along the downstroke. While the raw forces are measured versus time, the motion profile allows each and every force data point to be known also as a function of Contact travel. If the run begins from a key-adjacent state, the Contact travel is equal to the key travel at the Application Point (AP). A profile like Figure 1, incorporating an exact speed/slope of 0.025 mm/ms, was employed on two notes—C7 and B7—of a grand piano. Figures 2a and 2b show the resulting forces for each run, for C7 and B7 respectively. These graphs provide a good opportunity to define and describe several other important letoff parameters. The maximum force induced by the letoff event, for a given downstroke speed, is the Jack Trip Force. Since the maximum letoff force of such a downward keystroke always occurs—by definition—right at the Jack Trip Point, the force associated with the Jack Trip Point is the Jack Trip Force. When the ADF is subtracted from the Jack Trip Force, an equally important parameter—the Letoff Increase (LOI)—is obtained. The LOI represents the additional reaction force produced solely by the letoff event, above and beyond the Down Force, for a given downstroke speed. For keys C7 and B7, one can see that the Jack Trip Forces are 150 and 118 grams-force, respectively. The LOI values are 101 and 76 grams-force, respectively. Thus, the letoff event itself produces 33% more force on note C7 than on note B7. Since these two notes are relatively close on the keyboard, this disparity in letoff force is undesirable, possibly leading to unstruck strings during soft playing.

The LOI has proved to be a good measure of how much resistance the letoff event itself offers to the downstroke. In measuring Jack Trip Force, and thus LOI, it is usually best if the Contact quickly achieves a constant speed through the downstroke. In this way, one always knows what the Contact/key speed is when letoff occurs. Experiments by the author have shown that different speeds produce somewhat different Jack Trip Force values. As long as one uses a common speed for all keys, valuable comparisons of Jack Trip Force, LOI, and “letoff work” can be made between keys.

The technology associated with the Key Force One machines enables quick and automatic determination of the Letoff Collision String, and all forces and locations contained within it. The algorithms employed look for an initial strong, increasing nature of the forces (signaling the Letoff Start Point) above the prevailing Down Force values, followed by a significant and sudden decreasing trend in force—signaling the Jack Trip Point, all occurring before the BOP.

The Distance to Letoff Start (DLOS) is herein defined as the vertical distance between the Contact when at some Home Position and the Contact when it has depressed the key to its Letoff Start Point. The Distance to Jack Trip (DJT) is defined as the vertical distance between the Contact when at that same Home Position and the Contact when it has depressed the key to its Jack Trip Point. Similarly, the vertical distance that the Application Point (AP) of the key travels between its at-rest position and the Letoff Start Point is referred to as the Key Movement to Letoff Start (KMLOS). The vertical distance that the AP travels between at-rest and the Jack Trip Point is referred to as the Key Movement to Jack Trip (KMJT). As long as one knows the KCD, then:

\[ \text{DLOS} = \text{KMLOS} + \text{KCD} \]
\[ \text{DJT} = \text{KMJT} + \text{KCD} \]

The vertical displacement between the Letoff Start Point and the Jack Trip Point is an important new parameter, in and of itself. It will be referred to as the Letoff Duration, and is found by subtracting the DLOS from the DJT.
This Letoff Duration can be an important indicator of letoff regulation settings, and has a significant impact on the “feel” of the downward keystroke as escapement occurs. The author has found very wide variance in this parameter, among and within typical pianos.

With this string of force data, one may also calculate the work done—at the finger—in getting through the letoff region. This work could include the Down Force, or it could be Down Force-adjusted, representing only the work above and beyond that required to simply move the key. This can be looked at as the energy absorbed by the letoff event itself, for a given downstroke speed. On force vs. distance graphs such as those in Figure 2, this would be the area under the force curve—in the letoff region—minus the product of ADF and Letoff Duration. It is depicted in the Figure 2 graphs with yellow hatch lines. If the forces were graphed in the original time domain, then one could similarly calculate the impulse imparted to the key during the letoff event.

The vertical distance between the A.P. when the key is at the Jack Trip Point and the A.P. when the key is at the Bottom-Out Point is the actual aftertouch, as it is often defined. That is: Aftertouch = BOD – DJT. The Key Force One therefore also provides a way of actually measuring the aftertouch, as it is often defined. If the aftertouch is large enough, then one can actually see—in the resulting force plot—the force produced at the AP, as the hammer falls back onto the balancier. This little bump in force is visible in Figure 2(b), and is labeled Point F. Being largely an impulsive force, it quickly diminishes, and is nevertheless quickly masked by the compression forces of the front punching.

The ability to measure the Jack Trip Force, Letoff Increase, and Letoff Duration offers huge new opportunities for establishing continuity across the keyboard. Just as with many other keystroke parameters measured by the KFO, their very measurement forms the vital first step in making proper adjustments. A significant goal of such adjustments would be for these parameters to vary continuously across the keyboard.

**More on Kinetic Key Leveling: Locations and Forces**

Assume that the Contact begins a downward run from a Home Position corresponding to some finite but unknown vertical clearance between the Contact and at-rest key. This vertical clearance is the KCD which is to be determined. The point corresponding to the downwardly-moving Contact just starting to collide with the at-rest key will be called the Key Collision Point (KCP). A schematic of such a run is shown as Figure 3. The downstroke can be very fast, and should move the Contact well below the lowest possible point where the at-rest key might be encountered. The entire stroke, perhaps taking less than a quarter of a second, is accompanied by continuous force measurement at the Contact. The resulting force data can then be successfully analyzed for signs of the collision between Contact and key. As the Contact descends quickly through empty space, the continuously-measured forces are nearly zero. As soon as the Contact begins impacting the key, the forces begin increasing significantly, for some small period of time. After one or two mm of key travel, the forces settle down to the normal Down Force values, assuming the Contact had already reached a constant speed. The Key Collision String may be defined as this series of suddenly-increasing Contact forces, occurring when the Contact begins impacting the at-rest key on a downstroke. The beginning of the Key Collision String corresponds to the KCP. The vertical distance between the Contact at Home Position and the Contact at the KCP provides the actual value of the KCD. Figure 4 shows typical resulting forces, versus Contact travel, for such a run.
Assume that the Contact begins another downward run from the same Home Position as is used for determining KCD. The Contact is well controlled, following a given Motion Profile. It is able to stop at any time, if certain force trends or magnitudes are detected. The goal here is to first find the region of the downstroke that corresponds to compression of the front punching. Once the downward movement of the key has reached the point where such compression is occurring, each additional downward movement causes the compressive force to further increase. Such a string of force data points, all tied to known locations in the downstroke, is referred to as a Bottom-Out String. Its main characteristic is that the forces continue to increase with downward movement until very large forces are achieved. Typically, one only needs to create 400 or 500 grams-force to verify that this region is indeed the Bottom-Out String. Requiring such a large increase filters out the letoff event, in particular. The Key Force One is able to quickly produce this movement, and find the string. A Bottom-Out Force (typically 250 grams-force) is chosen ahead of time. The Bottom-Out Point (BOP) is the point on the Bottom-Out String associated with the Bottom-Out Force. The BOP is simply the vertical distance—from the Home Position—to the BOP of the downstroke. A schematic of such a run is given as Figure 5. Figure 6 shows typical resulting forces measured—versus Contact travel from Home Position—for such a bottom-out key leveling run. The Bottom-Out Force is notated as FBO. In looking at Figure 6, one can see that both the KCP and the BOP could be determined from the very same downstroke. The author generally utilizes two separate downstrokes, with the speed of the at-rest key detection run being significantly greater.

Once compression/deflection of the front punching is established, the key movement corresponds exactly to the vertical deflection of the front punching. One may then calculate front punching stiffness values between any
two points. The general equation for one-dimensional stiffness, as a body is deformed from state A to state B, is the \textit{change} in applied force divided by the deflection, between A and B. Each force data point measured along the Bottom-Out String can therefore be paired with any other point on the string, to yield a front punching stiffness value for that region. If the two points are close together, in terms of deflection and force, the resulting stiffness is a “local” stiffness. If the two points are fairly far apart, the resulting stiffness is more of an average or overall stiffness value. If one wanted to plot the actual forces on the front punching versus deflection, then the measured AP forces would be reduced by the Average Down Force (ADF). However, for the purpose of calculating front punching stiffness, it’s okay to use the AP forces; stiffness depends on the \textit{change} in forces, not the absolute values. On the force vs. deflection graph, the stiffness equals the slope of a line between the two chosen points. In Figure 6, the local stiffness between points 1 and 2 is given by the slope of the red line. The local stiffness between points 3 and 4 (the punching more compressed) is given by the slope of the blue line. A more “overall” stiffness would be that between points 2 and 3. This stiffness is exactly equal to the slope of the green line.

Front punching stiffnesses were measured on two separate pianos. For each piano, the resulting force vs. deflection curves will be shown for 12 notes scattered across the keyboard, mostly in the bass half. Figure 7(a) shows the force-deflection curves for 12 notes of Piano 1. Figure 7(b) shows the curves for 12 notes of Piano 2. Only the curve region between approximately 225 and 425 grams-force is plotted. For each curve, a line is drawn between the first and last point. The slope of the line, shown above its top point, is the average stiffness value between those two points. The exact note is specified below each curve. Any given curve’s horizontal placement on the graph doesn’t matter; what matters is the shape of the curves. The horizontal axis represents front punching deflection relative to any convenient reference point. Each division is 0.25 mm. Notice how Piano 2 has punchings that are much more compliant (less stiff) than those of Piano 1. Their force-deflection curves are also more nonlinear than those of Piano 1. The “local” stiffness tends to increase with increasing compression, on Piano 2. This nonlinear characteristic seems to occur more often than not, on pianos encountered in the field. The behavior of the front punching material, and indeed the smoothness of such behavior across the keyboard, is thought by some pianists to be either a help or hindrance to certain types of playing.

**Setting Up for Key Force One Measurements**

For the kinetic key leveling measurements, the machine is situated so that the Home Positions of the Contact, for all same-colored keys across the keyboard, form a line approximately parallel to the keybed or relevant keyboard frame datum. These Home Positions would also be approximately parallel to the front edge of the action. A theoretical line connecting the bottom apex of the Contact, when at Home Position, and over any and all same-colored keys across the action, is called the Zero Point Line. For the kinetic key leveling measurements, all distances (KCD and BOD) are inherently relative to the Zero Point Line. For the letoff data, all distances can be quickly transposed to the Zero Point Line, using the above equations relating KMLOS and KMJT to DLOS and DJT, respectively. The subsequent upstroke for these movements can be extremely fast, taking the Contact quickly back to its Home Position. Normally, the kinetic key leveling measurements are done first, so that: (a) subsequent runs can begin from a key-adjacent state, and (b) the letoff runs can proceed all the way to the approximate Bottom-Out Point, thus not missing any of the important jack-tripping information. When the final run on a given note is complete, the Contact is back at Home Position, and thus automatically clear of the key. The carriage then quickly moves automatically to the next note to be measured. Key leveling data, letoff force/location data, static force data, and others are therefore obtained while the technician is away doing other work.

**Key Leveling and Letoff Location Data, Plotted Together**

The machine was situated as described above, over a grand action, with key leveling and letoff measurements then performed across the keyboard. The results from eight white notes—all near the bass end of the action—are plotted in Figure 8. For each note, four points (KCP, L-O Start Pt, Jack Trip Pt, and BOP) are plotted, with \( y = 0 \) corresponding to the Zero Point Line. With all four values—KCD, BOD, DLOS and DJT—conveniently plotted on the same graph, one immediately sees where each location/point is relative to the other three! A Desired At-Rest Profile and a Desired Depressed Profile are then overlaid, with their placement dictated by appropriate specifications or other factors. These profiles represent
the desired heights of each at-rest and depressed key across the keyboard. The vertical distances (differentials) from each measured at-rest and bottomed-out key are then easily calculated—with a simple spreadsheet—relative to their corresponding “desired” profiles. In Figure 8, the desired profiles are simple horizontal lines, although they could be arcs or other desired shapes. The distance between the two is the desired key dip. For the at-rest values, simple action geometry would allow quick conversion of these “differentials” to actual required punching thicknesses necessary to be added or removed from the balance rail.

It makes sense to also try and get the Jack Trip Point—for every note—to a consistent location, relative to the Zero Point Line, and thus relative to the at-rest and depressed desired profiles. A theoretical Desired Jack Trip Profile could thus be added to the plot, allowing the technician to more easily know where the letoff points are relative to the “stroke limits” for each note, and relative to meaningful action datums. Similarly, the Letoff Durations should theoretically be consistent, or at least vary continuously, across the keyboard. The Letoff Duration is the vertical distance between the letoff start point and the jack trip point. Of course on real piano actions, interfacing with real strings, it will not always be possible to have the letoff events consistently located within the at-rest and bottom-out points. But the ability to easily see any pronounced and unusual variation in these letoff event locations is undoubtedly valuable information for the technician to have. Tremendous variations across the keyboard might signal certain problems in either the action or the stringing.

Rick Voit has a master of science degree in mechanical engineering and began playing classical piano 14 years ago. Prior to his own engineering endeavors at Full-Measure Response, he worked on tractor powertrain and tractor A/C systems as well as analysis of “heat management” problems of surface-mount microprocessors. Contact him at rvoit@keyforceone.com and learn more about his technology at the Full-Measure Response Web site: www.keyforceone.com.
My first mistake as a fledgling piano technician came on my initial day on the job in the summer of 1972. My dad had hired me to help out with his tuning/repair business while my wife and I were camping out for a month of the summer at his home. On day one he assigned me the task of refeltling a keybed while he was out on his tuning rounds. I was to remove and replace the front rail and balance rail felts, then strip off the old backrail felt and replace it with the corresponding thickness of new felt. In my defense, I heard his instructions to glue along the front edge only, but I assumed he was just skimping on glue for reasons of economy. I reasoned that glue couldn’t be that expensive, and decided to do the job right. I slathered the strip of green felt with glue, spreading it even with a butter knife and feeling quite pleased with work—right up until Dad got home late in the afternoon. Apparently there was a reason (other than saving a nickel) for gluing the front edges only. The keys, as it turns out, rest primarily on the back half of the back rail felt. By gluing the front of the felt but not the back, less sound would be transmitted when the keys dropped back into position. A-hah!

Dad didn’t get upset—he just got out a sharp chisel and put me to work scraping off the ruined felt to start over again.

I learned a lesson that day—that there is usually a reason for doing things the way they are ordinarily done. Especially when it comes to gluing parts together, following accepted protocols is important. Certain procedures that might on first glance seem to be halfway measures (such as the case of back rail cloth) are worth describing in detail, if only to help someone avoid the type of mistake I made.
To glue back rail felt on correctly, first cut the felt to size, then flip upside down (Photo 1). Run a line of glue (I use Titebond® for this job, but other glues will work as well) along the edge that is now closer to the back of the keyframe (Photo 2).

The glue is then spread on the leading edge (Photo 3), after which the felt is once again flipped and smoothed into position (Photo 4). Once dry, the edge of the felt closer to the front of the piano will be firmly affixed, while the back edge will be loose. If you check vintage uprights that have full-width felts, you’ll notice that almost always they’re done this way—for a reason!

Another similar procedure is commonly done for the abstract felt found on the bottom of the wippens of console pianos. I frequently change this felt out for the purpose of quieting down a noisy action. The felt acts less and less as a cushion when it wears, and new felt will often work wonders.

With a console action inverted on the bench, the wear and tear done to the abstract felts is obvious (Photo 5). The divots shown mark the contact points between the bottoms of the wippens and the brass capstans at the backs of the keys. The fact that the surrounding area is still fluffy is of no importance. If the capstans are sitting on a hardened divot, the action is going to be noisier than it was when the felt was new.

The solution, of course, is to replace the felt. When scraping off old abstract felt, one will quite often notice that the entire felt is not glued to the bottom of the wippen. Rather, the felt is glued on the front and back edges only (Photo 6).

The reason for this is the same as the reason back rail cloth is glued on the front edge only. In this situation, the brass capstan makes contact with the abstract felt in the middle of the felt. Consequently, that section is not glued, but instead is held in place by glue on either side. With this method of gluing, the felts are secured (Photo 7), but less sound will be transmitted because there is no physical bond between the felt and the wood at the point of contact with the capstan.

A similar protocol is followed when restoring hammer butts, but with one important refinement. The buckskin leather covering the lower curve of the hammer butt is anchored on either end (in a similar manner to the abstract felt) and not glued directly to the underlying felts that cushion it. Whereas the abstract felts are simply glued down flat to the bottom of the wippens, the buckskin should be drawn over the felts with a bit of tension. To accomplish this, the buckskin is first glued into place on one end, using just enough hot animal hide glue to do the job (Photos 8 and 9).

The inserted end of leather then is left alone long enough so that the glue is allowed to cure before proceeding. Once
the anchored end is secure enough that it can’t be pulled loose without ripping the leather, the other end is done.

On this end, a bit more glue is used (Photo 10) because the surface area between the wood and the leather is a bit larger. The most effective way to finish the job, I’ve found, is to use a coarse file (Photo 11) to grip the leather and push it firmly upward for a slow count of 10. Once released, there should be no observable pullback of the leather. Again, without glue between the end of the jack and the wood of the hammer butt, a quieter action is the result.

[Buckskin leather usually has grain and will resist a moving part more in one direction. Synthetic buckskin usually gives equal resistance in all directions. Technicians will take this into account when replacing buckskin. Ed.]

Grand backchecks are done in a similar manner for the same reason. When old leather covering backchecks is removed (Photo 12), it’s obvious that the leather was originally glued on top and bottom where leather and wood make contact, but not in the center where the leather covers the cushioning felt.

The most effective way to finish the job, I’ve found, is to use a coarse file (Photo 11) to grip the leather and push it firmly upward for a slow count of 10. Once released, there should be no observable pullback of the leather. Again, without glue between the end of the jack and the wood of the hammer butt, a quieter action is the result.

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Once again, gluing one end and using that as an anchor for stretching the leather up and over the backcheck will produce the best result. For quick setup, animal hide glue (either hot or cold) is a good choice. With hot animal hide glue, careful monitoring of the temperature and consistency of the glue is important. For this particular job, I chose a new bottle of cold animal hide glue because I knew I wouldn’t have time to do the entire job from start to finish, but would have to break the work into several short sessions. The use of cold glue allowed me more flexibility in my time schedule.
With strips of leather cut to size (Photo 13), the process is ready to begin. (These strips should be cut several inches longer than the actual finished length for reasons to be discussed shortly.) The lower portion of a backcheck is first coated with hide glue (Photo 14), and then the leather is firmly pressed into place (Photo 15), for a slow count of 10.

Once a section of backchecks has been completed to this stage (Photo 16), the glue should be allowed to set for at least an hour or until the bond between the leather and the wood doesn’t loosen when the leather is pulled up sharply. When the glue has cured to that point, the process may continue.

Next, apply glue to the top of the backcheck. Again, avoid getting glue on the felt cushion—just apply glue to the wood (Photo 17).
Wrap the strip of leather up and over the top of the back-check and pull firmly. A bit of glue will most likely squeeze out from the top of the backcheck (Photo 18), indicating a proper amount of pressure and glue.

Keeping the pressure on, clamp the leather in place (Photo 19), place the key on the bench, and allow the glue to cure overnight.

The next day, trim the sides (Photo 20) and back edges (Photo 21) of the new backcheck leather. A little work with sandpaper to remove excess glue completes the job.

Knowing where and how to apply glue on your shop projects can make all the difference in getting things done right (Photo 22). Sometimes, as it turns out, less is more.

If you happen to be traveling through the Midwest on I-35 or I-80, be sure to stop by for a visit. The coffee pot will be on!

Chuck Behm is the owner of River City Piano Restorations in Boone, Iowa. He can be contacted at behmpiano@gmail.com.

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jajones2@wisc.edu  
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But wait! There’s more! For an additional $25, our very own Golden Hammer winner and PTGF Museum founder, Jack Wyatt, will personally sign your apron.

These shop aprons will be available at the PTGF booth in the exhibit hall at the PTG convention in Atlanta.

This would make a wonderful present for the piano technician who has everything, while providing the museum with funds to operate.

The PTG Foundation Mission Statement

The Piano Technicians Guild Foundation supports the mission of the Piano Technicians Guild through charitable, historical, scientific and educational programs.

One of the missions is to provide funds for scholarships for Associates.

To make a tax deductible donation to the PTGF, please contact the PTG Home Office, or contact one of the PTGF officers listed on the right.
Our Last Hurrah (Officially, At Least)

By Dawn Purney
PTG Auxiliary President

The 2014 convention in Atlanta is almost upon us. This PTG event is especially significant to the Auxiliary now, as it will be our 56th and final one as a formal group. The time will be bittersweet, and I am both looking forward to it and dreading it—looking forward to it because I believe Convention is the best time of the year, and dreading it, as the closing of our group will be sad.

The Auxiliary has plenty of adventures planned for July, so I want to extend our invitation to you all.

We will have several options for involvement to all attendees. We will be presenting our final free scholarship recital along with Mason & Hamlin, featuring young emerging pianists. The students always put on an inspiring program. Afterwards the Auxiliary will be hosting a small reception. We will also enjoy a farewell luncheon on Saturday at a nearby southern restaurant. If there is still space available, we will offer tickets for this event during Convention.

We will also go on a tour on Friday, July 18. The theme of our day-long excursion is historic Atlanta. We will visit an actual plantation, complete with historic recreations and characters. We will view the famous Swan House, a huge and striking mansion. An elegant lunch at the Swan Coach House will be included. We will end our day at the Cyclorama, a huge 360-degree display depicting the battle of Atlanta during the Civil War. This exhibit features the world’s largest oil painting, a steam engine, personal narration, and a Civil War museum. The tour tickets will cover all costs, including transportation, entrance fees, lunch, and tips.

For anyone not attending classes, the Auxiliary will have quite a number of other activities as well. Along with all the activities mentioned above, we will have other adventures throughout Convention week. We will have the Dirty Santa gift exchange, business forum for those involved in the piano business, and our last council meeting, where we will finalize how to disperse our funds. Additionally, the book discussion on the historical novel Molokai by Alan Brennert will feature a picture presentation of the actual Hawaiian island present-day.

Since the Hyatt Regency is in the heart of downtown Atlanta, the Auxiliary will visit some other nearby sites. The Coke Museum highlights drinks, bottles, and ads from times past and from around the world. The Georgia Aquarium will be another stop for us. This huge aquarium includes many interactive displays and shows. All of these events are included in the Auxiliary registration.

If you have time, I urge you to leave a few extra days to explore Atlanta. The CNN studios and Olympic Park are within walking distance of the hotel. Margaret Mitchell’s house (where she wrote Gone with the Wind), Stone Mountain Park, and the Martin Luther King, Jr. Historical Site are just a few of the other attractions to visit in this great city.

So plan now to come to the Atlanta convention this year. We hope that you will join us for at least some of our events and programs and help to send us off in style!
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Pianos usually have over 200 strings, and we often tune each of them several times. While tuning we can play each note as many as 100 times. During a tuning we often find ourselves in slightly uncomfortable positions, such as against a wall or leaning over a player mechanism. Then, some of us might actually play our instruments; a few of us practice on them for hours.

All this can lead up to our own peculiar set of repetitive use injuries. Pounding on notes with our free hand, tugging on tuning levers, turning screws through an entire action, snugging plate and case screws, even removing cheek blocks or legs, and our wrists, hands and shoulders can be stressed up to or beyond their capacity for quick healing.

Then we go home and pound customer data into our computers. If you are like me, you probably spend much too much time in front of a screen and keyboard, creating another set of problems.

Muscles and even bones have an ample blood supply and can recover or adapt to regular use. Tendons and joints have far fewer blood vessels and require a much longer healing and recovery time. Tendon and cartilage do have the ability to recover from heavy use; we don’t actually wear away our joints from over-use—it can just seem that way. For most of us, the cartilage wear that results from normal use heals or re-grows with adequate rest. (Conditions such as arthritis are usually the result of immune system damage or infection and are beyond the scope of this article.)

We need to remember several guidelines:

1. Beginners should practice gentle and gradual conditioning. Avoid over-stressing backs, shoulders, elbows and wrists. Piano tuning isn’t supposed to be a strenuous job, but proper general conditioning does help with adapting to a tuning career.

2. Avoid heavy repetitive-use tasks such as tightening action screws all day or trying to tune 11 pianos in a row. If you have a tough work schedule, keep your activities varied.

3. If it hurts, don’t do it. If you need to do it, find a way that isn’t painful. Joints and tendons don’t respond to heavy stress the way muscles do.

4. Use the proper tools. There are many innovative tuning levers or tuning systems that put less stress on your joints. Key pounders or artificial fingers can take the stress off of your “pounding hand.” Piano jacks and action carts take the stress off of our backs. Good tools are a pleasure to use.

5. If you do find your joints sore, take a long or careful rest. Many doctors recommend as much as 12 weeks of easy, un-stressed movement or more for proper joint healing and recovery following injury. Some injuries can even take years!

Medications and supplements might help for some people, but you should not trust or rely on them to replace proper conditioning, good ergonomics and recovery following stress.

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