Fandrich-Rhodes Key Weighting

Myth Busters

with

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Mark, 6:4: Jesus said that only in his family and only in his home town is a prophet without honor.

There is a software program that does all the number crunching for touch weight calculations. John has developed three mushroom-shaped weights that fit between the sharps. These weights have revolutionized the process of weighting, reducing the time from four hours to under an hour. There is also a Teflon board made with a scale, weights and a rack for the key. Adjust the scale for proper support, match the numbers, the computer does the calculation, mark it and set the weights.

Technicians must know how to do things properly or the history of the acoustic piano is at stake.

We are concerned about "Myths" because

- Myths interfere with delivering high-quality service to our customers
- Myths damage instruments, and our credibility too
- The future of the acoustic piano depends on our ability to prepare and maintain instruments which are a joy to play.

Myth Busting

- Myths are popular and persistent procedures which interfere with delivering high quality piano service to sensitive pianists.
- Complainers listen hard to tunings and are critical of regulation, but are key to troubleshooting.

The Ideal Scenario

- Customer seeks technician
- Customer trusts technician
- Technician performs service
- Technician presents bill
- Customer pays bill, agree on next service date, shower technician with praise, and gives referrals
- Where's the cheese

Finding Cheese

- You're given a supply of cheese, a maze, and a hungry human. Put a piece of cheese in spot 37. The rat sniffs out the cheese and finds it. On day 4 put the cheese in spot 57. The rat will first go to 37. Then will sniff it out and find 57.
- With a human, most humans will find the cheese. Move the cheese again. The human is convinced with rational arguments that 37 is the only place where the cheese should be. The human will starve at spot 37. The rat is able to let go of believing that there is no cheese where there should be cheese.

Whom are we trying to please?

- Ourselves?
- Our tax accountant?
- Other technicians?
- Our customer?
- What type of customer?

Piano Owners Pie Chart

- 25 million pianos (US)
- 90% non-players
- 10% players
    - 2.5 million pianos owned by players
    - 9% indifferent to tone, touch, and tuning
    - 1% recognize there's something more to a piano
        - 50,000 pianos
        - 0.8% are desensitize to tone & touch
        - 0.2% (50,000) owners have real "ears" and are sensitive and perceptive. They demand cheese!

Piano Technicians

- 10,000 piano technicians
- 95% (9,500) tune & run
- 5% (500) tune & service piano
    - 500 fairly competent technicians
    - 4.5% (450) tune, turn screws, fix squeaks, poke needles into hammers
    - 0.5% (50) master technicians tune – verifying with aural checks, evaluate regulation by play and feel, voice for smoothness, blending, and dynamic range
    - They sell cheese! Match this technician up with a complainer, the complainer will no longer complain and will refer this technician to ten other people.

Cheese with every service

- Most pianists have not experienced cheese.
- Hype and misinformation destroy our industry's credibility.
- The long-term survival of the piano as a mainstream instrument depends on technicians who deliver cheese with every service.

Myths can cost lots of money

- Myths taking the form of fads, styles, misinformation, and hype
- Examples
    - Example #1: 1920 Steinway "B"
    - Example #2: 1994 Steinway "B"

Failing to deliver cheese

- Tuning stability
- Temperature & humidity
- Tone & voicing
- Touch & touch-weight
- Action modifications
- Features & gimmicks (e.g. accelerated actions, tension resonators, etc.)

Key Weighting

By Darrell & Heather Fandrich
http://www.fandrich.com

Traditional weight measurements

Heather would take about 2 hours with down weights and 2 hours with up-weights with Bill Spurlock's weights, and this is with experience. In the past, weighing off a set of keys after installing a new set of hammers was so tedious that most technicians wouldn't do it. With the Fandrich-Rhodes system, the process is so fast that it makes this necessary measurement easy and quick. De-friction the action first before taking measurements.

The other function of key-weights – hammer weight opposed by key weights.
Result: parts pressed tight together during play.
No dynamic lost motion (during play) – no need for a bridle tape.
When the action is removed, the front of a grand key drops down; the front of an upright key drops up.
We want the whippen to remain in contact with the capstan. It is impossible to regulate well with a turbo-spring (whippen-assist springs, invented in 1880). Throw away the turbo springs. A strong turbo-spring transfers the pressure from the jack and knuckle down to the capstan and whippen. Woven cushion cloth is not as tough as stretched leather.

Spurlock's weights sped up the time taken to take weight measurements. As long as the criteria are within reason, what really matters is that the touch is consistent up and down the piano. As long as the procedure is consistent the result will be good.

Fandrich-Rhodes System

- 45 minutes to do down-weights and up-weights
- Take three basic measurements at the bottom bass and at the top treble section.
    - Balance rail pin to front of the white key (Bass WW and Treble WW)
    - Balance rail pin to the front top of the sharp where it breaks (Bass BB and Treble BB)
    - Front of balance pin of black key to the front of the edge of the adjoining white key front. (Bass and Treble BW)

Why do some pianos choose heavy down-weights? A stuck key will get a warrantee complaint, but a key that goes down won't. At least the key will come back up when you take your finger off of it. This is why even new pianos can profit by doing a touch-weight on it.

Technique

- Move the weight up & down the key to the right place, then measure the distance from the front of the key. Enter this measurement into the computer.
- This ruler has several interesting features. The little holes enable you to see through. The numbers are easy to read.
- This principle works just like the double-weight system in a doctor's office. For example, to get to 70 grams, move the weight about 4mm. For the large weight, you pick it from ¼ to 1/8 gram. The important decision is how far to slide the weight on the key. These numbers are very accurate.

Friction

- Friction is half the distance of the down-weights and the up-weights.
    - Example: 52g down-weight --18g upweight = 34g / 2 = 17g friction
- Practical minimum friction is 12-15g in the bass tapering to 9-12 g in the treble.
- Higher bass friction results from greater internal friction due to heavier hammer load on knuckles and cushion felts.
- When humidity changes, friction increases; therefore lower friction is better. Friction is needed, but only in small quantities.

Tolerance and Significance

- In our experience, mid-keyboard down-weight 52-54g feels medium.
- Above 56g mid-keyboard touch feels heavy; below 50g feels light.
- The perceivable difference in down-weight average is about 2-3g.
- The perceivable difference in down-weight between adjacent keys is about 4-5g.
- Down-weight should taper; 6g higher in the bass is common.

Perceptions of differences in inertia are more subjective but seem similar to down-weight difference percentages. The finger can't tell the difference between two and three grams.

Action Ratio

Even on pianos where the down-weight is the same, why does one have a light touch and the other is very heavy? How can we get a number to give a clue how to make this piano more serviceable? When a piano is played pianissimo, the down-weight-up-weight factor is very important. When playing forte, inertia is the primary factor. Some pianos seem to have a long transition from triple pianissimo to fore, whereas others jump from one to the other with nothing between. This issue might have more to do with action spread geometry than with key weight.

Inertia is dominated by the hammer weight. The hammer weight as seen through the action ratio is noticeable. It is sensitive to the square of the action ratio. The angle by how far the key moves to how far the hammer moves, which is about 9. Square this and the ratio is about 80 or 90. Changing the hammer or the knuckle position makes a significant effect – far more than changing the key weighting. Placing the weight closer to the balance rail creates more inertia; a 17% reduction of the part of total inertia is insignificant.

Touch weight affects soft playing. It makes evenness of touch noticeable at a soft touch. We can't affect inertia with touch weighting. Inertia can only be changed by dealing with action ratio and hammer weights. It is harder to do trills in the bass because the inertia is greater. Key weighting will greatly improve the feel in the middle range.

In our opinion:

Touch weight of most new pianos would be better with

- somewhat less inertia,
- but enormously better with accurately weighted keys,
- and without wippen support springs that
    - Are impossible to accurately adjust
    - Produce wildly uneven key weighting patterns
    - Reduce the highly desirable opposed forces of hammer weight and key weight
    - Reduce the amount of key inertia highly desirable for key follow-through

Computer Measurements

The computer calculates the desired measurements from the actual measurements. These measurements are based on the initial three measurements at each end of the keyboard, and each individual down-and up-weight measurement taken. The desired target measurements are represented by a horizontal line in the middle of the chart; this is adjustable. The actual measurements are usually farther above and below this line. By looking at the graph one can figure out that the frictions are high. Having the friction scale graph on the same page as the weight results is so helpful that it makes the solution obvious. As you're going you can fix things.

Most measurements stay within a 10g range. This means that the factories do a relatively good job. Often we only need to replace a weight with a heavier one and maybe add a few small ones.

Take these preliminary steps before doing key weighting:

- Remove the action from the customer's piano, take it to the shop and take **measurements**.
- Shape and sand the **hammers** to get the basic weight.
- Do a rough **regulation**.
- Take care of **friction**.

De-Frictioning

Hammer Friction

To test the hammer swings, lift a section of hammers and see which fall the first. Remove those and test the swings. Once the fastest falling hammers are 10 or less, then pick the slowest falling hammers and check the swings. If they are more than 6 we are in the ball park. If they are less than 6 the flanges are tight. Darrell uses a pint of 99% rubbing alcohol with a teaspoon of Ballistol as a lubricant.

By slightly sanding the sides of the hammers, a gram to a gram and a half can be removed. Most new center pins are nickel. (Older center pins are bronze.) Play them for about six months and they will be burnished.

Key Friction

Re-bush the keys with German felt. Most of the older felts are glue-soaked. Use Probond wood glue. It doesn't soak into the felt, but it stays tacky long enough to get the new felts in. For Chinese uprights with loose key bushings, Heather used 409 glass cleaner (or Windex) and the felts fall out. Balance rail bushings take three dosings, and the front rail felts use two. It takes about 15-20 minutes to soften up the felt. The wetness also shrinks the holes and "glue sizes" the holes for a better caul fit.

Spray the balance and front rail pins with a Teflon spray. Also spray the key bushings with Teflon. You can feel the difference. To test, push the key to the side of the pin and rub the key up and down and you can feel the difference. Teflon powder falls out in a month or two, whereas the Teflon spray lasts for three to six months. Polishing the capstans makes very little difference. Ease the keys if necessary

Friction changes can happen with key pliers, but to get a nice tight fit and a uniform felt surface that will hold its tight clearance is best done by re-bushing the keys with new firm felt. Bill Spurlock's cauls produce consistent results. Saturate the felt with Teflon spray and iron the keys. Re-bush the keys, treat the holes in the wood, and spray Teflon on the pins is easier than trying to ease them. It takes about four hours to re-bush the keys.

Customer Awareness

Pay attention to customer comments. Don't ignore their comments. Don't tell them they're wrong. Delve into their concerns and do some research. Pay attention to the customers' tiniest comments and determine why they sense the problem, what it is and how to solve it. When you get beneath what the hand can feel – when your details are below the radar – then you are wasting your time on the miniscule because the people are already happy.

Key Weighting Process
(about 8 hours on average)

First Step: Reduce Friction

Glues
Elmer's ProBond (Fandrichs' favorite)
Franklin's molding glue works
Hot hide glue (Joe Garrett's favorite)

Size the center pin hole at the bottom of each key.

- At the Baldwin factory they would simply crank the key up and down a bit.
- Yamaha's tapered tool is good for easing the wood hole in the bottom of the key center pin hole.
- Darrell made a de-burring tool for beveling a hole from 5mm to 3mm. Do every hole whether it needs it or not. It de-burs the hole, bevels it, and feathers it so they are all consistent.
- With a rat-tail file, file on the side so you don't enlarge the pull.

Spray Teflon

- Shake the can because it is a Teflon powder in a solvent.
- It leaves a little white residue, so you can see where you've been.
- "SprayOn" brand by Grainger is inexpensive.

Iron the bushings

- Iron the bushings after the Teflon is on.

Ease the keys

- Chinese keys use a really hard wood, like hornbeam.

Test hammer flange tightness

- Test which fall fastest and slowest.
    - First to fall is the loosest
        - May need repining
    - Last to fall
        - Lubricate or re-pin
    - For any that are still tight:
        - Try a little exercise
        - Try a little heat
    - Work on the extremes until:
        - Bass swings 8-10 times, tapering
        - Treble swings 6-8 times, tapering

Lubricants

- Ballistol comes in both a spray and as a liquid. http://www.ballistol.com
- Mix Ballistol with 99% alcohol (90% alcohol contains some water and produces some shrinking)
- Spray at least five seconds but no longer than ten seconds
- Reserve applying TFE and soap to knuckles for slight friction corrections.
- Rub on soap lightly to increase the friction. It will make the jack-to-knuckle a little slower. Look for at least 8g. Soap will also eliminate squeaky knuckles.

- Study friction line on the graph
    - Will be a little higher in the bass due to greater internal friction from heavier hammers
- Correct for unevenness from
    - Rubbing or misaligned parts (for large differences)
    - Tight hammer flanges
    - Tight key bushings
- Immediately measure and enter changes into the program

Weigh and mark the keys

- Set up jig to support key.
- Position weights to match target keys
- Remove weights if necessary

Drill keys

- Use a Forstner bit
- Drill until a dimple comes out the other side.
- Flip the key over and drill from the dimple side for a clean hole.
- Make sure the key is elevated so the bit doesn't go into the bench.
- Keep the hole a little lower than center.

Pound the weights in

- Use a tiny anvil or a solid vice
- Use 5/8' weights from Schaff
- Tap them in from the side for a tight fit
- Make sure the oblong goes in with the end grain so it doesn't split
- File off any extrusions.
- European leads range from 15g to 10g

Final Steps

- Reinstall keys and re-measure down-weight only
- Results are usually 85-90% within +02g of the target weight
- Position and mark for as many 3/8" correction leads (on the capstan end if too light) as your conscience demands
- Drill and install leads
- Re-measure down/up weights, enter data, save-as "final" and print for customer.

Specific Demonstrations

Customer Awareness

Think about taking a 70g weight and going down the naturals. Make a graph and in about 10min or less you can find where the weight was. Eyeball where the weight was, slide it graph it, and so on. Graph it and the line will be all over the map. Explain to the customer that when you are done this will be a smooth line. Have the customer feel the keys, having them feel the difference between light and heavy keys.

The ultimate comment we want to hear is "I'm going to have to re-learn how to play this piano. It has a whole new feel that is so much better." "Oh, it feels better. I like it," and then, later at night a call comes in, saying "I can't go to bed. The piano plays so well that I can't stop playing it."

Fix Things As You Go (after friction has been fixed)

- When we get to a certain point of measurements and we know what types of changes need to be made,
    - Place a key on the jig, resting the end of the key on the end of the stand (sharps go on the lower part of the stand). The stand can be adjusted for variations, like keys that are tapered in length.
    - Read the existing weight and enter the measurement into the chart.
    - A target weight number appears in the appropriate box.
    - Place the sample weights on the key until the target weight is achieved.
    - Sometimes weighs need to be knocked out instead of added.
    - Darrell likes to leave at least two weights in each key to keep the key seated on the rail without bouncing off.
    - In the treble sometimes weights need to be added on the capstan side of the balance rail.
    - There are three sizes of weights – 15g, 12g, and 10g
    - Leave empty holes. It is not necessary to fill them.
- Mark the keys. Write what size weight to put there.
- Drill out the keys from both sides with a Forstner bit.
- Install the weights so they are tight in the holes. Smash them in with an oblong shape, pushing against the end-grain. Use a punch.
- Replace the key on the jig and enter the new measurement in the box: .3g is fine.

Web Site

- http://www.mypianotech.com/wb
- Since a computer is necessary for this system anyway, with the web site information can be up-dated.

This method of measuring came about because the Fandrichs were playing on John's piano, and it had a terrible touch. They started weighing off the keys with an Excel spread sheet and some mushroom weights Darrell had made to fit between the black keys. Since then the system has been perfected.

Things to Watch For

- Balance rail
    - Balance rail with studs in the air will give a heavy feel to the touch.
    - Bedding of the balance rail makes a big difference.
- Keys with absolutely no weights will feel very inconsistent.
- Damper timing is crucial. The proper distance is ½ of the hammer travel.
- Inertia is not affected by key weighting. Playing fortissimo is the inertia range, and key weighting is not noticeable.
    - Sanding the hammers into a V can make a significant dent in the inertia.
    - Action ratio has nothing to do with action spread. It has to do with the position of the jack.
- Voicing is a factor.
    - Jergen's book on voicing is superb.
    - Steam, pliers, glovers needles, moto-tools, sanding on the sides, are all techniques people have tried.

Further Program Applications

- Mirror-image actions would be determined by friction
- The mid-line between down-and up-weight can
- White and black boxes show where the whites and sharps are.
- Click on a certain note and it will display that note's specifics.
- The kit includes everything but the laptop for $465.00
    - CD with software
    - Scale
    - Mushroom weights
    - Ruler
    - Jig & stand
    - Instructions
    - This software will not run on a MacIntosh
- Things to buy
    - Get a laptop for $100 just for this program
    - Buy or find a little anvil
    - Some sort of jig for punching out the leads