Part 7—Practical Keyboards for Normal People

Alternatively-sized keyboards—i.e., smaller—are receiving more attention today than at any other time in my memory. I'll not discuss their merits; that is being done by others more qualified to speak on the subject. Suffice it to say there is some frustration among a growing number of pianists that these keyboards are not readily available at a reasonable cost. There are some practical reasons why this is so. In this article I will explore some of the technical challenges in making these keyboards practical as low-cost options in production pianos.

Background

During the late 1980s, I designed a very short grand piano for the Baldwin Piano & Organ Co. Before beginning the project I asked Engineering if there were dimensions for the key headscale—the parts of the keys that you see when you sit down to play a piano—that were recognized as industry standards. In other words, did the keyboard absolutely have to be the width we most commonly found in production pianos? I was exploring the possibility of using a moderately narrower key headscale.

I wanted this for several reasons. One was aesthetic—it would have made it possible to make the piano a little bit narrower and short grands look better that way. More important, however, I wanted to explore the possibility of making a keyboard that was more accessible to more people. During the years when I was doing a lot of field service work the subject of keyboard width had come up, if not frequently, at least often enough to catch my attention. As well, in my position as Director of Research and Development I regularly received letters on the subject from pianists with smaller hands who were having difficulties with the standard piano keyboard.

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I did not think I was promoting anything all that radical. I had drawn a key headscale with an overall width of 1195 mm—it works out nicely using metric units—which would have resulted in an octave width of 161 mm as opposed to ≈165 mm. Since the piano was intended for home markets this seemed a logical development. I didn't think it would be enough of a reduction to be objectionable to adults with large hands and it would make reaching certain intervals some easier for those with smaller hands. Plus, it would offer something available from no other piano maker.

Producing such a keyset would have required a new mold for the natural keytops but the sharps could have been used as is. Some machinery would have to be adjusted to accommodate the alternative keyboard. In the end it was decided that deviating from the standard key headscale might be confusing—pianists might not be able to transition easily from one to the other—and this keyboard was never built.[1] We did not even build a sample keyset for testing. Rather we stayed with the "standard" key headscale dimensions. And this brings me back to the question of just what was the standard?

It turned out that there was supposed to be a standard: the overall width of the key headscale was to be 1220 mm. So I dutifully drew—by hand in those days—a keyset using the dimensions provided and turned it in. After reviewing my beautiful drawing, the production people sent it back saying that they could not/would not build it! All of their machinery and keytop moldings were set up for a nominal headscale just a little wider than this. So I redrew the keyset to match the headscale design already in use, not the "official" standard.

Over the next few months I carried a tape measure with me and measured as many key headscales as I could find. It turns out that in practice there is no accepted industry-wide standard headscale width. From roughly 1900 on they have varied from about 1220 to 1230 mm in width with, ironically, some of the Asian piano makers at the wide end of this range. Each key maker, it seems, pretty much does its own thing, and I know of no current production piano using a keyset matching that illusive "industry standard" I'd heard about. Some older pianos, yes, but nothing in current production.

Current status

Since that time the subject of reduced-width key headscales has continued to come up from time to time and now seems to be gathering some momentum. Several studies

[1] Now that a number of alternatively-sized keyboards are available this concern has been demonstrated to be largely groundless but that is a story for others to discuss.

have been conducted on the physical difficulties encountered by pianists having smaller than "normal" hands but these have been ignored by contemporary piano manufacturers.[2]

During my years as a piano design and manufacturing consultant I have explored this topic with both key makers and piano manufacturers, so far without success. There are many reasons for this lack of interest but one major factor is simply momentum—the "we've never done it that way before" syndrome. No one wants to be the first. After all, it might not sell.

Another issue is *portability*: some professional pianists have expressed concern that transitioning from a long-established standard to an as yet untested alternative might be confusing. After all, if one's practicing is done on a piano with a different octave spread, converting to a piano with a standard octave spread might be difficult. Of course we don't really know if pianists will have difficulties transitioning between the different standards because pianos with the different standards are not readily available. We also don't know how many pianists might be affected since most will play almost exclusively on their own instruments.

This presents the classic Catch-22 dilemma: There is no consumer demand for pianos with reduced-width key headscales because there are no pianos with reduced-width key headscales available for purchase. And they are not available for purchase because there is no consumer demand for them.

In addition to the medical evidence, there is a growing body of information on this subject that explores the performance and portability issues related to alternately-sized piano keyboards. One paper that provides a good overview of the subject is "Hand Size and the Piano Keyboard—Technical and Musical Benefits for Pianists using Reduced-size Keyboards" by Ms Rhonda Boyle and Mr Robin G Boyle.[3]

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[2] One paper, *"Assessment of Muscle Activity and Joint Angles in Small-Handed Pianists,"* can be found here: http://l.facebook.com/l.php?u=http%3A%2F%2Fdigitalcommons.unl.edu%2Fcgi%2Fviewcontent.cgi%3Farticle%3D1007%26context%3Dmusicfacpub&h=tAQHzrafB

[3] This paper (complete with an extensive list of references) is available online at the following location: http://appca.com.au/proceedings/2009/part_1/Boyle_Rhonda_Boyle_Robin.pdf. This paper includes an extensive list of references for those looking for more information on this subject.

Steinbuhler to the rescue

Thanks to the work of David Steinbuhler, there are now at least a few pianos available with keyboards of reduced width for pianists with smaller hands to actually play.[4] These are still frightfully expensive but at least they are available. As a result there is a growing body of pianists who have actually played pianos with both alternate keyboard sizes and "standard" keyboards who find switching between keyboards with different octave spans relatively easy but old beliefs will die hard.

Other reasons standing in the way of practical narrow-headscale keyboards, however, are technical. The only narrow keyboards available are those made by Steinbuhler.[5,6] Although it is reportedly offered as a custom fit option on a very few new pianos, they are mostly available only on special order and at considerable added cost.

While much has been written about the desirability of reduced-width keyboards—see the above reference—I have seen little written about the technical challenges of producing a keyset with a reduced-width as a *reasonably-priced production option*. To build one-off or very limited production keysets is one thing; to build them in production quantities and make them affordable is a whole other issue.

The technical challenges

Small changes in headscale width can be made fairly easily—reducing the octave span from the current "standard" of 165 mm to 158 mm (drawn for a client but never built) as shown in Figures 1 and 2 would not be technically challenging in most grands—but some testing would have to be done to determine just how helpful such a change might be to the intended audience.[7] My experience at Baldwin convinced me that even a small reduction would be helpful for some but the active group of pianists who are leading the move toward reduced-width keyboards take exception to this and are asking for more.

Another source for up-to-date information on this subject for technicians is the Facebook page TASK (Technicians for Alternatively Sized Keyboards):
https://www.facebook.com/groups/TASKPiano/

[4] See last month's article on this subject.

[5] http://www.steinbuhler.com/index.html

[6] I am told that Laukhuff—best known for organ keys—is also now making some reduced-width keyboards. See: http://www.en.laukhuff.de/about-us.html

[7] In this article I discuss only grand pianos. The basic problems remain the same for verticals, but in these reducing the width of the hammer strikeline is more challenging.

Or should I say less—the two alternative standards they would like to see are for keyboards with octave spans of 152 (DS 6.0) and 140 mm (DS 5.5).

Unfortunately (and depending on the length of the piano and the length of its hammer strikeline) reducing the keyboard width much below 158–160 mm becomes increasingly difficult. There are several longer pianos—210 cm (6' 10 ½") and up—in which key headscales with an octave span of 152 mm might be fitted without too much difficulty but the cost of these pianos is usually quite high. And they take up a lot of space. In traditionally designed short- to mid-sized grands, things get more difficult. Let's investigate this a bit….

A moving target

First, we need to be aware that nearly every piano design requires its own unique keyset. Even though the visible headscale may look the same across a product line, behind the scenes there will be many differences. To make unique keysets available as reasonable cost options in every model of piano offered by any manufacturer, while not impossible, would be very expensive and, given the potential market, impractical.

As with most aspects of piano design, key design is a compromise of several disparate physical requirements. Among them are these:

- The width of the *hammer strikeline*—the distance from the centerline of the hammer strikepoint at A1 and the centerline of the hammer strikepoint at C88.
- The width of the *key headscale*—since the late 1800s this has varied from 1220 mm to 1230 mm. But, as already noted, there is no industry-wide standard.
- The amount of *key flare*—the keys do not go straight back from the key covering to their respective wippen/hammer mechanism. To accommodate this offset requires that the key sticks be angled to some extent immediately behind the end of the key covering. This is called key flare.
- The distance from the front of the keys to the capstan line—this distance varies considerably with the overall length of the piano. The shorter this distance, the greater will be the required key flare angles. This is why it is easier to fit reduced-width key headscales into longer pianos.

While it would be fairly easy to have agreed-upon standards for the width of the key headscales, there are good reasons why there are no industry-wide standards for any of the others. The hammer strikeline is part of the design of the piano. Its length varies with the size and type of piano, but in most pianos it is between about 1220–1260 mm. This

is some wider than is strictly necessary, but we seem to be stuck with the scaling architecture of the 1880s to the 1920s. At the time, and with very few exceptions, wider was considered better, partly because it made construction easier—certain tolerances did not have to be adhered to quite so tightly—but it was also dictated somewhat by the aesthetics of the day. (The reader may have noticed that many short grands patterned on early string architecture are about as wide as they are long.) Big was good and bigger was better.

Hammer strikeline length

And herein lies a large part of the problem: somehow, the width of the strikeline must be matched by the width of the key headscale. If the key headscale is 1224 mm (an octave width of 165 mm), even if the strikeline length is 1240 mm it will not be difficult to get everything lined up. See Figure 1. (Note that in all of these drawings I have centered the key headscale on the scalestick. This is not always the case, but it works well for illustrative purposes.) The keysticks are flared out to match the action centers but none of the flare angles are very large.

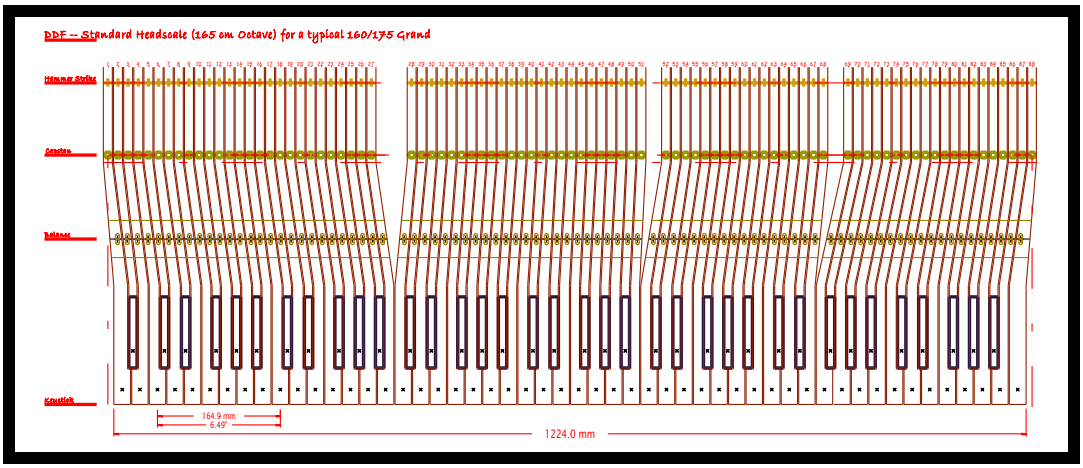

Figure 1. Strike line width = 1240 mm; headscale width = 1224 mm; octave width = 165 mm (6.5"). This is the normal key headscale in use today.

Now let's reduce the width of the key headscale just a little to 1172 mm giving an octave width of 158 mm. See Figure 2.

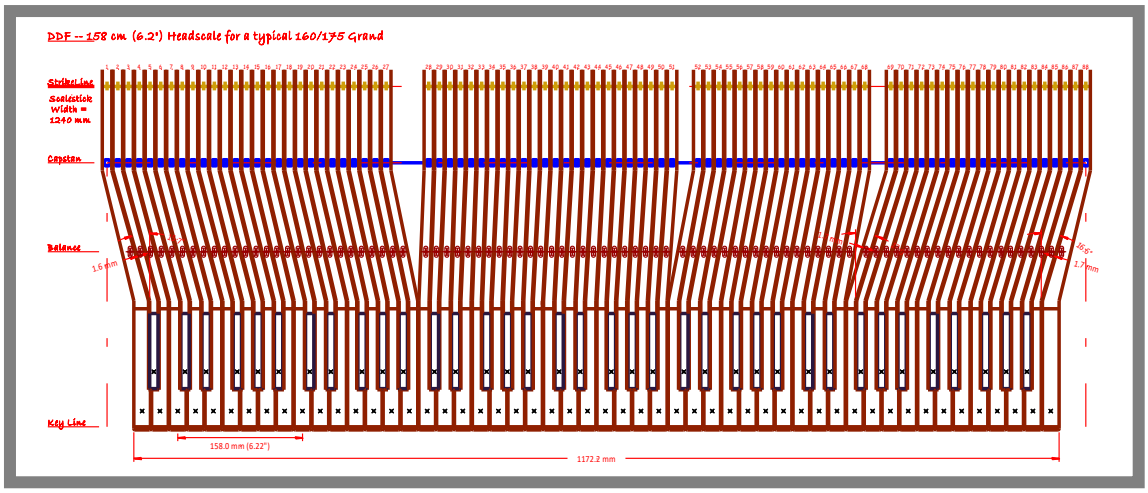

Figure 2. Strike line width = 1240 mm; headscale width = 1172 mm; octave width = 158 mm (6.22").

Now the string angles are much greater and problems are starting to show up in several areas. See the enlarged drawing of the bass keys in Figure 3.

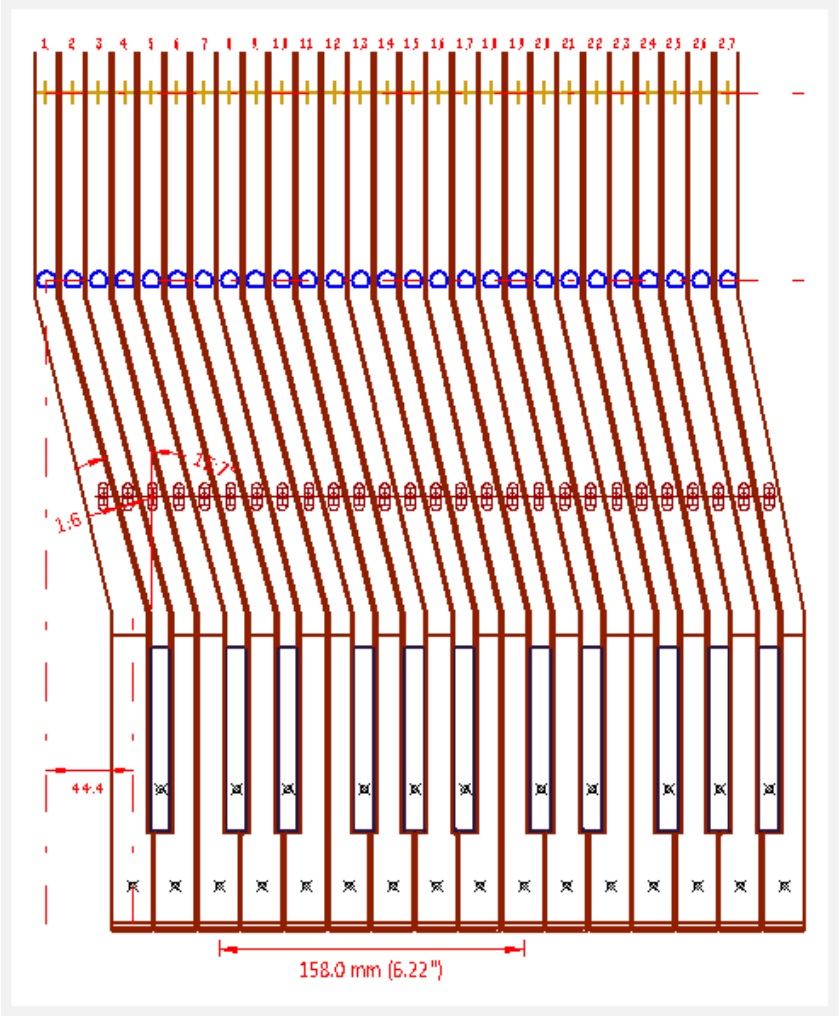

Figure 3. An enlarged drawing of the bass section of key headscale shown in Fig. 2. The problems show up around the key bushing mortises in the bass. The mortise must be cut parallel to the key fronts.

- The flare angles in the bass and treble sections are now both just over 15°. With modern keys—generally not as tall as they once were and made from second- or third-

growth wood—this is close to the maximum allowable.

- Even assuming perfect machining, the thickness of the center rail key button mortice wall is down to about 1.6 mm (at its narrowest point). This will be the weakest point in any piano key. This may not be a problem in the treble, but with the heavier bass hammers it can be.
- The offset between the key front and the capstan is approaching 50 mm and key twist is going to become a problem.
- This amount of offset will accelerate wear on the balance rail felt bushings.

Let's take this one step further. In Figure 4 I've drawn a keyset with the same 1240 mm scalestick but with a moderately shorter 154 mm octave span. The reduction in headscale width is not great—it is now 1143 mm—but the problems have multiplied. The flare angle is now just over 20°. The minimum wall thickness at the key balance pin mortice is down to 1.2 mm and the offset between the front of the key and the capstan is up to 59 mm. There is no possibility that I would recommend this combination to any client company. Key twist and wear on the balance rail bushings would be unacceptable and the danger of broken keys (especially in the bass) would be very high.

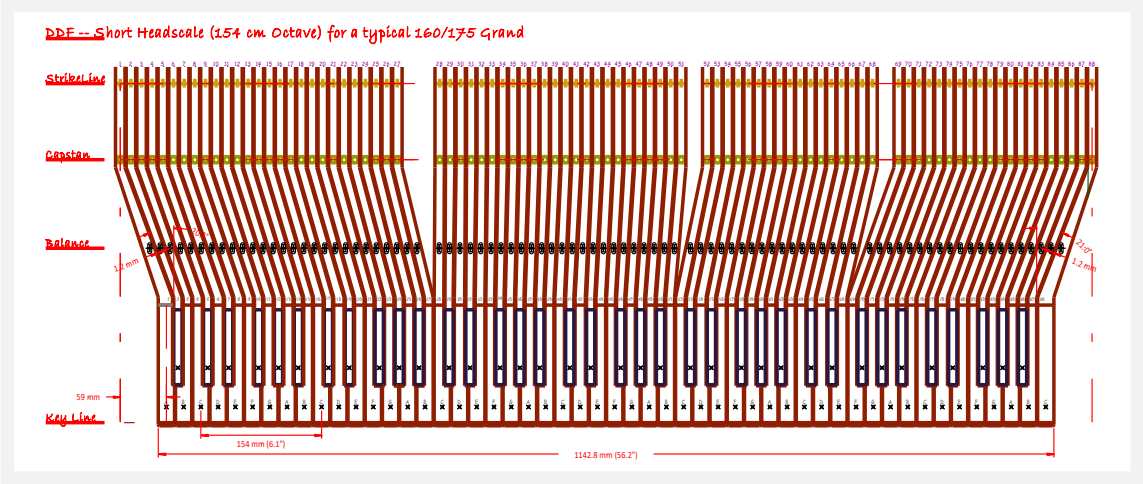

Figure 4. A 154 mm (6.1") headscale with the same 1240 mm scalestick. This is very close to the DS 6.0 headscale.

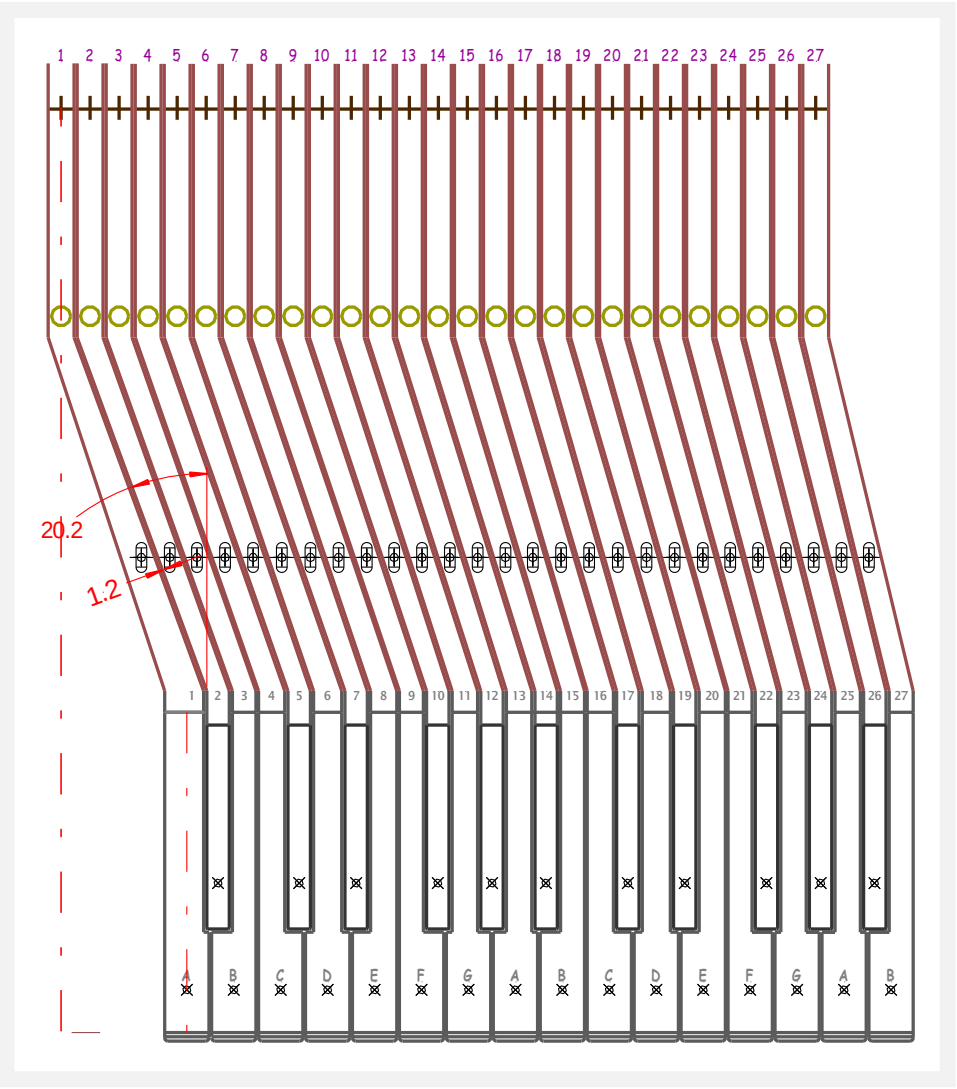

Figure 5. The bass section of the keyset shown in Figure 4. Note the flare angle and the distance between the balance rail mortise and the edge of the key.

When key flare is increased beyond roughly 15° all of these problems are exacerbated, especially in the bass at *forte* levels. If you are familiar with the design and construction of the Steinbuhler 7/8th keyboards you may have noticed their complexity. They have to supply additional bracing to at least some of the keys in the bass and treble. This adds to the cost of the keyset and makes routine servicing more difficult. While all of these problems are greater in short grands (or verticals with short keys) they are also evident in longer pianos. Just to a slightly lessor degree. No production piano manufacturer is going to be willing to accept such risks.

How to do it

This does not mean that we can't build grands using key headscales of reduced width. To be fair, the illustrations above are drawn to fit a strikeline length of 1240 mm and this is a little on the wide side. But they do illustrate the problem: to make these headscales practical we are going to have to develop pianos with shorter strikelines. Period. It can

be done no other way. One-off keyboards can be built as very expensive retrofit keyboards, but these are a long way from being commercially viable in production pianos.

Fortunately, this is not impossible. Thanks to computer-controlled machines, pianos at all price levels are today being built with unprecedented precision. This makes it easier to reduce the distance between each note along the strikeline. With careful design, even in short grands, the strikeline length can be comfortably reduced to 1200 mm. Figure 6 illustrates a keyset designed for a relatively short grand having a scalestick measure of 1200 mm and a key headscale of 1130 mm. This results in an octave span of 152.3 mm, or a DS 6.0 standard.

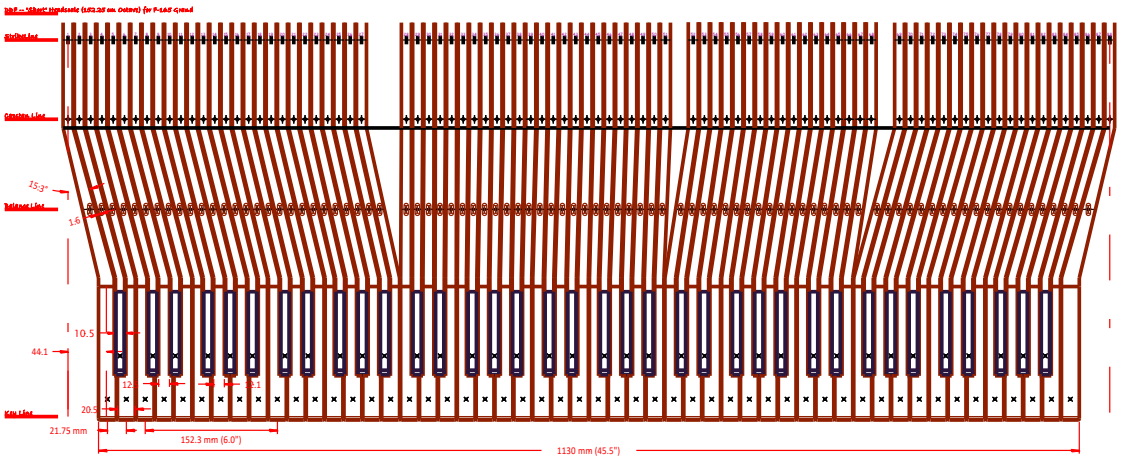

Figure 6. This shows a key headscale of 1130 mm and an octave spread of 152.5 mm, or 6.0".

This key headscale would be an acceptable fit for a piano of this design but it is close to the lower limit of what can be accomplished in a four-section cross-strung grand. We could reduce this a little more but even in this design a key headscale with an octave width of 140 mm, or approximately 5.5", is going to remain a custom-built rarity.

So, is there nothing more we can do? Well, yes, there is. But from here on we have to start challenging some of our firmly held beliefs. I'll go into some of these in Part 8.