THE
STRUCTURE
OF THE
CLASSICAL PIANO

Some unqualified thoughts given at ANVERPIANO .
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Is the early piano a reinforced harpsichord? A short look at several designs may help to answer this.

The instruments of Cristofori and Ferrini have full-depth diagonal braces against a relatively thick case bentside in combination with a thin, unbraced inner bentside carrying the soundboard. They have a brace or sucession of braces more or less tangent to the bentside and connecting the diagonals to the bellyrail. The hitchpinrail is a wide ledge above and not touching the soundboard. Obviously, this ledge is a substantial reinforcement of the bentside. At the same time, it shortens the backlength, in theory, to any given or desired measure. This could be to account for the additional space needed by the inner bentside, but it could also be to increase the stiffness of the stringband and to reduce the loss of energy through backlength and hitchpin. A sidelight, Dulcken's double-bentside would appear to do the opposite: to reduce the distance between bridge and bentside to any desired measure without increasing the stiffness or necessarily changing the bearing.

By comparison, G.Silbermann's bracing is much more straight forward, having no double-bentside and no full-depth diagonals. Instead, it is a sucession of elongated knees and struts very much in the local tradition. H.Silbermann's does have diagonals or lowerbraces with vertical endpieces reaching the liner mortised into them, very much like the bracing of the "big walnut"(l) or what the Friedrich Ring(2) once had. Again, a local tradition.

Quite different from the above is what I will call, for lack of a better term, south-German. It is found in the instruments of Späth & Schmahl, J.D.Schiedmayer and in the 5 octave L.Dulcken's. These have a true bentside, though not necessarily bent. They are made up of sawn curves along the bottom edge and forming the liner and joined by spacers. These spacers are horizontal blocks in Schiedmayer's. S & S' have vertical pieces mortised into the curves, a feature Walther will later borrow. The full-depth braces are perpendicular to the spine and diagonal bracing is usually afforded by struts, although Dulcken also has those curious dowels connecting the bellyrail to the bentside. There is no A-frame, even in the 1794 Schiedmayer.

Different — or similar — to both is what I will call the Augsburger school. The most obvious feature is the A-frame. In this respect, it is interesting to note that the 17th. cent. south-German harpsichord at the Courtauld Institute in London has an A-frame from tail to bellyrail and that the full-depth braces jump over this to carry the liner, but neither these nor the A-frame touch the bentside itself.

(l)The English Harpsichord Magazine, Oct.1987
(2)privately owned in Ludwigsburg.

Another somewhat later instrument, the 1702 A.Migliai, Florence at Leipzig, has a board shaped like a bootjack between the bellyrail and the first knee on the bentside, very similar to the Cristofori pianos — an embryonic A-frame?

The Augsburger instruments have a true A-frame, but here it is the basis of the bentside itself — a very different approach to that of Cristofori or the Courtauld instrument. They have no true bentside. Nonetheless, it would appear that Stein was well aware of Cristofori's work. It is easy to think of Cristofori's sucession of spacers tangent to the bentside as a single piece.

One thing must be noted: unlike the English, about which I don't wish to say anything, none have upper braces.

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What thoughts are behind these different designs?

Basically, one has only to maintain the outline of the case to insure durability. What a platitude! The south-German instruments, with their true bentsides, have what I will call a lateral bracing system, the full-depth braces, perpendicular to the spine, forming a frame which should not twist or distort and which butts, in a manner of speaking, against the ends of the pinblock. In the case of the Schiedmayer, there is no bellyrail knee or gapspacer and the bellyrail, at 24mm, is quite thin. The bottom is, at 19mm, also very thin, but it and the bellyrail serve to conserve dimensions in the x and y planes. Constructionally, there is no z dimension. There is little or no force directed against the bottom. Although there are no upper braces, this sort of design is one concieved only in a horizontal plane, flat and close to the strings. This reduces the load considerably, making the design in fact very stable.

To a certain extent, Augsburger pianos were thought to have a z dimension. The bottom is thicker and some of the force is directed against it. There is a gapspacer and, behind it, a knee. There is no bentside, this being made up of the A-frame and the shaped blocks constituting the "bent" sections. The A-frame's bracing against the bellyrail makes a gapspacer necessary and is undoubtedly the reason why Stein laid the grain of the bottom parallel to the A-frame. But it very much weakens the bentside-cheek corner, moving it, in a manner of speaking, outside of the instrument. The torsional stability of the bellyrail is relatively low, but it and the bottom must now bear most of the force causing corner distortion. The outline of a piano (or harpsichord) is that of a triangle fixed to a rectangle. The junction of the two at the spine is always good — too good — but the treble corner is always weaker. In the case of a true bentside, the line of force runs not parallel to the straight section of the bentside but through its body, an imaginary line intersecting the cheek roughly at

the bellyrail joint. With an A-frame, this line runs almost parallel to the A-frame, thus intersecting the bellyrail itself, a much weaker assembly which must stress the bottom, calling for a thicker one, and the bellyrail which in turn must be much thicker.

Is all this a gross misinterpretation of the A-frame on my part?

Although I don't think so, it is quite possible that the A-frame was just a simple method of making the case. In the Courtauld instrument, this is certainly not the case. In this instrument, the soundboard runs to the nameboard and the lower guide is actually a remnant second soundboard — two full-width gapspacers forming a square-tube bellyrail — an immensely stiff affair with very high torsional rigidity. All this makes up for the A-frame's weaknesses and leaves the bentside free to sound. Surely, this doesn't pertain to a glued up structure 30-70mm thick. I'll leave this open.

The traditional view would seem to be that of a vessel or box — bottom and sides with a membrane on top. The Augsburger and to a lesser degree, the south-German are statically speaking of an U shape, like the German and Italian harpsichords. As long as the instruments remained narrow, even the weaknesses of the A-frame were relatively unimportant. Especially considering the rapidly changing style which made most pianos obsolete in a short period of time — perhaps even shorter than it took for them to distort. The increase of compass and thicker strings caused some builders to reconsider the system instead of simply attempting to strengthen it with enlarged dimensions and additional braces. This lead to the "rediscovery" of the upper brace.

I would like to discuss a square piano made about 1805 by J.C.Haug in Stuttgart to illustrate this. Haug, an organbuilder like his father who apparently worked for J.H.Silbermann, was court instrumentmaker in Stuttgart. His piano is for many reasons very interesting, for instance because he uses a derivative form Cristofori's first action which works remarkably well. More important to us, however, is his case design. This piano is not a reinforced clavichord. The walls and bottom are thin at about 20mm. The hitchpinrail is a massive piece roughly square in section and glued to the right end wall. The braces, which form a Vee, run horizontally immediately under the soundboard to the yoke which is a very massive member running to the left endblock onto which the pinblock is glued. The pointed end of the triangular pinblock crosses over the bellyrail to butt against the hitchpinrail. The idea is to direct the force in a horizontal plane as close as possible to the source, thus reducing the z component to an absolute minimum. Here, we have almost pure upper brace. And it works: although this piano is lighter and higher than contemporary south-German squares, it is no more distorted, perhaps even less. In passing, I would like to mention a few other details.

The piano has a "double-bentside"; inside, parallel to the hitchpinrail, there is a frame or trestle with its own struts nailed and glued to the bottom and 5mm from the hitchpinrail. This forms the liner at the right end, separate from the case. The case was "pre-warped", i.e. the upper edge was planed out of plane before veneering. The keyframe is raised into position by inserts like Stein 's. Haug's father was from Zweibrucken, at the time he appears to have been in Straßburg, Stein was in Durlach which lays en route. All of them were organbuilders. Both Streicher's and Dieudonne's father were court employees. I don't think it presumtuous to assume some connection here. At least I am making one in continuing on to Nanette Streicher.

The series of 6 and 6 1/2 octave instrument commencing around 1807, is the first radical departure from tradition. The piano is built on the bottom which is very thin, but the bottom serves only as a template. It is two-part, joined at the bellyrail. The rim and bracing are assembled on the bottom but only the keywell bottom is glued to the rim. The frame is built up of 7 layers; the first two are only for the rim itself, except for the bellyrail, there are no crossmembers at these lower levels The third to sixth layers make up the actual framing which is all of the same depth. The "mortise and tenon" joints are made by alternating layers, much like bricklaying. All of this is of spruce. The seventh layer of maple about 26mm thick forms the liner. The pinblock ends are "mortised" into this system and the curved section of the bentside is made up of sawn pieces also inserted into alternating layers, thus forming a real mortise and tenon joint at the corner. There are two iron gapspacers, both butting against the endgrain of braces. After all this is glued up and planed to size, the bottom is removed simply by tapping it off. When the case is finished and the soundboard installed, the bottom is reinstated with 2d nails. It serves only an acoustical purpose and, bear in mind, it is only fixed to rim; there is no contact at the braces.

What do we have here?

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Bricklaying" in cabinetmaking was nothing new; the large complicated curves and arches such as in baroque organ cases were made in this fashion, but the application to pianomaking seems to be new. What is most important is that it makes joints that fit and hold, joints in which the glue is not removed in the process of sliding them together. It is dimensionally more stable because, at least in theory, the small dimensions of the single pieces dry faster and more thoroughly. One gets more out of the lumber because there are almost only short pieces, a knot in one layer has no influence on the stability. Since the pieces, except for the A-frame and the bellyrail, are of similar size, one can rough-cut to stock, accelerating drying. In a word, it is cheap, easy, light and strong.

Like the Haug, the bracing has been moved up as far as possible and this is the revolutionary thought behind it: the instrument is no longer a vessel, a U shape. It is now inverted, thinning toward the bottom, heaviest where the force is and lightening as it is removed from the area of stress. Essentially open at the bottom, this is the exact opposite of the traditional design.

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Although it has little to do with structure, I wish to say a few words about actions.

We lump all forms of German or Viennese or prell mechanic together, simply because, at first glance, they all look alike and catalogue them as the opposite of Cristofori's action. Is this permissible? I don't think so. Earlier, I tried to show that Cristofori's influence can be felt from the onset and even as late as 1805. What does his first action look like? A hammer on a fixed hammerrail is raised by a jack which escapes (!) because the intersecting arcs of the hammer butt and the jack no longer coincide. Because the jack is sprung, it can snap back into place after the hammer has returned. In Cristofori's configuration, the jack is necessarily mounted on an intermediate lever because his instrument has a real bellyrail to which the soundboard is fixed. Putting the hammerrail at the back necessitates having the soundboard overhang the bellyrail, but this reversing makes the intermediate lever unnecessary; the key can serve this purpose just as well. Note that as far as principles are concerned, nothing has been changed. Haug made just this, so did Köber. J.B.Streicher's Patented Action from about 1840 is also the same. Going one step further, you have only to rotate the beak by 180° to the back and substitute the jack with a hook, sprung and resting against a bumper. Pulling down the hook raises the hammer; Stein's first(?) action. It takes very little imagination to see the hammer moving with the key and the jack or hook fixed. The so-called German action is finished - but it is nothing but an inversion of Cristofori's first design, to a certain extent, a simplification. As we have seen, Stein, Silbermann and Haug must have known each other and were obviously well acquainted with Cristofori's work.

So much for principles, what about details? I would like to differentiate between two types: the Augsburger and the Wiener exemplified by Stein and Walter respectively.

Stein's (or Wirth's, or Schiedmayer's ...) action has a wooden Kapsel and a rather heavy escapement or hook very much in the shape of an organ pallet with a notch for the hammerbeak. Two things must be noted: first, the parchment hinge is in the same plane as the front edge i.e.. in line with the body of the hook and the hook stands vertically or slightly away from the Kapsel.

The Walter has metal Kapseln and a lighter hook in the shape of a 7. Here, the parchment hinge is not in the same plane as the front edge of the hook, but behind it and the hook leans toward the Kapsel.

What are the results?

The shape of the Stein-type hammerbeaks and the hard leather on them combine with the hook to make the escape a mathematical necessity, very much like the Cristofori action.
The tension of the spring has almost no effect on the point of release: if it is too stiff, the key will not return, even though this tension does not suffice to keep the hammer from escaping. Because of the backward position of the hook, the hammerbeak, on key return, drops into it, the hook is forced farther back and this increases spring tension.

Most of these instruments did not have backchecks. This wedging -in of the beak on key return helps to put the "brakes" on the hammer just as the wooden Kapsel does: its hard, thick felt bushing is meant to bind the axle. Out of all this follows that the hammer escapes at the string when the the keys are depressed normally. This affords the greatest possible control between pp and mf. Forte playing forces the hook off so that the hammer actually escapes farther from the string: the louder one plays, the less control you have, which is natural, but the action is quite safe. Even at forte, there's no "schäpern" until one oversteps the limits of the piano itself; the strings are lifted and the treble goes out of tune. The backcheck only makes it possible to violate the instrument and good taste, while improving nothing.

By comparison, something very different takes place in the "Walter" action. Because of its shape, the hook leans farther forward than it appears to do, since its line of force must be drawn from the hinge through the front edge. Because of this, the hook is pulled forward by the beak. The softer leather on the beak has a tendency to bind and this increases with stronger playing because it is compressed under the edge of the hook. For both reasons, the hammer escapes higher at forte than at pp and this, in theory, gives a greater dynamic range i.e.. it will play louder; whether or not the piano will and can is another story. Because the setup must be further from the string, you loose control at the lowest level. Actually, you've only moved the scale from pp-mf to mf-ff, so you have lost more than you have gained. And you have lost something else: on key return, the beak drops away from the face of the hook and the spring tension decreases, so there is no braking here. Add to that the virtually frictionless Wienerkapsel and you have created the absolute necessity for the backcheck.

Everything must be viewed in context, its own context, not ours.

In closing, I should like to digress even farther from my title (which I didn't choose). What is the classical piano and, even more ambiguous, what is the romantic piano?

Classical art, be it painting, literature, architecture, sculpture or music, follows an artificial code: it is very even and well proportioned. Proportion and harmony are the most important aspects. The classical piano must be very even and clear, clean in sound and it must retain a certain evenness in tone duration. For this it must have a relatively long scale, but its light weight and scant bridge are still sufficiently quick to speak without being explosive. The relatively slow attenuation makes pedaling, except in some special cases, unnecessary, even undesirable. The action must be very light and it must afford control high on the key. Extreme loudness or changes of tone color are not necessary. Classical art exhibits restraint. This is why bichord stringing, except perhaps in the highest treble, is better than trichord. Trichord doesn't sound louder, it only offers more resistance to the blow of the hammer, is harder to lift off the bridge and so makes heavier playing possible.

Likewise, a look at romantic art shows a lack of restraint, an open show of emotions, a wild assortment of colors, many of which are unrealistic, even bizarre. Nature is no longer considered coarse and unrefined. It is even, as in the English or American gardens of the period, exaggerated to make a point. It must be possible to be soft and tender, but it must be equally possible to be harsh, ugly, even dangerous. Applied to the piano, that means it must be very flexible tonally, it must play softly with reasonable ease, but it must by all means be explosive when pushed and one must be able to push it even to ugliness. This is best possible with a short scale and thicker strings. Short scale attenuates faster and this, too, is a good thing because it assists clarity where it is needed, especially in larger rooms. I am certain that the increasing use of the pedal after about 1810-15 must be viewed in this light. With judicious pedaling, short scale makes everything from dry clarity to waves of sound to ugly explosions possible. The longer scale is too slow to speak and also too even and nice sounding. Trichord stringing is obviously necessary and Graf's attempts at quadruple stringing show that still more explosiveness was considered desirable. Downstriking instruments are attempts at the same thing. Tonal color must be variable to touch which means that hammers need smaller cores with more leather. Of course, the moderator is important, but much more so is the true una chorda. Romantic does not mean lush or beautiful, foremost, it means unrestraint, even being unleashed. Beautiful or lush sound is not important, but extreme flexability is. We must rid ourselves of the idea that tone or tonal beauty makes music. Music is language. The piano must speak - speak nice and colorful and ordinary and fascinating and ugly and -- even dirty words.