The Case of the Weak Case

The question of statics in case design is one that has been too easily overlooked. There are reasons for this:

l. We builders do not, as a rule, know enough physics to even begin to tackle the problem, and those that do realize what is much more important; that

2. The number of variables in a system which is in reality not static at all defy "scientific" analysis - at least for all practical purposes.

Computers can give quite precise data for any given window or even any random window within a set of given information. But the information must be given, which means either, that

l. one is analyzing a known case - a historical instrument - a retrospective position which can say a good deal about What but virtually nothing about Why. This is not pure malice on my part, since I have actually subjected an instrument of mine to modal analysis, only to be told by the computer that the instrument was doing just what I wanted it to do, acoustically. It did not tell me why. or

2. one is dealing with a hypothetical case which must first be furnished with the variables mentioned above.

This is augmented by the fact that we make our instruments out of wood which, with all its idiosyncrasies, does not lend itself to standardization except on a statistical basis. This means that the assumed values must always be for the statistically most unfavorable state. Since the advent of building codes, this has been and is done in architecture and from this results overdimensioning.

A brief look at some old artifacts shows that they usually are anything but overdimensioned. Take the Colichon bass viol. It is quite large for its type and was made without a form. It has thin ribs, no linings for the back and no cornerblocks, using only cloth to reinforce the joints. Or take the Palladian wooden bridge across the Brenta at Bassano, or any 19th cent. covered bridge for that matter which uses the the covering itself as a stressed skin. Most of these covered bridges, if they are long like Palladio's, are also arched - prestressed by their own weight while tightening the structure at the same time. The singlestrung Pisaurensis at Leipzig contains virtually no bracing at all. Ruckers, with their weakening of the spine, are another extreme case: not a weak case, but a strong one deliberately made weak. The 1711 Pierre Donzelague, although it does have rather thick walls, has minimal bracing and this in a manner considered to be nonsense. In 1794, Johann David Schiedmayer was still using a l9mm bottom, a 24mm bellyrail with two big mouseholes, no A-frame and no gapspacer. His stringband and scaling is the same as Stein's who has both A-frame and gapspacer, but his instrument is less distorted. Many more examples can easily be found.

They all have in common that they are structurally weak - only as strong as is absolutely necessary.
This is true of violins, lutes, harpsichords and bridges.

How, then, did the old builders arrive at a design?

One obvious possibility is of course trial and error. To a certain extent, I think I must concede this. But, in what ever field you choose, there are just too few extant examples of this method to be found. Literary references are also very sparse. Especially in our case, there just are no extant blatant errors. The modern standpoint that these have simply self-destructed is not valid simply because there are in other fields - architecture or art or engineering - each several extant examples. Indeed, there are examples of instruments that have for exterior reasons - usually climatic - self-destructed. Why, if the "errors" were discarded as useless, were not these as well? Instruments like the 2-manual Kirckmans might be cited as errors, but the design "failure" was carried right over into the pianos and, in any case, the instruments were certainly accepted in their time. Other possible examples might be found in late French or German harpsichords such as the äbnerGr or Taskin. Here, however, the error is on the other side, the side of overdimensioning and so cannot be so readily detected. One might call these mute cases. The only extant error with which I am personally acquainted is the 1750 Goermans, which indeed has self-destructed several times.

With those builders from whom several instruments survive, there is generally only subtle development to be observed, variations on the same theme. Very rarely a complete about face. In some cases, they continue a tradition, making trial and error unnecessary. Others started the traditions and, strangely, they arrived on the scene in their adult form. No larvae or embryos, possibly a few unloved children. Others, again, renegades, created their own "tradition of one" represented only by them. A good example of these is Albertus Delin whose extant harpsichords are as a design structurally identical but different than anything else. They are the insight of a genius.

In all cases, the failing of missing links or errors is too blatant to be put aside.: there are just too many extant instruments, including the junk, for not even one error to have remained. There are collapsed buildings, technically bad paintings, disintegrating glass. In short, enough other examples of extant errors.

Where are the instruments(l)?

Obviously, trial and error was used for subtle development, especially in the action or with the monochord to determine string tension as a function of pitch and length and these, too, can be observed.

But in the thomist world of pre-enlightenment, trial and error seem to be inconceivable as a BASIC design principle.

What is conceivable?

One possibility is what can be called Divine Necessity. By this, I mean the method of using natural numbers, proportions, primes, Fibonacci numbers, Golden Section - part of the divine or natural order of their world - as a basis of design. This was in fact done, as is in the mean time well known. Not restricted to instruments, this originated in architecture with antique building masters. It is important to remember that until John Napier invented logarithms at the beginning of the 16th cent., it was not possible to use irrational numbers and even after the invention, their use was restricted to those few who were educated enough. Just like quantum mechanics today. Calculation as we do it was unknown. The most important characteristic of the Fibonacci numbers in this context is, that any two consecutive numbers beyond 5 always approximate the Golden Section which is an irrational number. The monochord, too, served to underline the natural order of natural numbers and proportions. All perfectly tuned intervals result in whole number divisions of the string. Using these "natural" methods, the old builders could really do nothing wrong. The use of "GOD-given" order could yield only the same. It is entirely possible to design a case for a 10 inch scale using that inch as unit 1, and the Fibonacci row 1,2,3,5,8, etc. in which the bridge, though having been placed only in relation to the bentside, nevertheless results in a practical approximation of that 10 inch scale. I know this for a fact because I do it this way. It took me many years to become simpleminded enough to dare.

> "Seeker of truth, follow no path, all paths lead to where,
> truth is here."(2)

Another possibility is intuition. To my mind, this is not only a possibility but a certainty. We have, at one time or another, all experienced this sudden insight, for that is exactly the right word, this certain knowledge that we cannot know. Usually, it is disqualified as a "lucky guess". Children normally experience this more than adults because they have not yet been so ruined by so-called enlightened education. Normally, too, they reap a disqualification such as 'children should be seen and not heard'. When I was about 11 or 12 years old, in 1955 or 56, the following incident happened.
My father, who was products information manager of Ford Division of FoMoCo in Dearborn, and I went, I think, to the car show, with Louis Gelsch, leading development engineer at Lincoln-Mercury Division. He picked us up in a big white Lincoln. During the ride, my father called my attention to the additional scientific instruments and informed me that this experimental car contained Louis' pet brain-child, air-suspension. I

remember that Louis said very little. On the way home, I very seriously commented that the suspension would not work because the car, even the Lincoln, was too light. My father was mortified and I caught all hell when we got home. The point of the story is the intuition I voiced which was not a lucky guess and which even almost 40 years later is still true: air suspension does not work on light vehicles. Perhaps Louis knew this as well and I was only reading his mind.

I would like to include several quotes from two American psychiatrists of different schools which I find very pertinent.

"Not only is the individual unaware of how he knows something; he may not even know what it is that he knows, but behaves or reacts in a specific way as if (als ob) his actions or reactions were based on something he knew."(3) "Genetically, these attitudes are well-sublimated derivatives of scopophilia, watchfulness and oral receptivity"(4)

"There is little doubt that intuition is an archaic faculty. It is well known that "logical" thinking interferes with its efficiency and distorts its messages."(4)

"It is not so well known that "ethical" thinking also interferes with intuition..."(4)

"It appears", then, "that verbalizing knowledge is different from knowing about something. Special training in any field is directed toward consciously increased selectivity in scanning configurations and refinement of verbalization, but these are below the level of consciousness."(5) And,

"Psychologically speaking, an amateur in any field becomes a professional when his scanning processes sink below the level of consciousness and function in an integrative rather than an additive fashion."(6)

"...some readers may feel that these words are only a new form of "mysticism" and have nothing to do with science. But this attitude obviously dodges the whole issue by disparaging it. It is interesting that the term mystic is used in this derogatory sense to mean anything we cannot segmentize and count. The odd belief prevails in our culture that a thing or experience is not real if we cannot make it mathematical, and somehow it must be real if we can reduce it to numbers. But this means making an abstraction out of it — mathematics is the abstraction par excellence, which is indeed its glory and the reason for its great usefulness.

“Modern western man thus finds himself in the strange situation, after reducing something to an abstraction, having to persuade himself that it is real. ... the only experience we let ourselves believe in as real is that which precisely is not."(7)

Obviously, I am enlisting all the help I can get to reinstate intuition. I am absolutely certain that the old builders were able to see the case moving, not only in its dynamic state but in its projected,

immaterial state. With these abilities, they were able to conceive of the proper design without trial and error. The reason that I am so sure of this is that I am also able to do so. I am not alone.

"I want to emphasize that I did not get my insight as though I were dreaming, with the world and myself opaque and cloudy. It is a popular misconception that perception is dull when one is experiencing this state of insight. I believe that perception is actually sharper. True, one aspect of it resembles a dream in that self and world may become kaleidoscopic; but another aspect of the experience is a sharpened perception, a vividness, a translucence of relationship to the things around us. The world becomes vivid and unforgettable. Thus the breakthrough of material from unconscious dimensions involves a heightening of sensory experience. We could, indeed, define the whole experience that we are talking about as a **state of heightened consciousness**. Unconsciousness is the depth dimension of consciousness, and when it surges up into consciousness in this kind of polar struggle the result is an intensification of consciousness. It heightens not only the capacity to think, but also the sensory processes; and it certainly intensifies memory."(8)

Intuition, then, is not guessing. Instead it is, for one, being able to see without the blinders of preconception. The holograms caused by the moving object can be seen by an open state of consciousness. Beyond this, it is what might be called Divine Inspiration.

Let me quote Johannes Brahms:

"...directly after that, I feel vibrations running through me. These vibrations take on the form of certain mental images after I have voiced my wish and decision concerning what I desire, namely to be inspired, ... Immediately, the ideas pour into me...(9)

And the chemist August éKekul von Stradonitz on his discovery of the benzol theory:

"One summer day, I took, as usual, the last omnibus through the deserted streets of the otherwise so bustling metropole; outside on the roof of the bus as always. I drifted away in daydreams. The atoms danced in front of my eyes. I had always seen them moving, those small beings, but I had never been able to apprehend how they moved. “
“Today, I saw how two smaller ones joined to pairs; how larger ones encompassed two smaller ones, still larger ones held three and even four smaller, all in a whirling round dance."(10)

What we are hearing here are testimonies to a higher source of knowledge which can be tapped under certain semi- or subconscious conditions generally known as trance or meditation. Whether this source is called God or Tao or collective unconscious is irrelevant: it appears to manifest the entire knowledge of all beings, past, present and future. As such, it offers infinite solutions to infinite problems, as these quotes

demonstrate.

Of course, one could initiate a series of experiments, however long, to determine the so-called optimal condition - scientific method - and I'm sure we've all done this. The point is that this position really is the concession, 'I don't know what I'm doing' and this leads automatically to the question, 'why am I doing this?'. By simple deduction, harpsichord builders suddenly find themselves at the center of the world, sharing as they do the dilemma of modern man.

Having established - v e r y shakily - how designs, both outline and inner structure, were arrived at, let me look at what was arrived at. What was their intention? Or, putting it scientifically,

What are the parameters of case design?

It seems a safe assumption that the retention of the horizontal outline is paramount. The integrity of the xy plane is the basis of structural and acoustical functioning since this plane defines the points of the stringband. The ultimate example of this is the cast plate of the modern grand piano. This establishes all stressed points (this is a simplification) on one immovable fixture. The wooden structure bears no load in the xy plane. Depending on the type of plate and the height of its ribs, the plate may also carry all of the load in the z plane. The wooden rim serves as a convenient structure, attached to the plate, to which other things like the soundboard are attached. This is the root of our visualizing problem: even when the plate is done away with - the step from Pleyel and ändlerM-Schramm to the Bachmodelle - the **vision** of this immovable rim remains. It is our ghost in the closet.

Since retention of outline, integrity of xy plane, must be considered a prerogative, what can be said of the vertical dimension, the z plane? That the instrument shouldn't jackknife is obvious enough, but apart from that, one finds different solutions which I would like to look at. First, those that flex in the z direction. Strangely enough, this group is made up of those that supposedly have the least to do with each other, thin-walled Italians and Ruckers. Rainer Schuetze jokingly (and reverently) referred to these Italians as being "geocentric".
They have an ideal center from which all force lines radiate. It is toward this point on the bottom roughly at the Golden Sections of length and width that stress is directed, causing the instrument to cave in from all directions. This can be observed on almost any thin-walled Italian, new or old. This type flexes quite a bit in the z direction, thus allowing the xy plane to deform as well, but the outline remains unchanged. Like the wooden bridge, the symmetrical compression actually better holds the structure together.

I've discussed Ruckers' design concept elsewhere(10). So, I will only repeat that they deliberately weakened the case at the spine to match the inherently weak treble corner, thus allowing the case to flex in the z direction as if on a hinge. This relieved the case of the twist

strain, something the Italian idea did not do. Unfortunately, those so-called followers of the Ruckers Tradition followed more in word than in deed, leaving off, one by one, the important features until at last only the forced-in upper brace was left and this only in the Kirckman/ Broadwood shop. The French had long since done away with everything but the paint. Delin, probably the only true heir to the Ruckers, showed at least that he understood the ideas, even if he reversed them. Instead of weakening the spine, he inserted a second cheek between bellyrail and bentside making precisely the width of a 4 octave Ruckers and restoring for that larger part of the instrument the original outline. The treble corner was substantially reinforced, and since he was using two 8', this was definitely necessary. He removed the upper braces entirely, placing the lower braces roughly where the uppers had been and raising them almost to the liners. Otherwise, dimensions were kept exactly the same as Ruckers and even the 49cm rule is adhered to. Basically a Ruckers case very subtly changed to bear twice the load with almost no increase in mass, it is the work of a genius.

There is another approach to the xyz orientation, one I am tempted to call Germanic. In it, the three axes are realized as rectangular coordinates: the bottom, spine and belly rail with lowerbraces form a grid to which the other sides are then fixed. Most of these instruments have no upperbraces and indeed a few have no bracing at all to the bentside, which is usually also thin. Since the rectangular grid is meant to be stiff in all three directions, it follows that the bentside is both thin and unbraced: it is the flexible part, its main brace being the soundboard itself.

Though looking nothing like any of these, the Donzelague still manages to do the same thing. It is a freak, a pan-European instrument that looks French, sounds Flemish, has the outline of a Dulcken though 40 years earlier, is built on the bottom like a Italian and is entirely itself. The lower braces running from back to front stiffen the spine like any other lower braces, but because they meet the bentside at an oblique angle, they do not stiffen it. .

The three very slight upper braces are rectangular to the spine and so also have little effect. The bentside is thus uniformly flexible as in the Germanic design. Because of this, Donzelague planed the edge of the soundboard along the bentside to very uneven, undulating thickness to control the vocal character and **inflection**. We will meet this again with Dulcken. The term inflection is my translation of Rainer Schuetze's "Tonwoelbung" which has also been called "bloom," but Schuetze's term is older and bloom is so corny. I prefer the word inflection because it has both physical and rhetorical meaning, as well as having the same root as flex. It describes the way the individual tone changes pitch and, **much** more important, vowel sound during its period. Inflection has to do with mass, soundboard stiffness, ribbing and especially distance of bridge to bentside as well as many more subtle things. Inflection alone would fill a whole book; To make it work, you have to see it working.

An interesting question is posed by the rather sudden appearance of dovetails in the 18th cent. They can be considered a cabinetmaking trend of the period. They are more difficult to make but easier to assemble and do not need to be clamped, important points in a big shop like Kirckmans. This is all true, but I think the truth is a little deeper. As a stiff joint, dovetails are almost hopeless, but they stay together even if they come unglued. So they allow for some inevitable flex on these late, very heavily loaded instruments.

Directly related to flexibility is the equilibrium of case mass and the energy of the stringband. Both for tone quality and tuning stability, the instrument must only be as strong as is necessary, or, put differently, as weak as possible. Note that I am not saying as light as possible, though this could in some cases mean the same thing. In order to qualify this, let me consider the tonal implications first.

Mass and weight are, of course, directly related, so a light instrument like an Italian cannot have much mass. This does not mean that it need be weak. The amount and placement of mass has primarily tonal results. Italians generally have concentrations of mass in the wrestplank and in the bottom with its structures. In the bridge and around the edge of the soundboard there is very little mass. These light members are easily excited, making the speech loud, fast, and explosive. The limited energy is drained off quickly, both by the bridge and at the hitchpin, so that the sound attenuates quickly, especially when compared to the inflection of the tone. It is this quality that creates the illusion that the instrument is still sounding after it has actually stopped. In the Italian, it can be seen that the concentration of mass tends to coincide with the geographic center, the point of flex, and this keeps all subsystems in phase. That is why they have such a strong fundamental and carry so well, actually becoming louder as the rooms get bigger. .
This is the result of the centering of the point of flex and the distribution of mass, not the actual weight or such things as scaling or plucking point, even less of material. Even with a curly maple soundboard, an Italian retains its character.

Thick-walled instruments obviously concentrate the mass around the edge of the soundboard. Most also have heavier bridges and lighter wrestplanks than Italians. The energy drain is slower, concentrated mostly on the soundboard and because the mass at the hitchpin is higher, a larger amount of energy is reflected back toward the bridge. Attenuation is much slower, allowing the inflection to level out completely before the sound is gone. The inflection itself is more complex.

The strings are stretched springs. In them, a certain amount of energy is stored as force pulling on the case and pushing the

soundboard down. The soundboard is also a spring which should exert some counterforce to the stringband, enough to maintain a state of equilibrium. The obvious example is the violin. The strings force the bridge against the belly and since there is a soundpost within, the bridge moves sideways, depressing the belly at the bassbar which is nothing but a wooden spring. Though correct, this description doesn't begin to touch reality - which in the end may not be possible. The pull of the strings on the neck pull this forward and since the neck is a square or compound lever whose other leg is its foot glued to the ribs, this force is redirected to the belly as a compression force and to the back as a stretching force. Because of the arching, both the belly and the back rise against the force of the bridge, creating, hopefully, equilibrium, a live system on the verge of excitation.

It is in this connection that the weak case comes into play. Case deformation exerts forces which can counteract the stringband and are the tonally advantageous. They can also be very dangerous. In this respect, the soundboard is the primary brace of the bentside, bracing it evenly. The upperbraces disrupt this evenness, creating a vocal unevenness which is so important for polyphonic clarity. Soundboard thicknessing and ribbing also contribute to this. Other tricks such as an unbent or underbent bridge forced into shape while gluing it on also create tension. In this case, the bridge twists toward the gap, pulling the soundboard behind the bridge up and counteracting both down- and sidedraft. In my own experience, wrestplanks veneered only on top and cross-grain also generate tension since they have the tendency to buckle upwards, i.e.. against the downforce of the nut(11). Besides these and other desirable dynamic forces caused by deformation there are of course as many undesirable ones. Soundboard cracks and jammed slides for instance. It is my observation that those instruments which are conceived to flex in the z direction don't require gapspacers.

All of this has tuning implications as well. As said, the stringband is a collection of springs for the most part stretched to quite near the breaking point. Case equilibrium is reached when the case and the strings are just able to bear their respective loads. Normal climatic differences cause only a little more flexing of the case or bentside, allowing the strings to stay in tune. An overdimensioned case pulls the strings at will. Here we must look for the differentiation between "hinged" cases like the Ruckers and center or bentside oriented designs. This latter group is made up mostly of two unison instruments: there is no 4' to be considered. The "hinged" instruments direct most of the flex away from the center to the area of the hinge or the gap which is common to both 4' and 8'. Thus, the flexing effects both 4' and 8', even though the 4' is not hitched to the bentside. In this respect, too, the flexing of the bentside itself as seen in cross-section is extremely important and is the reason for tapered and or double-tapered liners as well as high liners together with flat, thin upperbraces. The shape of the bentside curve is also in this respect important: the deeper and more

uniform the curve is, the more it can resist this cross-sectional flexing for purely formal reasons, quite apart from thickness. It cannot bend in without bending down, something a straight piece can, so it needs fewer braces or can be thinner, or a combination of both. It can be seen that Ruckers' even curve is not primarily a function of the scale. By all of these means, general and local dynamic forces can be generated by the force of the stringband and are commensurate with it. **In a weakcase**. This cannot be better demonstrated than with Dulckens double-bentside. This isolates the soundboard from the bentside in order to keep the pressure off the soundboard edge - or so the accepted definition goes.

In my opinion, this is only half true. By removing the soundboard from the bentside, he can let the bentside flex in any way he sees fit without effecting the soundboard. The bentsides of these are very convex in cross-section because of the tension. Once tuned, they stay very well but are difficult to get in tune because the bentside keeps flexing, i.e. the stringband, especially with Dulckens' very long scale, pulls the bentside to fit, both stringband and wood exercising some give within their range of elasticity, but without affecting the sound board. It has been shown elsewhere(l3) that the upper braces were inserted exactly like those of Ruckers by forcing them back until the soundboard was sufficiently stressed. The stress of the bentside between the upperbraces is missing, however, and with it the uneven quality. With each consecutive instrument, Dulcken added flat leafspring-like pieces of spruce to the underside of the soundboard, butting against the liner, in effect reinstating the deformation force he had so efficiently removed, if for other reasons.
Remember, Donzelague recognized the same thing. Dulcken finally did away with the internal bentside, using instead a double-liner which allows the outer portion to flex without bearing against the soundboard edge. You may have noticed that Dulckens work is a classical case of trial and error, seemingly refuting what I said at the beginning. Granted. But the insight to isolate soundboard from bentside is a stroke of genius - and it is there right from the first without any experimentation. (No, I am not overlooking Cristofori.)

I can offer examples of experimentation. In my first Italians, I added a sort of upper brace at about c2 between bentside liner and bellyrail. At that time, I could see nothing move, and equally, I mistrusted the flimsy boxes. Actually, my first Italian was a very straight forward naive "copy" and probably only for that reason worked quite well. Then I improved. The instrument did not; it went out of tune around c 2 in opposite directions. I didn't get it, so I did it again. And again, it looked good and strong. Finally, it dawned on me that this immovable point was the cause. To show that we - or at least I - learn very selectively indeed, I will relate another story. Some of you may be

familiar with the 2 man. instrument referred to as "the big walnut" which has been erroneously labeled 17th cent. French but is actually German. It was restored by Christopher Nobbs and very well indeed. At the joint of the first cross brace and the bentside there is a sloping brace from the liner down to the bottom at the bellyrail. This brace was reconstructed to fit glue traces and shadows since the previous "restoration" by Pleyel had left little untouched. In subsequent copies, both Chris and I unquestioningly made this brace as well. On the original, the soundboard is cracked at exactly this point. Both it and the copies go out of tune at this point in diverging directions just like my Italians. It dawned on me that I should have known better. Through the mousehole, I have sawed the sloping brace in the copy apart and the problem is gone. It is entirely possible that this brace is indeed an "improvement" itself, since it is possible to insert it through the mousehole.

I hope that I have been able to show a few things about our trade. The flexible case is to my mind an absolute necessity for an instrument if it is to be musical, stay in tune, and last. More important for me personally is seeing the instrument move, and intuition. Though I have inadvertently contradicted myself here and there, it is my desire to show that the basic concept of the weak case was universal, and that the local principals of realization appeared out of nowhere, strokes of genius.

Lauffen,den 17.06.1993
William Jurgenson

Footnotes

1. Christopher Clarke has brought another "error" to my attention: a grand fortepiano from about 1800, unsigned and listed N°.115 of the catalogue "Klangwelt Mozarts", Vienna. There is another very similar piano in Carpentras. This would seem to be an example of negative intuition, a design so "unguided" that it cannot have lasted more than a couple of years. This instrument falls in what is called "The Age of Enlightenment", a period in which all but the very enlightened mistrusted anything "unscientific" (not unlike our own). Since it is well and cleanly made, it could well be that the maker was "thinking" too much.

2. Complete Poems 1904-1962, E.E.Cummings, Liveright Publishing Corp. New York, 1991 p.775
3. Intuition and Ego States, Dr.Eric Berne MD, TA Press San Francisco, 1977 p.5
4. ibid. p.160
5. ibid. p.46

6. ibid. p.47
7. The Discovery of Being, Rollo May, W.W.Norton & Co., New York, 1983
8. The Courage to Create, Rollo May, W.W.Norton&Co. New York 1975, Bantam Books , New York 1985 p.65
9. Gesprache mit ühmtenBer Komponisten, A.M.Abell, G.E.Schroeder-Verlag, örlKleinj bei Flensburg, 1981,
pl24"...ich spure unmittelbar danach Schwingungen, die mich ganz durchdringen. ... Diese Schwingungen nehmen die Form bestimmter geistiger Bilder an, nachdem ich meinen Wunsch und EntschluB bezüglich dessert, was ich mochte, formuliert habe, nämlich inspiriert zu werden, ... Sofort strömen die Ideen auf mich ein ..."

10. Berichte der Deutschen chemischen Gesellschaft, 1306, G.Schultz, 1890 : "An einem Sommertage fuhr ich wieder einmal mit dem letzten Omnibus durch die zu dieser Zeit öden Straßen der sonst so belebten Weltstadt; 'outside', auf dem Dach des Omnibus, wie immer. Ich versank in Traumereien. Da gaukelten vor meinen Augen die Atome. Ich haste sie immer in Bewegung gesehen, jene kleine Wesen, aber es war mir nie gelungen, die Art ihrer Bewegung zu erlauschen. Heute sah ich, wie vielfach zwei kleinere sich zu Parchen zusammenfugten; wie großere zwei kleinere umfassten, noch großere drei und selbst vier der kleineren festhielten, und wie sich alles in wirbelndem Reigen drehte."

11. All pieces of veneer and the plank are toothed and sized and schrunk for as long as possible. The pieces are then jointed and glued individually, starting in the center and working towards both ends and applying glue only to the plank. In this way expansion of the woods is held to a minimum.

12. Ruckers Enigma, William Jurgenson, 1991

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4. Intuition, Kreativitat und ganzheitliches Denken, Volkamer/Streicher/Walton, Sauer-Verlag Heidelberg, 1991
5. The Self and its Brain, Karl R.Popper & John C.Eccles,

Springer Verlag Berlin, 1981
6. Die Dymanik des Unbewußten, C.G.Jung, Gesammelter Werke Band VIII, Walter-Verlag Olten & Freiburg 1971
7. The Power of Limits, Proportional Harmonies in Nature, Art & Architecture, Gyorgy Doczi, Shambhala Publications, Horticultural Hall, Boston, 1981
8. American Barns and Covered Bridges, Eric Sloane, Wilfred Funk, New York, 1954

The Case of the Weak Case was written for Antwerpiano 1993. I conducted the fora during the week and the topic of crowning was discussed. This prompted me to write the following on that evening for the following day.

Crowning: some afterthoughts

Talking in a general sense about crowning is an oversimplification: not the arch upward as such is important but the dynamic positive impedance of the system. It is also important to remember that the soundboard works as a membrane . In order for this to resonate freely, it must be able to oscillate in phase on both sides of the median. The stringband forces the soundboard down, depending on the amount of bearing, etc. so it must have a head start, so to speak. When this is not the case, some of the energy of the stringband is required to reposition the x-axis. The amount of potential energy the soundboard can, as a tensioned membrane, add to the whole system is reduced. In some traditionai styles, this dynamic state was/is reached by prestressing the case after the soundboard was glued in, as with Ruckers and even Broadwood. So, one will have to look hard to find any evidence of arching or crowning, apart from sizing or differential drying. Indeed, their ribbing system(s) do not make arching in the piano makers sense possible. Most traditional systems don't. This is the most important reason why most Italians have cross-ribbing. Their design doesn't really allow for prestressing. One can, as Schuetze did, compress the case with barclamps while gluing in the soundboard. This is the reason for cross-ribbing and crowning in varying degrees in pianos. The much stiffer case and, before 1830, usually closed bottom do not allow prestressing. Crowning is the only alternative available for creating the dynamic condition. Since the pressure of the stringband is

higher, the impedance must also be higher to maintain the equilibrium. In weak-cased instruments like harpsichords or violins, the forces of the stringband on the case tend to help maintain this equilibrium by desired deformation. This is no longer possible with the piano. Another aspect of the arching is that the downpressure forces the edges of the soundboard against the case. Without crowning, the downpressure would pull the edges away from the rim in sinking below the median. It is true that the prestressing methods do exactly that in stretching the soundboard like a drumhead, but the forces involved are infinitely smaller, in a manner of speaking, below the breaking point, whereas in the modern piano they are above it.
But one should not be too quick to sense the fatal contradiction here. To be sure, the modern piano is no longer a flexible case, as for all practical purposes the romantic piano also was not. But at the root the desire to make the design as weak as possible is still present: the plate takes all of the stringband force and the rim has only to take the relatively small bending forces. Arching or crowning can now be chosen solely with respect to tonal intentions as can the bearing. This is indeed done and is the reason why rental concert grands have only a short life whereas grands to be sold need some years to mature. Equilibrium is either present at the onset or the bearing creates it within a given and controllable amount of time. The period of decay is also known, painfully, as can be witnessed by the Steinway "bell".

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