The Mysterious “platzende Seyte”
or
(for academic purposes)
A Case Study:
Inadequate Standards of Illumination
as the Cause of Industrial Accidents
in
Early 19th Century Viennese Piano Factories

by Paul Poletti

A very interesting organological puzzle is presented by a couple of letters written to the Streicher firm around 1810. None other than Beethoven himself had arranged the ordering of a piano for one Dorothea Krug, a pianist of some note in Frankfurt. When the instrument finally arrived, though Krug was completely satisfied with the tone, she reported in a letter to Nanette Streicher that she had experienced the following problems:

(1) Upon arrival and uncrating, the instrument was badly out of tune and some strings were already broken.
(2) When the tuner was summoned, he found the pitch level to be about a semitone below Frankfurt orchestra pitch, which was “1/16th higher yet” than Viennese pitch.
(3) Upon attempting to tune it up to Frankfurt pitch, even more strings broke, causing the tuner to abandon the attempt.

Krug concluded that the mensur had accidentally been made about 1/2 Zoll too long, which she determined by comparing the length of d3 on the newly arrived instrument with the lengths of the same note on other instruments already in Frankfurt. The letter she wrote to Streicher contains two strips of paper and two ruled lines, giving the lengths of the other pianos as well as that of the new Streicher instrument. Michael Latcham has measured these lengths and reports them to be as follows:

(1) Strip of paper labeled “This is my measurement I had sent you”: 119 mm.
(2) Strip of paper labeled “This is the measurement in the Flügel”: 129 mm
(3) Two ruled lines both labeled “Scaling for d3 from pin to pin”: 119 and 117.5 mm. These two ruled line lengths also carry the notation: “Tuned in orchestra pitch triple-strung throughout. The sixth octave strung with No.2”

Krug’s conclusion was that “the worker who made [the piano] probably lost the measurement [she had sent] or ignored it.” Latcham’s analysis consists of comparing the length of d3 on “the Flügel” to those of two other Streicher instruments, one each from 1808 and 1811, as well as the instruments of “Papa” Stein from several decades earlier. Based upon this, he seems at least to support Krug’s observation about the scaling, though saying nothing about the possible cause of the “mistake”, by concluding that “the Streicher firm supplied Demoiselle Krug with an instrument with a treble scaling exactly two semitones longer than in their usual design.” Unfortunately, Latcham leaves the most interesting and critical piece of the puzzle completely unaddressed: exactly how high was orchestral pitch in Frankfurt? An attempt at answering this question as well as a more thorough examination of the documentary evidence brings us to a very different conclusion.

The easiest interpretation of Krug’s description would of course be “1/16 of a tone”, which is in fact the interpretation taken in the Bonn catalog. By

inference, it is also the assumption made by Latcham, at least as much as can be determined by his discussion of tension levels and safety margins which follows his brief treatment of the Krug letter. Unfortunately, there is one major drawback to such a straightforward interpretation: 1/16th of a tone is simply much too small to be of any significance, either for a piano or for practicing orchestral musicians. It amounts to a mere 13 cents. In more practical terms, if we assume “normal” Viennese pitch to have been 430Hz, Frankfurt would have been 433.1. Such a tiny amount of pitch sharpening is well within the normal pitch handling capability of any piano of the era. More importantly, such a small amount is within the range of adaptability of most wind instruments, even without resorting to the use of such common contrivances as alternate joints. Thus if Frankfurt pitch were a mere 1/16th of a whole tone higher, it is exceedingly unlikely this would have been seen as being any different from Viennese pitch, and certainly not a pitch level for which special instruments would need to be made. Therefore it is also unlikely that Krug would have felt the need to send Streicher a special piano scale length which needed to be matched.

What then is the meaning of this mysterious “1/16th”? The answer may well lie in understanding how intervals and pitch were compared and described at the time. Logarithms had been around for hundreds of years, making the use of cents possible. However, the difficulty in doing log-based calculation, as well as the complete lack of practical applicability of the result, explains why the use of cents seems to have been limited to theoretical works on temperament written by those well versed in mathematics. Though various admirable attempts at the precise measurement of frequency were made in the late 18th and early nineteenth centuries, including all manner of elaborate contrivances with multiple tuning forks, the subdivision of very long strings which had fundamental periods of oscillation slow enough to be observed and counted with the naked eye, and the like, it was not until the late 19th century that the nascent sciences of photography and electricity made the precise measurement of frequencies comparatively easy. Until then the most common way of both determining and specifying pitch differences was with the proven ancient acoustic tool, the monochord.

An enlightening text is found in the small tuning and maintenance manual for the owners of clavichords, harpsichords, and fortepianos published in Vienna in 1805 by Gall. In discussing tuning, he first spends several pages giving thorough instructions for moving through the circle of fifths. He then provides a rather cursory discussion of the topic of temperament, explaining briefly the reason why tempering is necessary, and then going on explain the two basic methods (actually the two extremes) of tempering: meantone and equal. In order to teach the instrument owner how to hear and produce subtle variations in the size of fifths, he continues by recommending the construction of a simple instrument with three strings, a sort of triple monochord. He then

continues with the following paragraphs:

> “A means of determining the pitch level [Tonhöhe] for tuning is the well-known monochord, a long narrow little case above which a string is stretched. Beneath this string, on the [sound]board of the case, the proportions of the tones are marked, as determined with the help of a compass. One positions a bridge under the strings on these division points, one by one, in order to produce the sounds of fifths, thirds, and so forth. With an equal thickness and tension the half of a string length gives the octave above, two thirds give the fifth, 3/4 the fourth, 4/5 the major third, 5/6 the minor third, 3/5 the major sixth, 5/8 the minor third. Two strings produce a unison when they make the same number of vibrations in the same amount of time. The octave above makes once again as many oscillations as the fundamental; the fifth makes three oscillations for every two of the fundamental, and so forth.
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> “Of course, the length of the case, which is called a monochord, is by no means determined by any hard and fast rules, but is instead a matter of whim. The only advice is that it be of a length which is easily divisible. Normally one makes it 2 feet long, but it could also be 4 or 8 feet, and approximately 4 fingers wide and deep.”

At first reading, it might appear that Gall is recommending the use of a monochord to determine the size of intervals as an aid in setting the temperament. However, his description of the pure intervals produced by simple-fraction string division is in direct conflict with the previous passages on temperament, in which he states that the fifths, fourths, thirds, and half steps must all be tempered more or less in order to keep the octaves pure. His real intent is made obvious by the paragraphs which immediately follow those quoted above:

> “The pitch pipe is no less helpful in determining pitch level. This is a square wooden pipe, made just like a normal flute except without [finger]holes, and having a securely fitting sliding stopper, which one either pushes deeper inward or pulls further outward, according to the markings thereupon, in accordance with which one can determine the pitch for this or any other keyboard instrument.
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> “Regarding the pitch at which an instrument should be tuned, one notes that chamber pitch is approximately one whole tone higher than chapel pitch, which in Germany is called choir pitch, which is commonly used in the churches.”

Without venturing into the murky waters of the relative heights and

differences between choir and chamber pitch in various locations in Classical continental Europe, at least two conclusions can be made from the above texts: (1) pitch differences of considerable amounts were common, and (2) both the monochord and the pitch pipe were being recommended here as tools for determining the general relative pitch levels among various instruments, or the pitches used in various musical settings. Because all orchestral instruments, even the most troublesome woodwinds, have at least some degree of pitch flexibility, such “ballpark” measurements need not be so terribly precise, which explains the implied acceptability of the rather coarse differences between theoretically-pure intervals and their tempered equivalents (which can be as much as 20 cents with major thirds). This also explains why the notoriously-imprecise pitch pipe is here mentioned as being equally well-suited for the task at hand.

In light of the above passages, it is quite possible that Krug’s enigmatic “1/16th” referred to a monochord proportion. She probably meant that the difference between Vienna and Frankfurt pitch was the same as the difference produced by stopping a string at 15/16ths of its length, i.e. “1/16th higher”. Such a determination could have easily been made by her or anyone else, simply by taking a Viennese tuning fork (such as the one which came with the Streicher piano - see below), taking the choir on a Frankfurt-tuned piano which sounded the note produced by the fork, tuning one string of this choir to the pitch of the fork, and then seeing at which point this same string needed to be stopped in order to raise the pitch back up to the pitch of its properly-tuned neighbor(s). A length difference of 1/16th works out to be 112 cents, or a fat semitone. Again assuming a “base” Viennese pitch of 430, Frankfurt pitch would therefore have been 459. This is a significant sharpening, one which might be capable of causing problems with breaking strings on a piano not specifically designed for such a high level. It is also certainly a big enough difference to require specially-made wind instruments, which undoubtedly would have created a general awareness that Frankfurt pitch was higher than Vienna pitch, a background situation which Krug’s letter strongly implies. If we accept this pitch as a starting point for a reexamination of the scaling issue, how does the it fit into the story of the breaking strings and the supposed “mistaken” scale length?

Latcham compares the 129 mm string length of the d3 string of Krug’s newly-arrived piano with two other (very) roughly-contemporary extant Streicher instruments, 1808/#764 (GNM MIR 1117) and 1811/#902 (GNM MINe 119), which have d3 lengths of 117 and 116 mm respectively. The difference in semitones is 1.7 and 1.85 semitones respectively, which Latcham curiously converts into “*exactly* [my italics] two semitones longer than . . . [Streicher’s] usual design.” Not only does he create the illusion of a degree of precision which is simply *not* evident in the data, but there is also the question of whether or not only two extant instruments, separated by 3 years and 140

pianos, are sufficient for establishing convincingly the string lengths for the “usual design” . . . assuming of course that such a thing even existed. The already highly-questionable nature of this conclusion is greatly increased by the fact that the treble part of the bridge on #764 is completely loose from the soundboard, and the treble portion of the soundboard itself is in bad condition, making it exceedingly difficult if not impossible to firmly establish the original length of d3 on this instrument. This reduces Latcham’s “normal design” d3 length to that found on only one extant instrument, a sampling far too small to convincingly establish any sort of norm.

Latcham also compares the length of the Krug d3 to that of other instruments of the Stein/Streicher dynasty by deriving a c3 length of 145 mm (by calculating a length 2 equal-tempered semitones longer than d3), and then stating that this is “the length Stein used in the 1780’s.” Why the d3 lengths must be converted to c3 lengths to make such a comparison in unclear, but in any case, the conclusion, while true, is misleading; one need not turn the clock back 25 years or so to find such a long treble scaling. The Geschwister Stein instrument of c.1795 (GNM MIR1104) has a d3 just as long. Even later, the c.1804 5 1/2 octave Streicher in Leipzig (Inv. No. 3189) has a d3 only about 1/2 of a semitone shorter, while the slightly later instrument #649 (Priv. Germany) has a d3 of 133 mm, or 1/2 semitone longer! Another Streicher from 1805, #673, now in the Sibelius Museum (Inv. No. 20), with its c2 length (the only treble length given by Latcham for this as well as many other instruments) of 301 mm probably has a d3 even longer yet; were this instrument’s scaling Pythagorean, d3 would be 134 mm - 5 mm or 0.6 semitone *longer* than than the supposed “mistakenly long” d3 on Krug’s instrument! Excluding the 1808 #764, the chronologically-nearest surviving earlier instrument is another early 6 1/2 octave, #733 (GNM MINe 135), which has a d3 of 122 mm, only 1 semitone shorter than Krug’s instrument.

Actually, the whole issue of comparing the length of Krug’s d3 to other Stein/Streicher instruments, either previous or contemporary, is a red herring. Not only is the discussion of scale length without simultaneously stating the gauge of wire mounted (which Krug does do, but Latcham not) an exercise in futility, but the length of d3 is not applicable, neither for analyzing what caused the pitch problem nor for specifying or comparing overall scale lengths. Even worse than the traditional modern organological reference note - c2 - this note suffers from the disadvantage of being much too high in the compass, too far above the area where the *real* arbiter of maximum pitch level - the highest stress level - is always found: the tenor. The proportion between the length of any given note in the high treble and in the scale length in the critical tenor region is extremely variable, being affected by any intervening gap spacers as well as the overall scaling logic, which may or may not include either a progressive or sudden lengthening of the treble - or both. Furthermore, because the lengths in the high treble are so short, any minor

errors in the workshop during the placement of the bridge will represent a much greater proportional difference than the same absolute error lower in the compass. Even though such errors might create aberrations from the ideal scaling of as much as a semitone, or even more, they probably would have been tolerated, since the old builders new that treble strings are almost always significantly understressed in comparison to tenor strings. Therefore an error in the direction of too long in the high treble wouldn't have caused wire breakage problems unless it became extreme. However, when such short string lengths, originally determined with generous tolerance margins, are used to extrapolate the *overall length* of the entire scale - and by inference, the maximum pitch level as well - any conclusions must be taken with equally generous grains of salt.

Krug's piano is an excellent illustration. Even with the high level for Frankfurt pitch assumed above, Krug's d3 length of "1/2 Zoll too long" would have been no problem. Krug gave the lengths of two other instruments which could be successfully tuned to Frankfurt pitch, and states that the 6th octaves were strung with gauge 2. Therefore we can assume d3 was most likely strung with gauge 1. Although the d3 lengths given by Krug for these instruments are similar to Latcham's proposed "normal" design (117.5 and 119 mm), a d3 of 129 could easily have withstood Frankfurt pitch. Using Latcham's proposed strength/diameter specifications for Nürnberg wire of the time, gauge 1 would have been slightly more than 2 1/2 semitones below rupture load at Viennese pitch, or about 1 1/2 semitones at Frankfurt pitch. In other words, the safety margin below a believably level for the elastic/plastic extension border would have been about 1/2 semitone at Frankfurt pitch - close to the maximum, but still possible. It is true that the scale shape of many extant instruments is such that the larger and weaker tenor strings would have been pushed above the elastic/plastic border, given Krug's d3 length and the assumed pitch. But without knowing anything about the scale shape of this particular instrument, it is impossible to say. A tapered scaling could have easily included both Krug's "mistaken" d3 length and tenor lengths that would have been safe. Krug wonders outloud what might have happened to the measurement she sent to Streicher, guessing that the workman who built the soundboard had either lost or ignored it. The truth of the matter is probably that he simply discarded it for what it was: utterly useless as any indication of overall scale length for Frankfurt pitch, and also useless as a guideline for designing a scale length for this or any other specific pitch level. For these purposes, one must use the lowest note on the instrument which has not yet been subjected to the ubiquitous low tenor/bass scale (fore)shortening. It is this note that will almost inevitably be <u>the</u> most highly stressed, and therefore this note which will be the arbiter of maximum pitch.

Thus, while we can draw no firm conclusions about the situation from the specified string lengths, there remains several important clues: the instrument

arrived in a bad state of tuning, with broken strings, and the pitch level was “about” 1/2 step below Frankfurt pitch. Further documentary evidence is provided by another letter from the Streicher archive, this one from J. A. André, Streicher’s agent in Frankfurt at the time. Writing 8 months after Krug’s letter, he discusses the problem with the instrument, stating again that it couldn’t be brought up to Frankfurt pitch, and could only barely be tuned at the Viennese pitch given by the fork sent with the instrument. A thoughtful analysis of this information may well lead to a more credible explanation.

As stated above, the highest tension/stress levels on Streicher instruments of this era (indeed on almost all instruments) are usually found in the tenor region, and the higher one looks in the treble, the lower the stress levels; high treble regions are usually one or more semitones further from breaking than those of the tenor. Therefore, it is tenor strings which are the first to break if the instrument is subjected to conditions which cause “spontaneous” string failure, such as when the overall tension rises due to excessive humidity (which causes the soundboard to crown - another phenomenon largely limited to the tenor register). Furthermore, since the tenor strings place the highest load upon the flexible wooden case structure, if and when they do break, the sudden release of tension allows the structure to relax a bit, placing yet more tension on all the remaining strings, causing their pitch to rise. In fact, were it not for the rapid fall-off of stress levels to either side of the tension/stress peak in the tenor region, it would be possible for an instrument to go into catastrophic string failure. In such a scenario, the breakage of several of the highest tensioned/stressed tenor strings could lead to a vicious circle of rising pitch and further breakage which would only end when all the strings had spontaneously broken. Luckily, such things only occur when instruments are completely destrung by starting in the bass instead of the treble. Even lacking such drastic occurrences, however, the delicate balance between tension and case flexibility are readily perceivable and well-known to anyone with experience tuning fortepianos, especially instruments larger than 5 octaves. This phenomenon was also quite accurately described by Schiedmayer in his 1824 reprint of Streicher’s 1802 maintenance manual. Therefore, we can assume that when the Krug piano arrived in Frankfurt, the remaining unbroken strings were at a pitch level *higher* than the intended design pitch, even after the humidity had returned to a level which allowed the board to return to a normal degree of crown.

At this point, it is most instructive to examine the question of whether or not a “normal” Viennese instrument could have been tuned to the assumed Frankfurt pitch. Or would Streicher have needed to build special instruments for that destination, as is seemingly implied by the length which Krug had sent with the original order. Based upon the Stein/Streicher pianos which have survived with gauge markings, the safety margin in the critical tenor regions seems to have been kept consistently between about 1 1/2 and 1 1/4

semitone below the elastic/plastic border (assumed to lie about 1 semitone below the rupture load of a freshly mounted string). As stated above, treble stress levels ubiquitously fall to significantly lower levels, so we need not consider them in regards to possible maximum pitches. Thus it is quite possible that tuning an instrument to a pitch slightly more than 1 semitone higher than the design pitch was within the design limitations of the “normal” Viennese model, although pushing the limits. Such a conclusion explains many things. First, while Frankfurt pitch may have been *possible* on a normal Viennese model, it would have been common knowledge that such a pitch was at the limit of possibility. Therefore, Krug might have felt the need to send a mensur length as a warning, an example of a length which (she felt) should not be exceeded. Secondly, this explains a seeming contradiction created by a remark near the end of Krug’s letter of complaint; in discussing a replacement instrument, she says, “Since I assume you will choose [the replacement instrument] from many already-finished instruments . . . I would like one with a tone which is rounder and more covered, and a keyboard in ivory.” This strongly implies that instruments from the normal stock were indeed usually capable of being tuned at Frankfurt pitch, though the instrument may have had to be chosen with care.

So if a normal model could have met Krug’s pitch requirements, we are back to the question of whether or not a mistake in the scaling was made during the construction of the soundboard of this instrument. This conclusion is extremely difficult to believe, for while it is possible to conceive of a such a mistake being made, it is outside the realm of possibility that a scaling error as gross as 2 semitones too long would not have been noticed latter by the “Verfertiger” during the final stages of tuning and voicing. Indeed, the unlikelihood of such a mistake being made during construction is supported by the opening section of André’s letter to Streicher. It is a mocking parody, written in strong dialect, an obvious joke between he and Streicher at Krug’s expense. It rather pointedly pokes fun at her for even entertaining the very idea that such a mistake in this critical aspect of an instrument’s construction was possible. Evidently imitating Krug, André satirically writes that the strings had been tuned “as close to the angels in heaven” as possible, but when they were tuned up to “Frankfert” pitch, “platze en Seyt und n Seyjte und alle Seyte.” This is because the “de Mensur is zu gruß”, which in turn is because one of the workers at “Stracher” glued the bridge on the “fartepiane” in the dark. The reason “der alte Stracher” didn’t notice this error was because he was so happy that it was only this one instrument which had this mistake, and not all the others as well!

So if the mistaken bridge location theory is not to be believed, how can we explain the problem of the breaking strings? There is one possible scenario which convincingly resolves all the seeming contradictions: a mistake was indeed made in the Streicher firm, but *not* in the Soundboard Department, in

which case it most certainly would have been caught later along in the construction process. It is more likely a mistake made as the instrument was going out the factory doors: in the Shipping Department. It is quite easy to imagine that during crating, the intended destinations of several instruments were confused. The piano Krug received could well have been purposely made for a lower pitch, probably destined for somewhere in northern Germany. The scale may well have been *one* semitone longer than the “normal design”, as is found on some extant pianos of Hofmann. In this case, the Verfertiger would have noticed nothing unusual; he would simply have tuned and voiced the piano at its intended pitch, probably about 1/2 step lower than Viennese. In the packing room, the instrument was probably confused with one of “normal” design which was to be sent to Krug. This would explain the inclusion of a normal Viennese fork, probably part of the “standard issue” maintenance kit which the boys down in the packing room routinely threw into each crate along with each “standard” model, regardless of the actual pitch at the final destination. Only with instruments designed specifically for *lower* pitches, i.e. with longer scales, would the workers have been instructed *not* to include the standard fork, since tuning such an instrument to standard pitch would have been dangerous.

Underway to Frankfurt, this mistakenly-addressed “low-pitched” instrument was probably subjected to excessive humidity, causing the pitch to rise to a point where the most dangerous tenor strings began to break. The pitch level at which this would happen would have been somewhere around a fat semitone higher than the intended design pitch, the point at which the wire would have begun to go into plastic deformation, and eventually breakage. Assuming a design pitch of one semitone lower than “normal”, failure pitch level would have been about a quarter to a half semitone higher than Viennese pitch. The resultant release of tension upon the case in turn caused the pitch of all remaining strings to rise somewhat, though not quite enough to break. The final result, once the instrument was uncrated and acclimatized, would have been that a number or tenor strings were broken, the piano was horribly out of tune (as noted), and the overall pitch of the remaining strings was still generally higher than the intended pitch for the instrument - in this case, an estimation of the pitch of the unbroken strings might well have been somewhere near normal Viennese pitch, or “about” a semitone lower than Frankfurt pitch (as observed by the tuner). This would explain why more strings would have broken *immediately* when the hapless tuner tried to raise the pitch yet further to Frankfurt pitch. It also explains André’s comment that the instrument could “only just” be tuned to Viennese pitch, which would have been in the same proportion to the instrument’s lower design pitch as Frankfurt pitch was to a “normal” Viennese model - possible, but pushing the limits. So Krug could well have been right; the mensur was in fact too long, though her and Latcham’s conclusions about the degree of the scaling difference were probably both wrong, as was Krug’s suspicion about the guilty

party.

Note that the observed phenomena would not have occurred had Frankfurt pitch been only marginally higher than Vienna and/or had Latcham's estimation of the lengthening of the scale been correct. If the scale were indeed 2 semitones too long, even normal Viennese pitch would have pushed the tenor strings well beyond breaking, let alone a pitch either slightly or significantly higher, and André's comment that the instrument was only just capable of being tuned to Vienna pitch would not have been true. Had the scale been one semitone too long and Frankfurt pitch only 13 cents higher than Vienna pitch, the piano could probably still have been successfully tuned to the Frankfurt level, and Vienna pitch certainly would have been no problem. Likewise, had there been no mistake at all in the scaling, and had Frankfurt pitch been as high as suggested here, there also would have been no problem with the tuning. Only a combination of a scale lengthening in the area of one semitone plus a higher Frankfurt pitch level of about one semitone brings all the pieces of the puzzle together into a convincing whole.

Whether or not this scenario is a valid explanation for what actually occurred rests primarily on one key piece of information: how high was Frankfurt orchestra pitch? While the above series of conclusions is logically sound and therefore quite possible, it remains nonetheless only a theory. In such matters, the evidence from keyboard instruments is generally not precise or conclusive enough to really draw any firm conclusions - too little is really known about wire strengths and which scale lengths were intended for which pitch levels. Perhaps evidence from contemporary wind instruments will someday provide us with more reliable information about Classical pitch levels in Frankfurt. Only then will we be better equipped to decide whether or not we agree with the final sentence of André's satirical little piece:

"Der alte Stracher weß wuhl was er thuet."