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The Restoration of a Fortepiano by Conrad Graf, ca. 1838, in the Collection of the Metropolitan Museum of Art

Stewart Pollens

One of the preeminent fortepiano makers of his day, Conrad Graf (b. Riedlingen, Württemberg, 1782; d. Vienna, 1851) was active in Vienna between 1804 and 1842 and received a gold medal at the 1835 Austrian Industrial Products Exhibition.[1] His instruments were owned or played by leading pianists and composers, including Beethoven, Brahms, Chopin, Czerny, Kalkbrenner, Liszt, Mendelssohn, Schubert, and Schumann, as well as by such dignitaries and notables as the Archduke and Archduchess of Austria, the Empress of Russia, and the Queen of Saxony. Approximately eighty of his instruments have survived; most are in museum collections in Europe.

In 2001, the Metropolitan Museum of Art in New York acquired one of Graf's fortepianos made ca. 1838 (Figure 1). Its nameplate reads: Conrad Graf / kaiserl~: kön~: Hof-Fortepianomacher / Wien / nächst der Carls-Kirche im Mondschein N°. 102 (Figure 2). The inscription identifies Graf as a court fortepiano maker in Vienna and indicates that his place of business (a former dance-hall named the Mondscheinhaus) was located at no. 102 auf der Wieden, next to the Karlskirche. He worked at that address from 1826 until his retirement, when he sold the property to the piano maker Carl Andreas Stein.[2] The serial number, 2564, indicates that the fortepiano was made shortly before Robert Schumann's Graf (now in the Vienna Kunsthistorisches Museum), which is numbered 2616. The Metropolitan Museum's instrument was acquired from the Castelbarco family in Florence, Italy, and it is said to have been purchased by that family directly from the maker. It has six-and-one-half octaves (CC–f^4), is triple strung (except for the bottom seven notes, which are double strung), and has four pedals controlling the dampers, two moderators, and an *una corda* shift.

1 Deborah Wythe, *Conrad Graf (1782–1851), Imperial Royal Court Fortepiano Maker in Vienna* (PhD. diss., New York University, 1990), pp. 9–10.

2 Wythe, *Conrad Graf*, p. 19.

Condition at time of acquisition

When acquired, the instrument was in fairly good physical condition, with minimal case distortion due to string tension. A few sections of veneer were missing along the upper edge of the case and the edge of the lid, and the once vivid, mahogany-colored stain had faded considerably on exposed parts of the lid, as well as the cheek piece and bentside. However, the original color was well preserved on the less frequently exposed surfaces of the front sections of the lid as well as the keyboard console. The instrument retained its original hardware, turned legs, pedal lyre, and so-called dust board.

The piano was not in playing condition, and from reports of the owner, it had not been tuned or used within living memory of anyone in the household. The mechanism was not functional due to deterioration of key and action cloths, broken hammers and other action parts, corrosion of lead weights in the dampers, and a dozen broken or missing strings, many of which were tangled up on the soundboard. Though the case structure was in good condition, the far end of the bass bridge was unglued, as were several of the soundboard ribs. The soundboard had numerous hairline cracks and two cracks requiring narrow shims.

One of the reasons this particular instrument was acquired for the Metropolitan Museum's collection was that it had never been restored and thus retained most of its original strings, hammer and damper leathers, moderator cloth, as well as key and action cloths. In many surviving examples, these parts have been replaced, often with materials that have different properties than the originals.

The decision to restore

The Metropolitan Museum of Art's director, Philippe de Montebello, was required to give his consent before the Musical Instrument Department could purchase the instrument, and he did so with the proviso that it be restored to playing condition after it had been acquired. Because the fortepiano was largely intact, the author elected to retain as much of the original "ephemeral" material (wire, cloth, leather, etc.) as possible and to replace only the missing or badly degraded parts that rendered it unplayable.[3]

3 Between 1976 and his retirement in 2007, the author was the conservator of musical instruments at the Metropolitan Museum of Art. The restoration work on the Graf fortepiano was planned and carried out by the author in 2001/2002. A conservation intern, Zsuzsanna Mehrli, assisted with gluing in some of the new action cloths.

Preliminary disinfestation

Because the Graf fortepiano was to be temporarily placed in the museum's storeroom that housed thousands of instruments from the permanent collection, and ultimately exhibited in the public gallery with hundreds of other instruments, it was imperative that it first be disinfested to kill active woodworm, moth larvae, and other pests. This was accomplished by encapsulating the instrument between heat-sealed sheets of aluminized polymer film (Marvelseal 360), purging the enclosure of air, and filling it with humidified argon (an inert gas). Packets of an oxygen absorber (Ageless Z) were also sealed in the enclosure with the instrument. Oxygen and carbon dioxide levels were monitored to verify that respiration had ceased and that all the insects, larvae, and eggs had been destroyed.[4]

Restoration work on the action

The only original parts that had to be replaced were action cloths (including those mounted on the back rail, escapement rail, escapement jacks, as well as the hammer rests on the key levers), which had been almost completely devoured by moth larvae (Figure 3). As the thickness and resiliency of these pieces of cloth are critical to the proper working of the action, it was necessary to replace them with similar material. Fortunately, the author had a bolt of English wool flannel that matched the thickness and tactile properties of the original parts. When new cloths were installed, the proper key dip was restored, the beak leather slipped nicely into place underneath the escapement levers, and the action came into almost perfect regulation. Though the moderator cloth was somewhat compromised by moth damage, the author elected not to replace it.

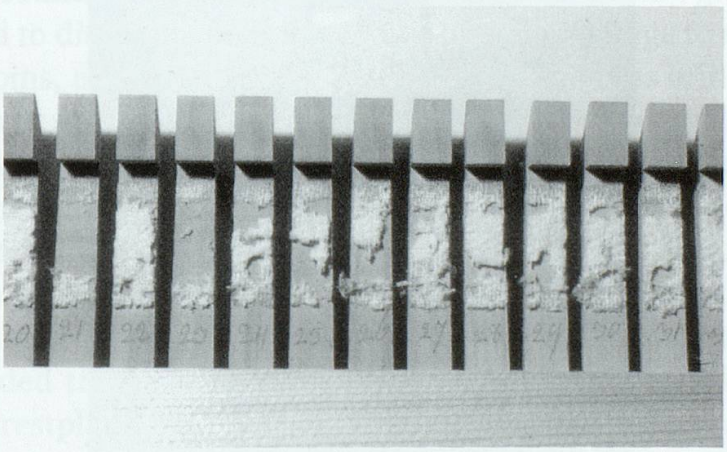

Figure 3: Detail of action cloth of fortepiano by Conrad Graf.

4 Charles Selwitz and Shin Maekawa, *Inert Gases in the Control of Museum Insect Pests* (The Getty Conservation Institute, 1998). Argon-gas disinfestation was done by Robert Koestler in the museum's Objects Conservation Department.

Several of the hammer shanks and other action parts were broken and were glued using hot animal hide glue. The outer layers of leather on the hammers were in fairly good condition and were brushed with a stiff bristle brush to remove impacted dirt and to revive their nap.

The damper rack required some re-gluing, and all of the bass dampers were jammed together because the lead weights in them had corroded and expanded (Figure 4). The corroded weights were removed and new ones were fabricated with an arch punch, pressed into place, and leveled with a scraper (Figure 5). Some of the lower extensions of the dampers were broken off. Most of the broken parts were found, but two new extensions had to be fabricated of pear wood and glued in place. Many of the brass guide pins for the dampers were also bent and had to be straightened; a few of the leather-lined parchment loops at the lower ends of these guides were ripped and had to be replaced. A number of the leather covered damper wedges had to be unglued and repositioned so that they would sit squarely on the strings.

Several of the keys needed to be "eased," and final regulation of the action was carried out with a standard kit of piano technician's tools supplemented with a pair of *Kapsel* pliers. Sluggish hammers (due to oxidized oil in the *Kapsel* bearing) were cleaned with mineral spirits and re-lubricated using a clock oiler and Moebius 9010/2 synthetic oil. The right mortise for the check rail required a thin strip of leather to prevent the check rail from shifting out of position.

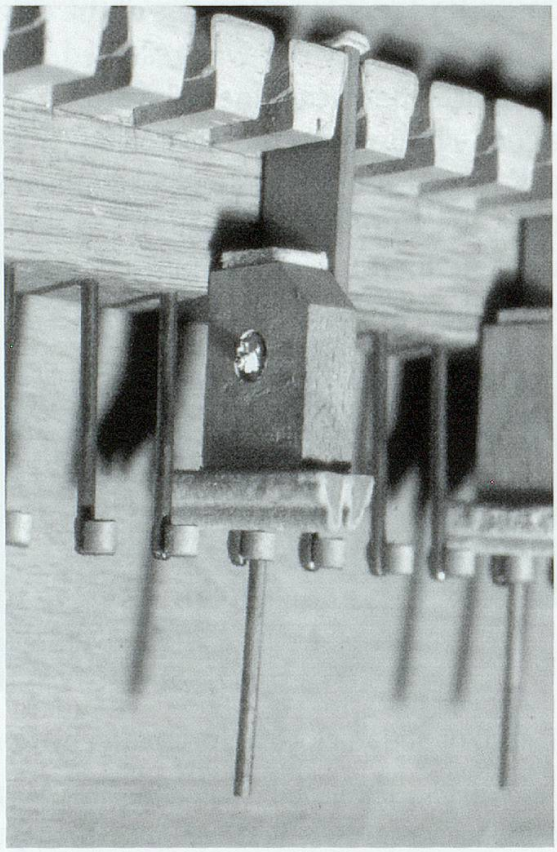

Figure 4: Detail of corroded lead weights in bass dampers.

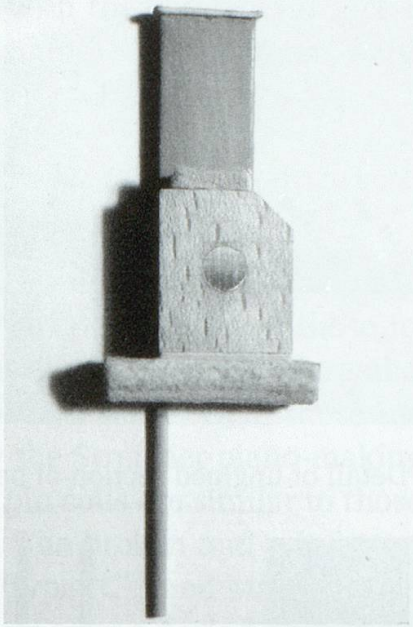

Figure 5: Detail of a replaced lead weight in a bass damper.

Restoration of the case and soundboard

Graf pianos of this period have screwed-in bottom panels. When removed, the openings provide access to the internal framing and the underside of the soundboard. This facilitated re-gluing of the bass bridge, which was partially unglued and sprung (Figure 6), as well as some of the barring on the underside of the soundboard. To re-glue these parts, boards fitted with Jorgensen veneer press screws were clamped across the top and bottom of the case (Figure 7). The veneer screws were adjusted to apply pressure on the loose part from above while supporting the soundboard from below, and *vice versa*, during gluing operations (pads were used to distribute pressure and to prevent damage to the soundboard, bridge, bridge pins, and other parts). Before gluing the bass bridge, the original strings were carefully loosened so as not to disturb the tuning pin coils, and the hitchpin loops were slipped sequentially onto a length of wire fixed to a block of wood to keep them in order (Figure 8). After the bridge was re-glued, the strings were then re-hitched and tightened up. A fiber-optic viewing device was also used to examine the joinery, and a few needed repairs were made. The wrestplank appeared to be in good condition, with all but a few tuning pins fitting perfectly. Those that needed tightening were repaired by inserting thin hardwood shavings into the wrestplank holes. When removing the tuning pins to insert these shavings, care was taken not to loosen the tuning pin coils so that the original strings could be retained.

The soundboard was vacuum-cleaned with the assistance of a stiff bristle brush to remove dust and other debris, and de-ionized water was used to remove stains in the soundboard and so-called dust board. A few hairline cracks in the

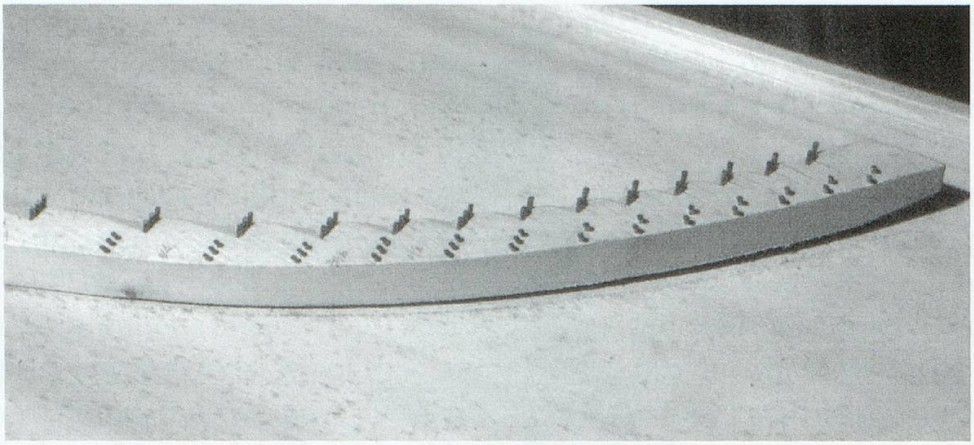

Figure 6: Detail of unglued section of bass bridge.

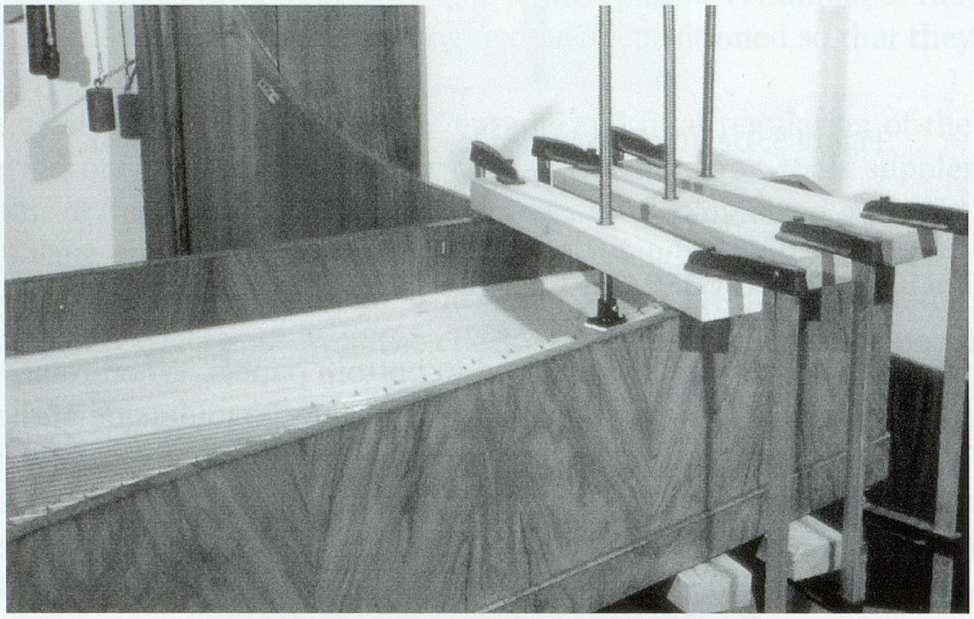

Figure 7: Clamping system devised by author to reglue bass bridge. As pressure is exerted on the bridge from above, the soundboard is supported from below by Jorgensen veneer press screws.

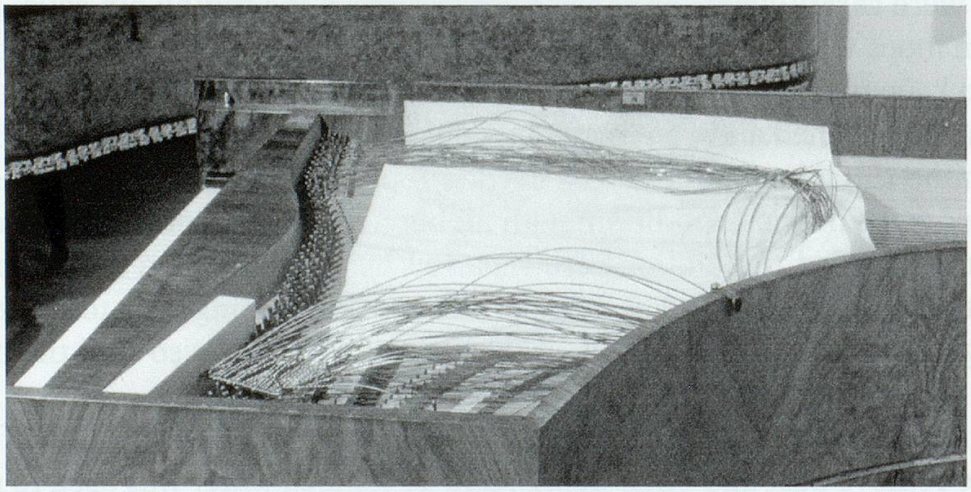

Figure 8: Temporarily unhitched bass strings.

soundboard were leveled with the clamping device described above and then glued with hot animal hide glue; two thin shims were also glued in.

The strings

The Graf fortepiano's strings appear to be original, as their thicknesses and original gauge markings are consistent with those found in other Graf pianos (though they are somewhat thicker than the "Nuremberg" wire gauges tabulated by Thomée in 1866 and a bit thinner than those indicated by a string-gauge caliper used after 1825 by the Streicher piano-making firm).[5] Furthermore, the hitchpin loops and tuning pin coils are similar to those in other Graf pianos that the author has examined. The broken and missing strings were replaced with Malcolm Rose's iron wire (type "C") and Malcolm Rose's brass wire. These new strings held their tuning and after a period of time blended tonally with the old strings. The broken overspun strings were copied on a string-winding machine constructed by the author. (Gauges of the cores and windings of the broken strings are tabulated below.) Unlike some eighteenth- and nineteenth-century string-winding machines (such as the one intended primarily for bowed-string instruments depicted in *L'Encyclopédie méthodique*; Paris, 1785) that twist the core at one end, the author's machine uses two sets of gears linked with an iron rod that rotate both ends of the core at precisely the same rate. This prevents the core from twisting, which often results in "false" strings. The machine also has a device that applies tension to the core during spinning. Malcolm Rose's iron wire (type "C") was used for the core of the overspun strings, and Malcolm Rose's brass wire (annealed by the author) was used for the winding. All old string fragments were placed in polyethylene bags, tagged, and stored.

Case cleaning and polishing

Superficial cleaning of the case was carried out with de-ionized water and a non-ionic surfactant (Triton X-100, 1 % solution), followed by mineral spirits and hexanes to remove wax, grease, and old furniture polish; some splattered house

5 H. Thomée, "Untersuchungen über Draht- und Blechlehren," *Zeitschrift des Vereines Deutscher Ingineure* X (1866), pp. 659–660. Alfons Huber, "Saitendrahtsysteme im Wiener Klavierbau zwischen 1780 u. 1880," *Salzburger Museum Carolino Augusteum Jahresschrift* 34 (1988), pp. 193–222. Paul Poletti, "The Interpretation of Early Wire Gauge systems: Fixed Diameter or Proportional Relationships," *Matière et Musique: The Cluny Encounter. Proceedings of the European encounter on instrument making and restoration (Cluny, 1999)*, eds. Claire Chevallier, Jos van Immerseel, Thomas Steiner (Antwerpen, 2000), pp. 227–240. Michael Latcham, *The Stringing, Scaling, and Pitch of Hammerflügel Built in the Southern German and Viennese Traditions 1780–1820* (München, Salzburg; 2000).

paint at the tail end of the instrument and lid was removed with a flexible plastic scraper. A French-polishing pad lightly moistened with ethanol was then briskly wiped along the varnished surfaces for final cleaning. Missing veneer pieces were fabricated and glued in place using hot animal hide glue. The new pieces of veneer and scratches were then retouched with Winsor & Newton water colors. New wood, retouches, and areas where the varnish was worn away (primarily at the case corners, moldings, and edges of the lid) were lightly French polished with bleached and de-waxed shellac (180 grams of shellac flakes dissolved in 1 liter of ethanol), which was padded on without the use of lubricating oil. The case and top surface of the lid were then solvent-polished with a French-polishing pad lightly charged with ethanol. Undersurfaces of the front sections of the lid and the keyboard console were not cleaned with alcohol, French polished, or solvent polished.[6]

The ormolu frame around the nameplate was corroded and was treated by immersion in a .5 molar solution of tri-sodium EDTA (a chelating agent).[7] The frame was then given a light, protective coating of B-72 (acrylic resin dissolved in acetone) applied with a sable brush.

Tuning and use

As the piano had evidently not been tuned in many years, it was well over an octave below pitch. It was brought up gradually over a period of several weeks to approximately A-430. Initially, tuning stability was extremely poor, and many tunings were required before the instrument would hold well enough in tune to be used in concerts. Between 2001 and 2002 (when string tension was restored) and the author's retirement from the museum in 2007, no structural or acoustical problems developed. During this period, the Graf piano was used with great success in several public concerts in the museum's musical instrument galleries. When paired with a modernized Stradivari violin in one spirited performance of Beethoven's "Kreutzer" Sonata (featuring Anthony Newman and violinist Stephanie Chase), the Graf held its own, producing at times a big, aggressive sound.

6 During the author's period of employment at the Metropolitan Museum of Art, the museum's scientific department lacked the capacity to analyze organic materials, such as varnishes. To facilitate analysis of the Graf fortepiano's finish at some future date, the author decided not to clean or French polish the undersurfaces of the front lid sections and keyboard console.

7 The .5 molar trisodium EDTA solution was produced by adding 185 grams of bisodium EDTA and 215 grams of tetrasodium EDTA to 1 liter of deionized water.

Conclusion

Though the tone of the instrument might be improved through restringing, the application of a fresh outer layer of leather on the hammers, and new moderator cloth, the instrument works quite well with its original parts. The author believes the retention of original parts should be of primary importance when restoring instruments preserved in a permanent collection. However, the renewed string tension (approximately 6,000 Kg) will certainly lead to increased case distortion and perhaps to severe damage to the case and soundboard. At some point, the Metropolitan Museum of Art will have to weigh the advantages of maintaining string tension and playability against concomitant physical deterioration.

In conclusion, though there is at present considerable controversy regarding the restoration of early keyboard instruments, particularly those that are discovered in a relatively pristine state, the restoration of this Graf piano was relatively straightforward and was carried out with minimal intervention or replacement of parts.[8]

Gauge markings and diameters of strings found in the instrument[9]

CC overspun, core 1.12 mm/winding .59 mm
CC♯ overspun, core 1.05 mm/ winding .53 mm
DD overspun, core 1.05 mm/winding .53 mm
DD♯ overspun, 2.01 mm overall diameter
EE overspun, core .92 mm/winding .45 mm
FF overspun, 1.80 mm overall diameter
FF♯ overspun, 1.55 mm overall diameter
GG overspun, 1.38 mm overall diameter
GG♯ overspun, 1.30 mm overall diameter
AA, (marked 8/0), 1.27 mm, brass
AA♯ (marked 8/0 ½), 1.22 mm, brass
C (marked 7/0) 1.15 mm, brass
D♯ (marked 7/0 ½), 1.05 mm, brass
F♯ (marked 6/0), .97 mm, brass
A (marked 4/0), .90 mm, iron
d♯ (marked 4/0 ½), .88 mm, iron
a (marked 3/0), .83 mm, iron
$d♯^1$ (marked 3/0 ½), .77 mm, iron
c^2 (marked 2/0), .75 mm, iron

8 Gabriele Rossi Rognoni, editor, *Restauro e conservazione degli strumenti musicali antichi* (Florence, 2008).

9 String lengths and thicknesses of the plain iron and brass strings were made by Donatella Degiampietro.

f♯^{2} (marked 2/0 ½), .70 mm, iron
c^3 (marked 0), .68 mm, iron
g^3 (marked 0 ½), .66 mm, iron
d^4 (marked 1), .60 mm, iron

General dimensions

Overall length 2375 mm
Width 1250 mm
Case depth 330 mm
Keyboard width 1073 mm

String lengths

CC 1820 mm
FF 1747 mm
C 1565 mm
F 1288 mm
c 1111 mm
f 856 mm
c^1 560 mm
f^1 419 mm
c^2 281 mm
f^2 216 mm
c^3 143 mm
f^3 103 mm
c^4 72 mm
f^4 57 mm