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Objective surveys concerning the validation of the restoration processes on the pianos of the Romantic period: two Rossini Pleyels and other cases

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1. Introduction and research purposes

The historical pianos of the XVIII and XIX centuries represent in modern day Europe an enormous historical patrimony, which is object of study, conservation, restoration and reuse. These instruments represent the tone-colour to which all pianistic literature was actually aimed until the elaboration of the second late Steinway Romantic typology (eighth decade of the nineteenth century) prototype of the modern piano. Until that period the piano did not present a univocal physiognomy, but was rather articulated in a few principal typologies differently interpreted by the individual manufacturers. Various sub-typologies referred to the principal typologies which had become popular in the various countries (Austro-Hungarian Empire, France, Germany, England and the United States).

The cult of originality peculiar to Romantic aesthetics and the faith in the inexhaustibility of the developments of production characteristic of the Industrial Revolution contributed to the multiformity of the tone-colour, aesthetic and technological features of the piano. Subsequently an univocal acceptation of the idea of the instrument became popular, rendering the many Romantic pianistic typologies obsolete within a few decades. Thus the complex productive equilibrium which had permitted the production of those refined instruments disappeared. The Romantic pianos became deaf documents of a concluded musical civilisation.

The research regarding restoration, of which this paper presents a few aspects, has aimed at developing both the stages of the study and of the conservation of these objects and those of their restoration and reuse: the purpose was to decode

the precious information and suggestiveness intrinsic to these instruments. It has concentrated primarily on these objectives:
1) To put into optimal relation the need to guard (conservation of the original materials and structure, reversibility of intervention) with the reutilization of the instruments for interpretative research, that is the full phonic-mechanical efficiency;
2) To tie restoration procedures to scientific considerations and objective quantifications freeing them from the contingency of individual and episodic judgements;
3) To present a solution to the challenge represented by the restoration of these instruments through the recomposition of competence of the individual agent or of the small studio in relation to the utilisation of today's advanced technology. In fact, the production and the commercialisation of these instruments were possible thanks to the forced fragmentation and to the organisation on a medium scale of the manufacturing process.

2. Aspects of the obsolescence of historical pianos
This research has presently aimed at three central aspects of the problem of tone-colour restoration:
1) the obsolescence of the soundboard, which presents itself with longitudinal cracks and concavity of the surface consequential to both transversal contraction tension. It is due to the hygrothermic difference in level between assembly and medium operating conditions and the viscous sliding from tracheid weight with subsequent modification of the original physical structure and of the sound production;
2) the obsolescence of the hammer-sets resulting from regular usage of the instrument, which presents itself with the consumption and the crushing of the felts (or of the skins) and which entails the deformation of the tone-colour attributed to the instrument by the manufacturer. Over a certain level of consumption of the material the tone-colour can become almost unrecognisable;
3) the wear of the mechanics, which consists in the consumption and destruction of the perishable anti-friction and noise parts, entails the impossibility of bringing the object back to an efficiency which allows to newly subject it to the instrumental virtuosity stress.

Due to the absence of objective data which permits to define with certainty

the various tone-colour identities and the acoustic performance range of the antique pianos the recourse to acoustic research has been particularly important in order to obtain the initial reference data. In the future the accumulation of this type of data will contribute in objectively configuring the various tone-colour aspects.

Furthermore, the restoration suppositions have undergone verification through concert reutilization since the mere registration of the piano performances was not sufficiently reliable being it at times origin of inaccurate evaluations. Indeed, the interpreters and the audience are able to verify the extent of the possibility of restoring to the listener the subtlety and the breadth of the dynamic and tone-colour indications of contemporary pianistic literature only through the live utilisation of the instruments.

3. Restoration and replica of hammer-sets: two pianos Pleyel petit à queue of Gioachino Rossini

Regarding the question of the hammer-sets, it is to be underlined that the reutilization for interpretation of the instruments belonging to the typologies of the Romantic period and the decoding of the precious historical information and aesthetic suggestiveness which they contain, encounters today a serious impediment in the problem of the consumption of the felt hammer-sets, which are less resistant than those built entirely of leather.

If modern replica hammer-sets which can allow the use of the original hammer-sets only on particular occasions, thus preserving them from progressive destruction, are not available, the particular destructive modalities pertaining to the utilisation of the pianos do not allow to begin an executive praxis of some impact and diffusion for the pianos of the Romantic period.

The modern availability of such hammer-sets is hindered by a few particular technological aspects connected to the modalities of their consumption. The type of indispensable procedure, which had already begun to take shape in the fifth decade of the XIX century, provides for the use of particular machines for the application of the relevant thrusts (presently in the order of several tons) necessary for the gluing. At the present time, preshaped felt strips (much thicker than those used in the Romantic period) are utilised and their availability is possible only within a context of mass production. The supply of limited quantities of hammer-sets of a shape and consistency entirely different from the current ones

would therefore entail unsustainable productive expenses.

On this problem has been undertaken a research that has centred on the problem of the restoration and replica of the I. Pleyel hammer-sets of the Romantic period, on the occasion of the complete restoration of the Pleyel piano petit à queue n. 10966 of 1844, property of the City of Bologna and the petit à queue n. 11695, of 1846, part of the small collection of F. Ponzi. According to a journalistic testimony of the end of the nineteenth century (to be found at the Civic Museum of musical bibliography of Bologna) the first of the two instruments was supposed to be used by Rossini during his stay in Paris. As regards the Pleyel n. 11695 a handwritten letter by Rossini of August 10, 1846 (certainly from the Pleyel archive) , documents without doubt its purchase in that year by Rossini himself.

Among the most prestigious manufactures of this period was the one founded in 1807 by Ignace Pleyel, a musician who had been J. Haydn's pet pupil and was also a composer, editor and constructor.

Up to the third decade of the nineteenth century the piano hammer-sets were for the great part constituted by wooden support; covered with several layers of rather thin leather. The animal type from which the material was made, the thickness and the tanning procedure contributed in conferring the particular transient desired by the manufacturer to the instrument.

It is known that the piano hammers underwent a constant increase in weight and dimensions in correspondence with the increase of the chord strength between the second half of the 19th century and the end of the 19th century.

In the first decades of the 19th century the use of various materials was experimented. However, these did not diffuse on a large scale in the manufacturing process. In 1826 H. Pape, the ingenious manufacturer, who had begun his activity in Paris as Ignace Pleyel's employee, patented the felt covering which, in a few decades, would almost completely replace the one in leather.

The manufacturers slowly drew away from the nasal tone-colour taste (connected to the use of leather), that had characterised the classic piano. In Paris, up to the fourth decade of the 19th century, Érard and Pleyel superimposed felt on the hammers made of a lance-shaped wooden support (mahogany or maple), trimmed with two or three thick layers of leather. Later, Érard maintained a trace of the leather sub-felts almost only in the many-colour of his multiple woollen sub-felts while the Pleyel manufacture remained faithful to the leather sub-

felts (at times a cork layer was also applied). The constructive elegance of the Pleyel hammer-sets, which denotes small, yet constant typological oscillations in the choice of materials and in the thickness of the layers, testifies the refinement of the pursued result and documents the presence of rather peculiar and demanding auditory-perceptive abilities probably shared both by the manufacturer and the purchaser. In this aspect the urban environments of the time, subject to sound pressure levels which were lower than those of the present day, and the generally different socio-acoustic conditions, probably play an important part.

These subtle diversifications are justified within the particular tone-colour taste of this instrument, which aims at privileging the availability of very subtle nuances of pronunciation within a restrained exploitation of the acoustic resources of the soundboard. This character is connected to the musical praxis centred in halls of modest dimensions, and to the important costume represented by the "salon". With regard to this point we can refer to the creative experience of Chopin whom, as is well known, was an appraiser of the Pleyel typology.

Even the creative experience which Rossini dedicated to the piano in his later years took place in the circle of the salon of his Parisian home of Rue Chausée d'Antin. In this ambience periodic and exclusive soirées were offered to a selected public with the participation of some of the most important musicians of the time (among which Franz Liszt on one occasion).

For the objective delineation of the tone-colour characters of this typology and to direct the restoration, the replica and the intonation of the original hammer-sets, four different hammer sets have been compared since the present time:

ia) the hammer-set of the Pleyel piano n. 10966 (1844).

The felt is irreparably consumed especially in the 40 most acute hammers. The sub-felts, made of cowhide, elk skin and deer skin, are in perfect conditions. The leather and elk-skin layers, of which the former is harder while the latter is softer, are very thick in the lowest hammers. The deerskin layer is considerably softer and thinner. The outer felt has a lower density (about 0,30 g/ cm.3), than the one more frequently found in the Pleyel piano of about the fifth decade of the nineteenth century. The size of the hammers progresses with a gap and it draws away from the course of the strength as the following diagrams show.

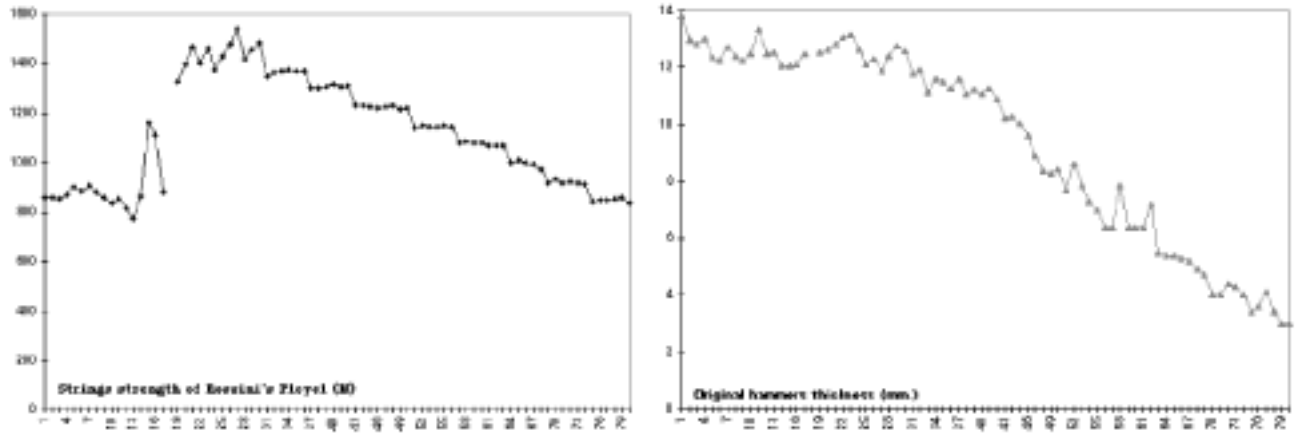

Fig. 1 - Strength and thickness in Rossini's Pleyel n. 10966

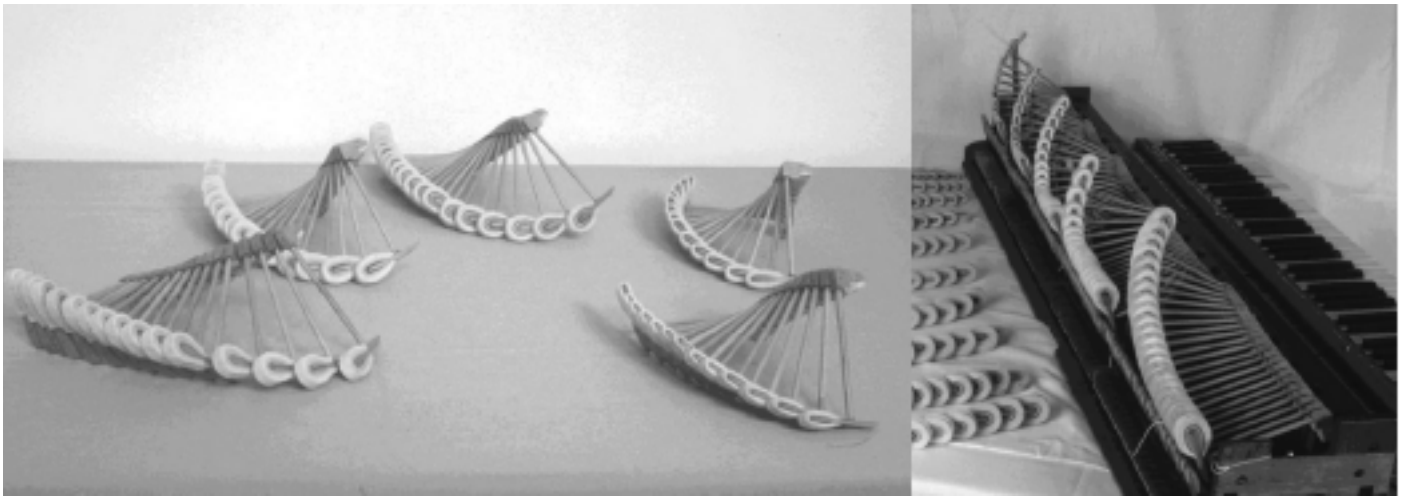

Fig. 2 - Replica of hammer-set in the Pleyel 10966. At the left the hammer-set with a lower density (about 0,30 g./cm.3), at the right the one with the higher density (about 0,40 g./cm.3).

No intervention has been made on this hammer-set, which in any case would have disregarded the principle of the reversibility of restoration procedures.

b) The hammer-set of the Pleyel piano n. 11695 (1846): This hammer-set was greatly decayed: much felt was broken at the top; 37 felts were missing; 14 hammers were completely lost. In this hammer-set the constructor left out the leather underfelt and put under the outer felt a big layer of elk skin and a small one of deer skin. The refelting has been executed in part with pure wool modern felt having a density analogous to the original one (about 0,40 g./cm.3). A few original felt strips which were still retrievable (those belonging to the lowest hammers) have been moved on higher hammers and slightly rotated.

The felt strips which were broken at the top have been utilised to form a new felt

strip which could give information in the comparison with the entirely refelted hammers, thus giving a precious verification of the efficiency of the modern material employed.

c) A first hammer-set replica, at the left of Fig. 2. The sub-felts are made according to the model of the Pleyel hammer-set n. 10966 (1844); the felt has a density similar to the original one.

d) A second hammer-set replica, at the right of Fig. 2. The sub-felts are made according to the model of the Pleyel hammer-set n. 10966 (1844); the felt has a density similar to the one found on the hammer-set of the Pleyel piano from 1846 (and more frequently found in the Pleyel firm about the middle of the XIX century).

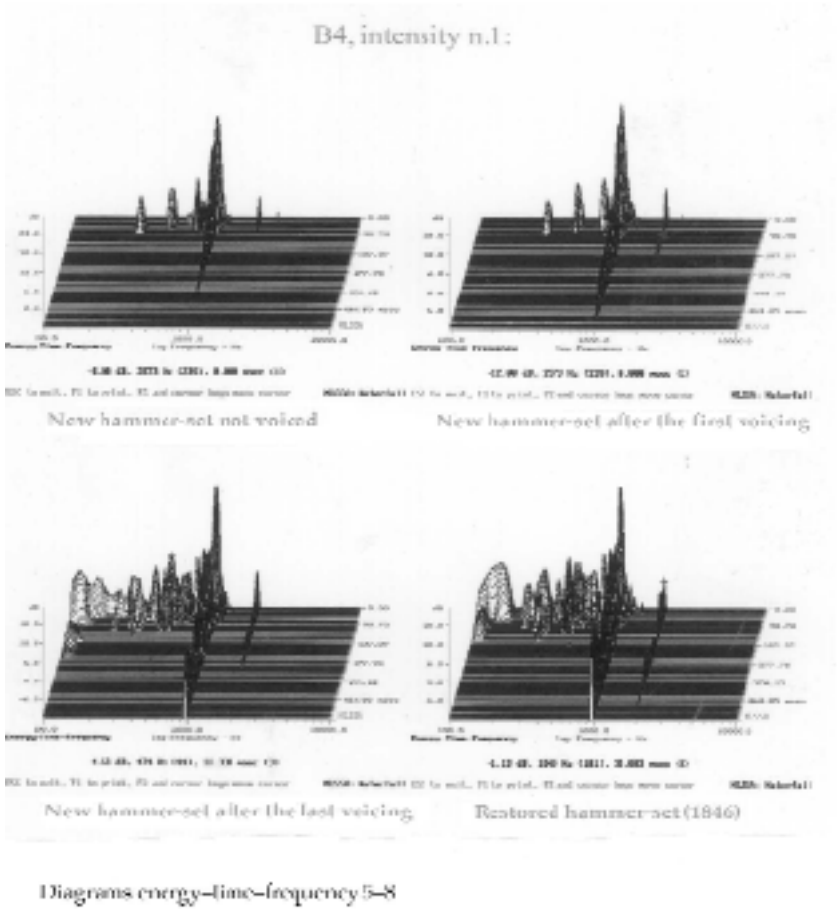

fig. 3 - Pleyel: waterfall on FA # 3 by hammer of SOL 3 with original and modern felt (up to down); shorter (0,223 s.) and longer (0,054 s.) time-window (left to right)

On this occasion have been utilised two different devices especially designed and

executed, which permit the control of the pressure and traction applied to the material.

It must be noted that the application of inadequate thrusts is the cause of a dull sonority and of unpleasant distortions in the transient, besides a drastic limitation of` the dynamic possibilities of the hammer.

The sound samples have been obtained through the mechanical stress of the key, by means of two electromagnets fed with four different voltages, in order to make the differences of progression in the response of the hammers in the various dynamic bands noticeable (corresponding to approximately the dynamic gradations: p, mp, mf, f).

It is to be remembered that very seldom these hammer-sets have been handed down to us in a state of preservation which permits to unquestionably document the exact size of the felts and the profiles of the hammers. Therefore, the replica hammer-sets have been constructed by applying an oversized thickness to the felts which initially produced an unpersuasive sound and a limited dynamic. The subsequent voicing interventions, aimed at bringing the replica hammer-sets to a satisfactory efficiency in the interpretation of the music of the Romantic period, particularly that of Chopin (who, as is known, preferred Pleyel typology) have substantially confirmed the reliability of the indirect measures to be found on the side-borders of the original hammer-set.

The acoustical analysis has been carried out analysing the wave-forms and the spectral analysis of seventy-eight keys out of eighty-two for each hammer-set (on the Pleyel n. 11695), with four degrees of mechanical excitation, as already mentioned, and gathering more than one thousand five hundred wave-forms.

With regard to the adequacy of modern felt used, it is possible to appreciate the similarity (Fig. 3) between the spectral shape in the transient on the same strings (F sharp 4) of two different hammers, the one gasket of original felt and the second refelted with modern felt (of the restored hammer-set of 1846).

Starting the analysis from the waveforms of the low frequency keys, here the comparison (Fig. 4) between the replica last voiced and the restored original hammer-set of 1846 for the key G 1. We could point out the increasing of the dynamic range in the new remade hammer, going from intensity 1 to intensity 4, while the waveforms are still quite similar.

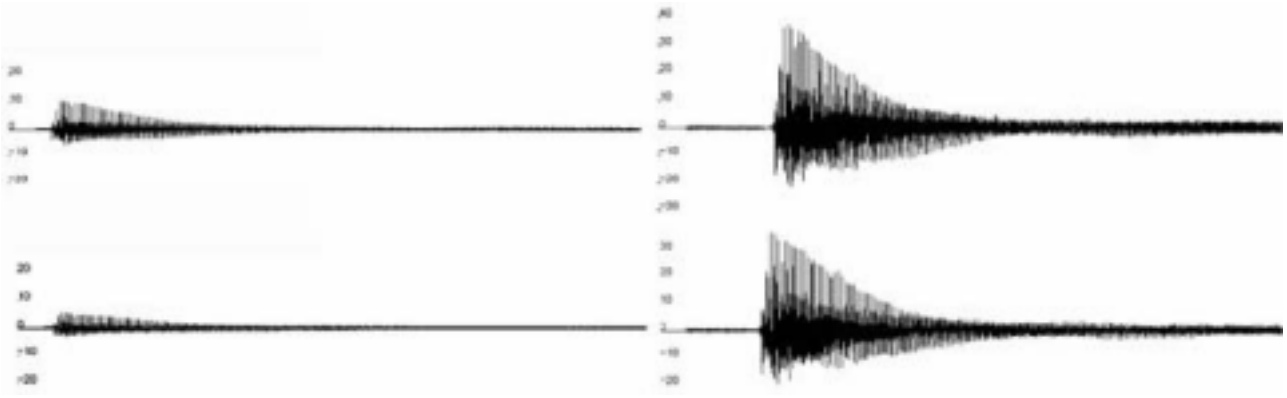

fig. 4 - Pleyel: SOL 1, second remade hammer-set below, and original one above (1844), after the last voicing: intensity 1 and 4

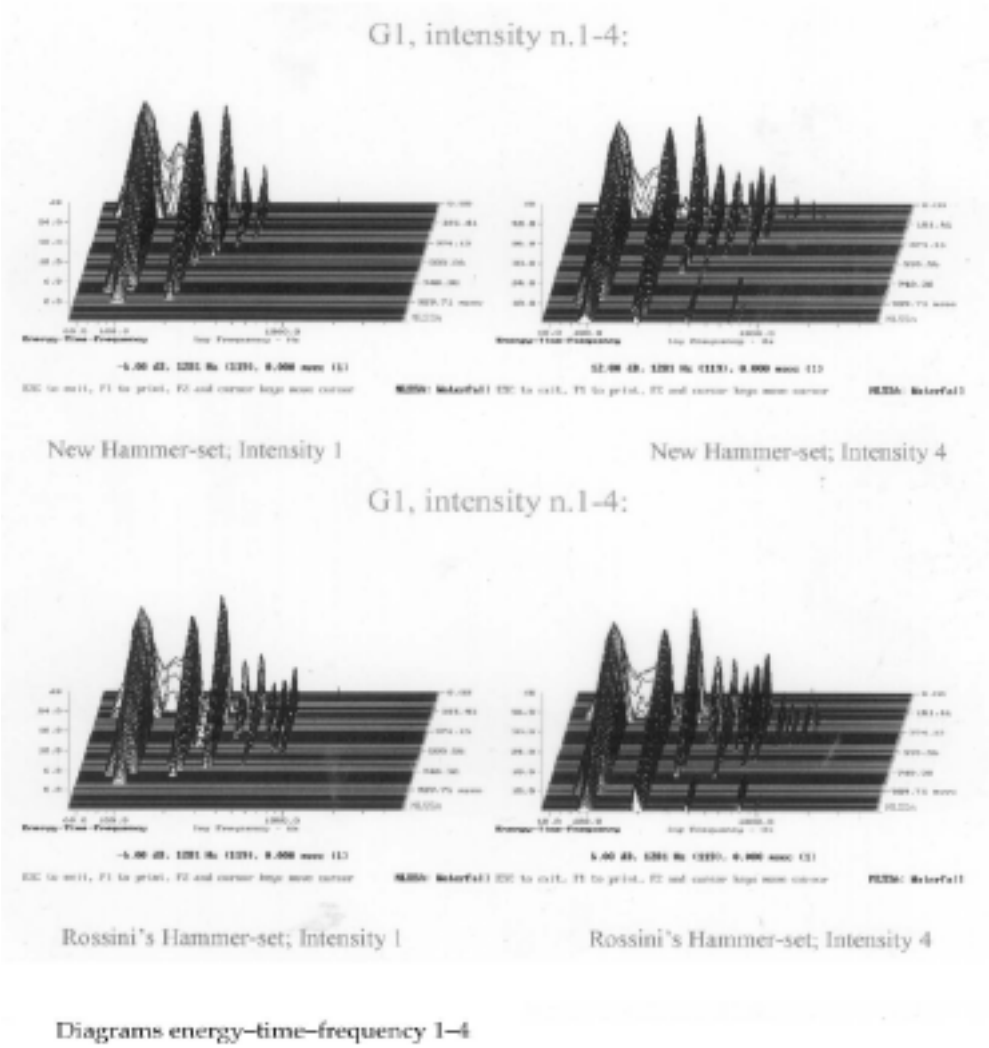

Fig. 5 - Pleyel: SOL 1, waterfall of second hammer-set replica (0,40 g/cm.3)and original one, after the last voicing; intensity 1 and 4

From a spectral point of view, in the comparison between the second remade hammer set and the original one of Rossini's piano (Fig. 5), it is possible to find out a rather similar configuration, except the greater content of higher harmonics

in the original hammer. In this connection must be remembered the consumption of the original felt, which makes the original hammer set not sufficiently controllable in the dynamic progression.

Having a look at the frequency analysis of the acute hammers (Fig. 7), the analysis points out that voicing has meant to increase the harmonics of the new remade hammer set, in comparison with the restored hammer set of 1846. The voicing of second remade hammer-set has been also validated by means of a performance, in which has been asked to a trained panel of students of the Faculty of musical heritage preservation, many of them graduated at the Conservatorium, to pay attention in thimbric and dynamic behaviour of the piano. The questions were randomly shuffled, in order to avoid bias error on answering.

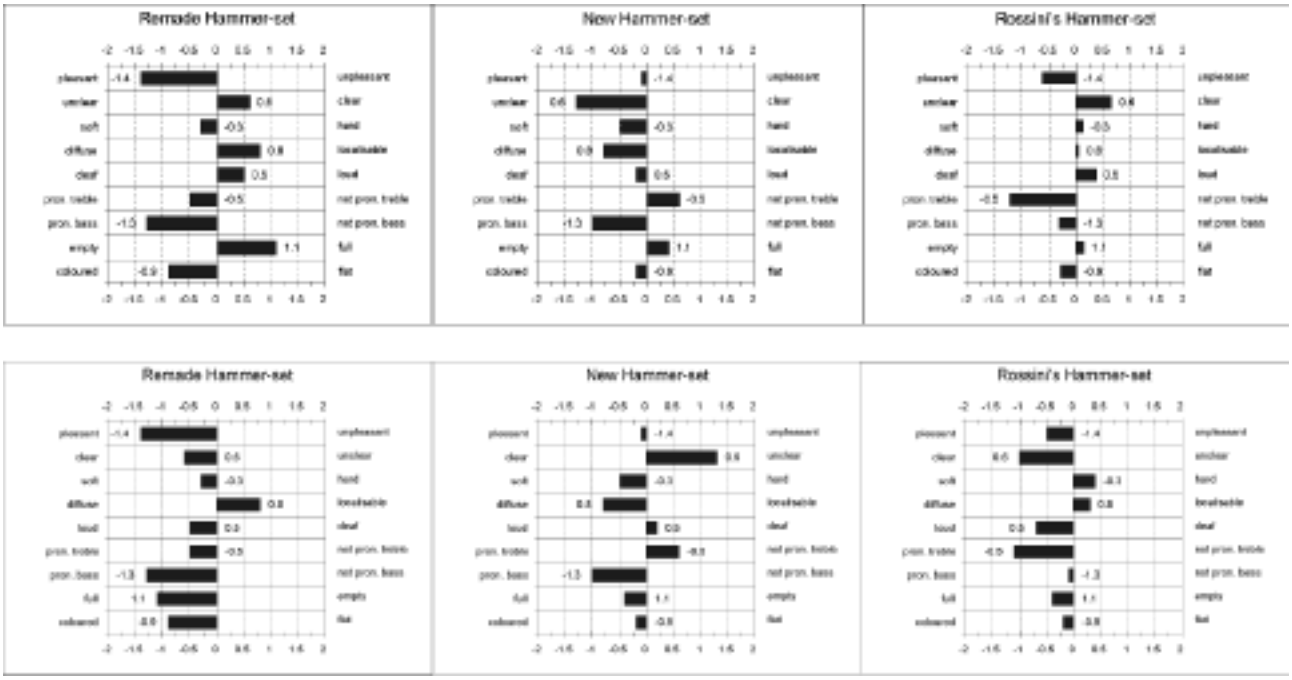

Fig. 6 - Average of answers to the questionnaires for different hammer-sets

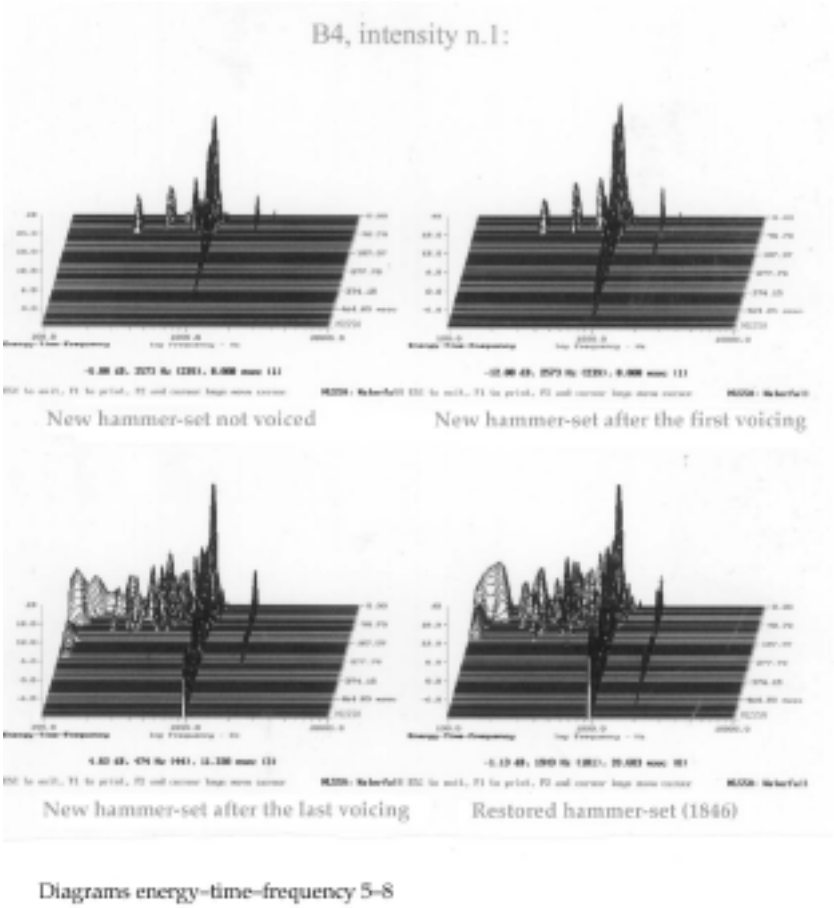

Fig. 7 - Pleyel: SI 4, voicing influence on sound quality

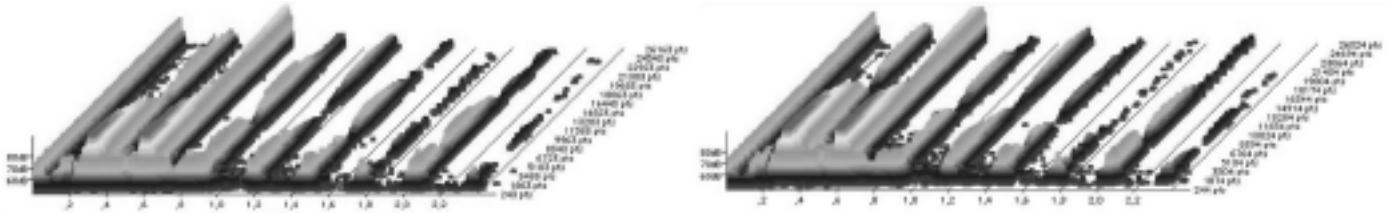

Fig. 8 - Pleyel, RE 3, from left to right: waterfall of original hammer-set already voiced (n. 10966, 1844), and of first remade hammer-set (0,30 g./cm.3). Intensity 4. Frequency: 289,6 Hz. Temporal window; 1,186 s. and 1, 193 s. Frequency range: 0-2500 Hz.

After the last voicing, the new remade hammer set has been utilised for a certain number of performances on the Rossini Pleyel of 11695 (1846) .

4. Permanent deformations of the soundboard: the restoration of a piano à queue Érard of 1852

The methods of intervention on the soundboard outlined here, have already been applied on four historical pianos of the nineteenth century:
1) J. Heitzmann, 220 cm., Vienna, sixth decade of the nineteenth century;
2) Steinway & Sons, 220 cm., New York 1868;
3) Pleyel & Wolff, 225 cm., Paris 1868;
4) Érard, 212 cm., Paris 1852.
Here will be presented some data relevant to the piano Érard à queue petit modèle, n. 23915 (1852). The cracks in the soundboards due to contraction are the consequences of either conditions of extreme humidity at the moment of the assembly of the instrument, or the difference between the average hygrometric level in the production place of the instruments (in general higher than the one in Italy), or the phenomenon of hysteresis. Such cracks have been repaired in excellent, rigorously controlled hygrothermic conditions.
The registrations of the samples, which are to be compared, have been done in conditions with an identical hygrometric level and temperature, as it is known that there is a relationship between the factors of humidity and temperature and the acoustic performance of the wooden chordophones.
The splits have been filled up with shims of material, homogenous to the original as regards the arboreal composition and the direction of the cut, that is spring picea abies Karst. These shims have been obtained by removing the summer part of the growth, which is harder. In fact, the cracks are being formed in the softer spring-part of the annual growth ring.
A more complex problem was the modification of the dispositions of the soundboard as a consequence of obsolescence. A change of 1 point in the balanced humidity brings with it a variation in dimension of 0.24% of the cross-direction of the picea abies Karst wood, cut in radial direction. The maximum width of the soundboards of the pianos of the nineteenth century can exceed 120 cm. Moreover, for the same wooden substance, the dimensional variations in longitudinal direction (which is of interest here, seen the disposition of the ribs) are almost irrelevant. These elements can give an idea of the relevant tensions between sounboard and ribs, caused by either the hygrothermic differences between the assembly conditions and the average working conditions, or the considerable hygrothermic swings usually verifiable in closed environments without adequate air-conditio-

ning units during the year.
Strong falls in the balanced humidity add an extra push, produced by the tendential dimensional contraction, to the vertical force of the cords on the bridges. The position of these bridges tends to be lower, in comparison with the original disposition made up by the maker, which modifies the size of the vertical force itself. This reiteration of such tensions makes a permanent strain component prevail over the initial, mainly elastic one, in the unit soundboard-ribs, which is under the stress of the horizontal and vertical traction.
At the moment the research is concentrated on the identification of the amount of impact of each of the following factors, all equally connected to modifications in the acoustic performance:
(i) lowering of the bridges;
(ii) decrease of the applied vertical force;
(iii) prevalence of the permanent component of deformation.
The maintenance of the original disposition of the unit soundboard-ribs was probably a common problem for the makers of the nineteenth century. In some particularly well preserved instruments we can verify the convex profiles given by the makers to the unit soundboard-ribs in order to compensate the vertical strength exerted by the cords on the bridges (Fig. 9).

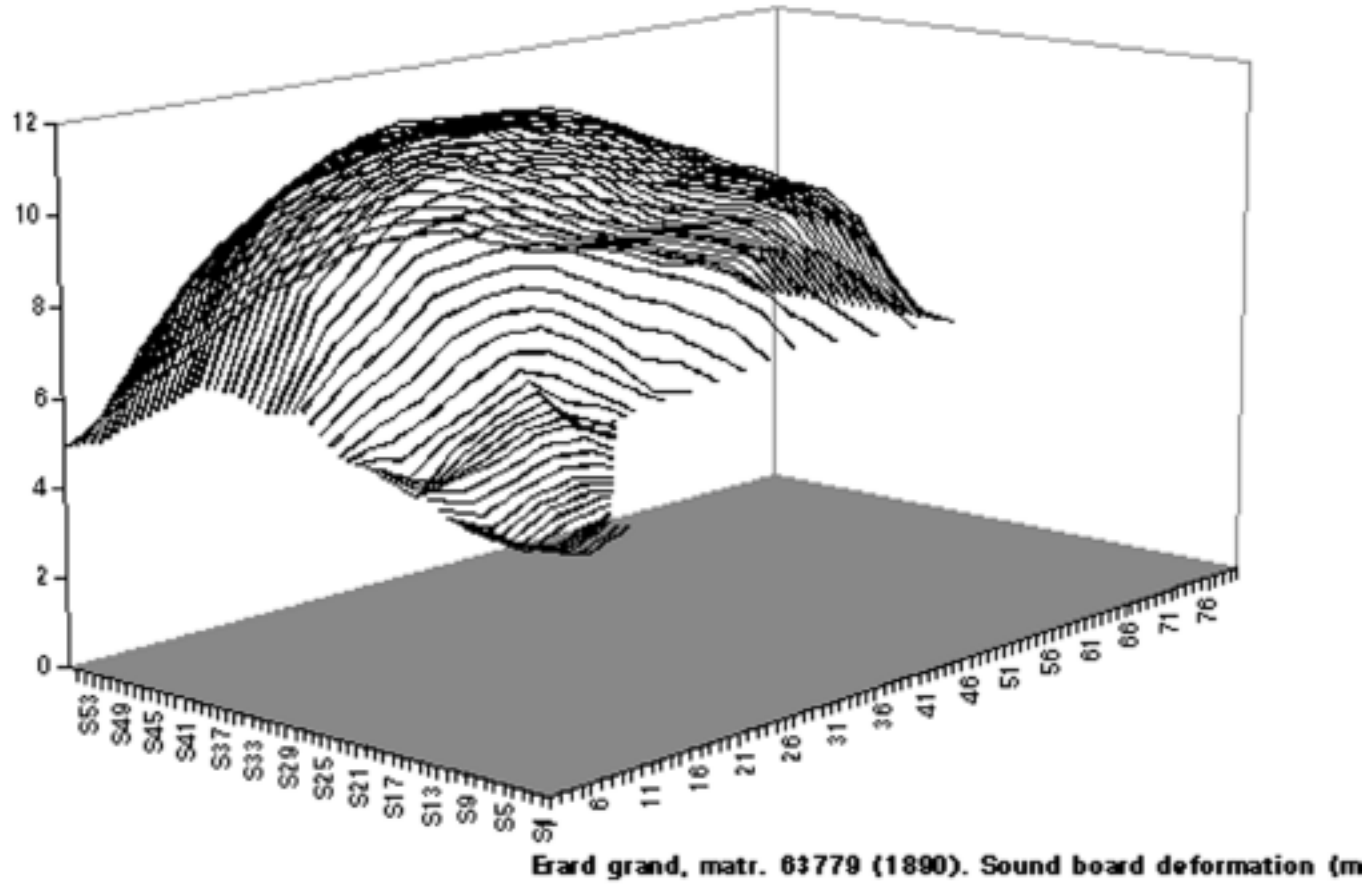

Fig. 9 - Soundboard disposition of Érard Grand, 1890

Sometimes (as in the case of the Pleyel of 1868), the complete disassembly of the soundboard has allowed to study the attribution of the slightly lifted profiles of the impost on which the soundboard must be glued. In the seventh decade of the nineteenth century, in the Steinway pianos, a device was applied to put tension on the bigger ribs of the soundboard, which thus exerted a strong push on the points of the ribs themselves.

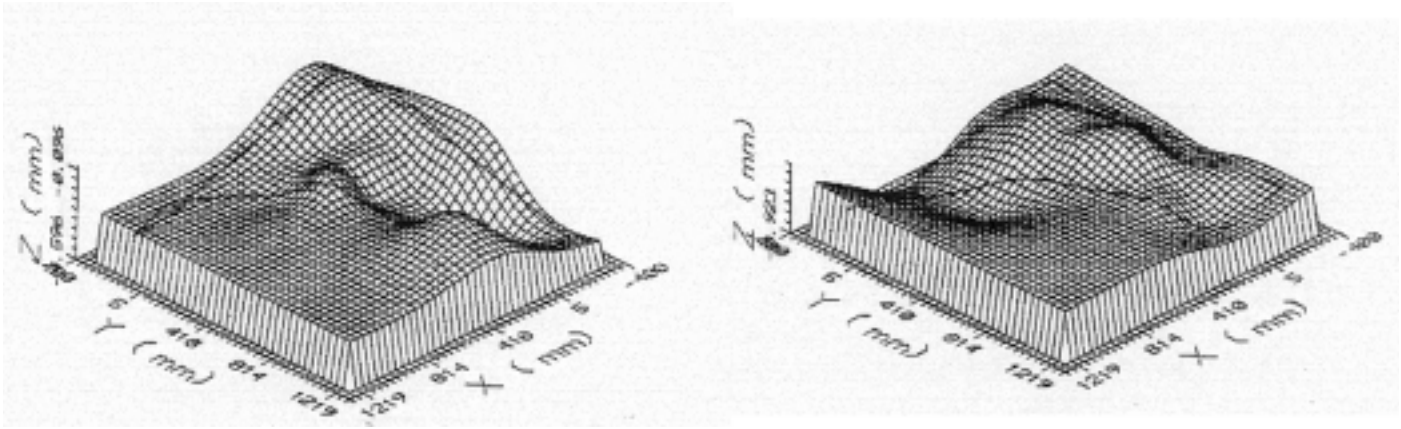

Fig. 10 - Displacements before and after restoration (up to down)

In the course of the complete restoration of the Érard piano à queue petit modèle of 1852 the complete disassembly and the consequent re-assembly of the unit soundboard-ribs have been carried out in order to provide the instrument with a disposition, close to the original, which was modified by the obsolescence.

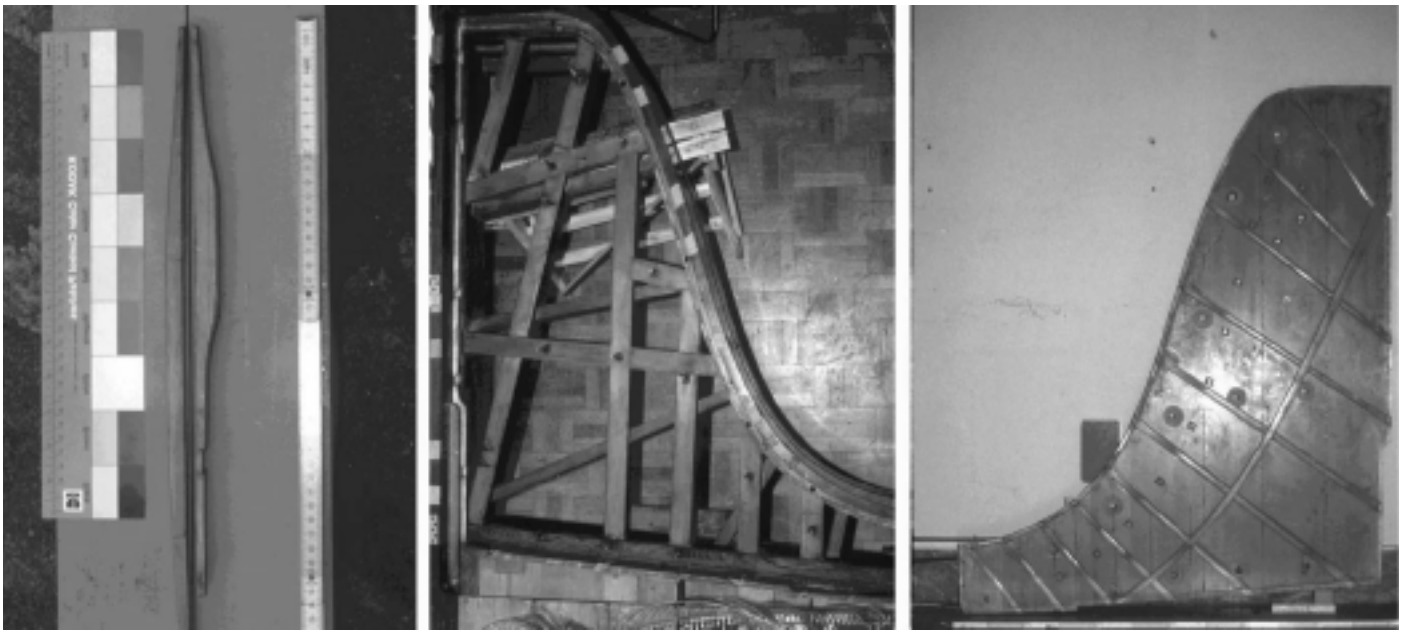

Fig. 11 - From left to right: disassembled ribs, wood frame, and soundboard of Érard n. 23915.

Recordings of acoustic samples before and after the restoration have documented this intervention.

Fig. 10 shows the disposition of the soundboard before and after the restoration, with frame and disassembled cords. The intervention has resulted in an almost perfectly level position of the soundboard with tense cords, after the restoration. In fact, it is worth considering that the repair of the vertical and horizontal strength of the cords has brought with it a lowering of about 4 mm. in the points, which have been moved most.

Fig. 12 - Displacements of the bridges before and after restoration of Érard, 1852

Fig. 12 documents the displacements of the bridges on the intersection point with the cords before and after the restoration, and Fig. 13 the horizontal strength to which the instrument is subjected.

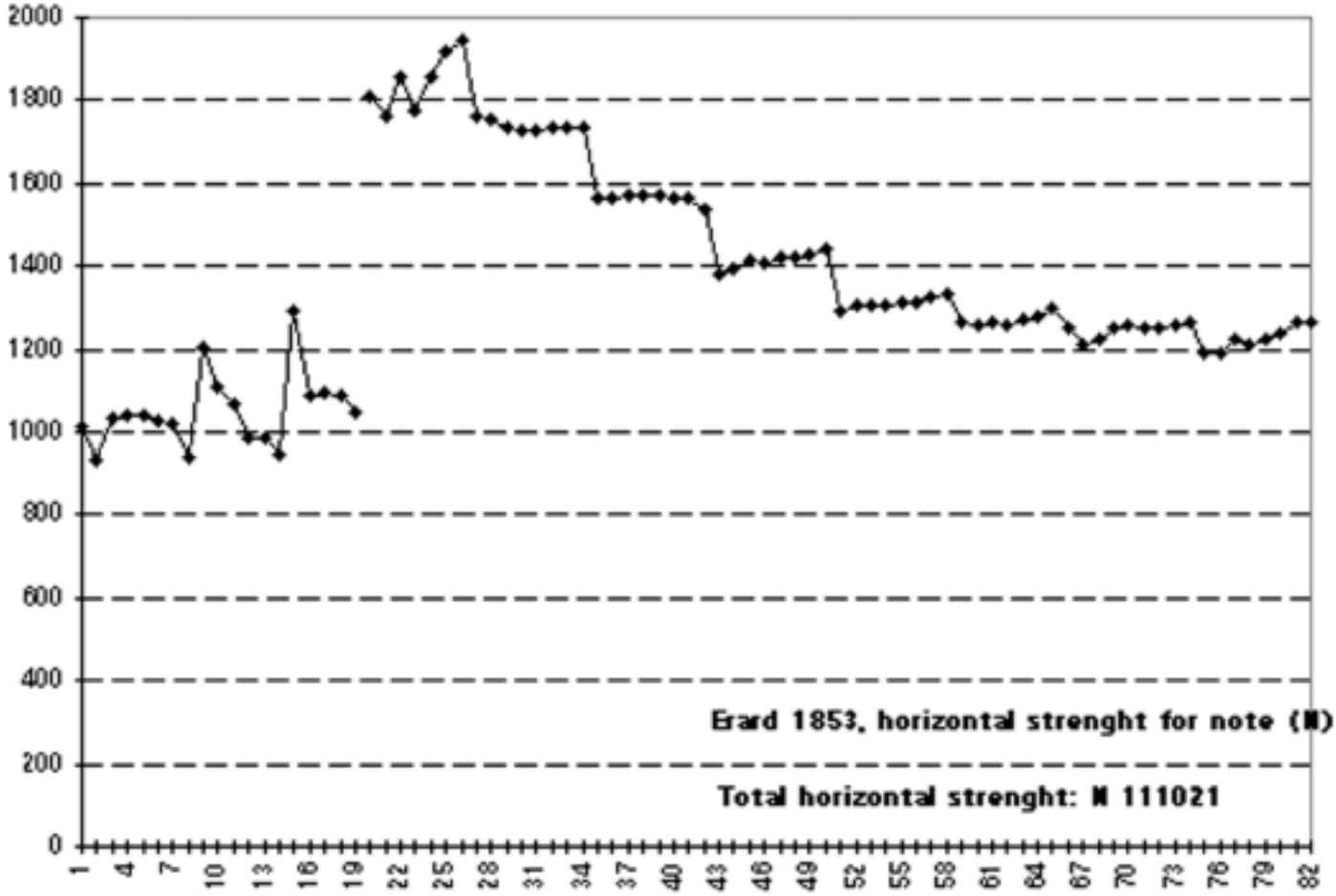

Fig. 13 -Horizontal strength of Érard, 1852

Before recording the sound-samples, the action has been restored in perfect working conditions. The tone of the hammer-sets (which was already in excellent preservation conditions) has not been touched again. The acoustic sample material of two notes for every octave has documented the phonic performance of the instrument before and after the restoration.

The acoustic analysis seems to demonstrate major modifications of the space-time configuration in correspondence with the points of major variations of the physical disposition before and after the restoration.

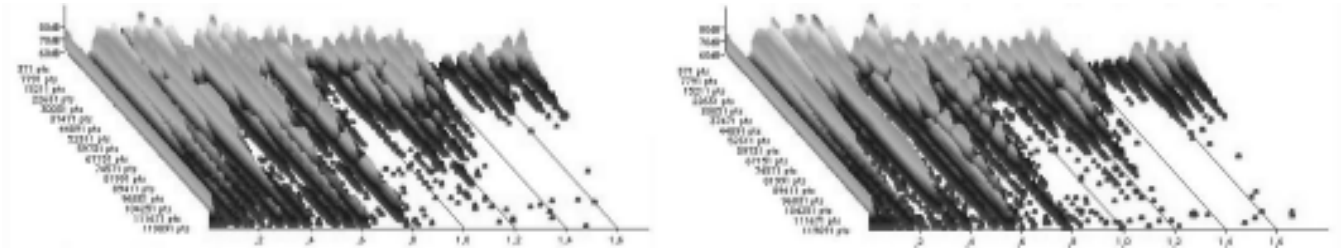

Fig. 14 - LA 0: waterfall before and after the restoration for Érard, 1852. Intensity 4. Frequency: 54,834 and 54,752 Hz. Temporal window: 9,924 s. Frequency range: 0-1800 Hz.

The waterfalls at Fig. 14 visualise the note LA 0. Major modifications of the recorded sounds before and after the restoration are verifiable in the waveforms and waterfalls on Fig. 15-16 and 17-18, relative to the notes MI 1 (n.17) and MI 2 (n.29), on which the restitution of a level disposition of the soundboard has coincided with a relevant shift of the bridges.

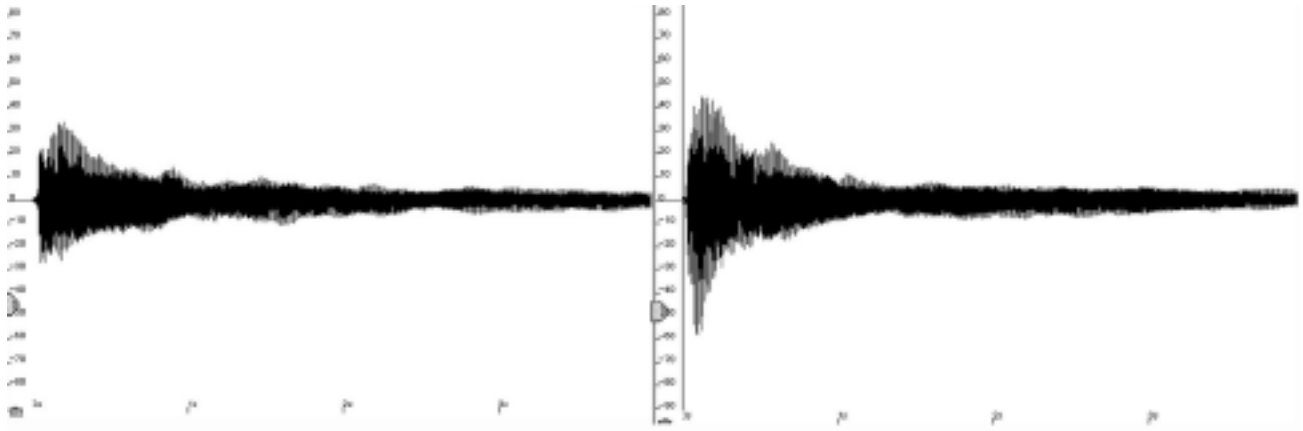

Fig. 15 - MI 1 before and after the restoration waveforms for Érard 1852.

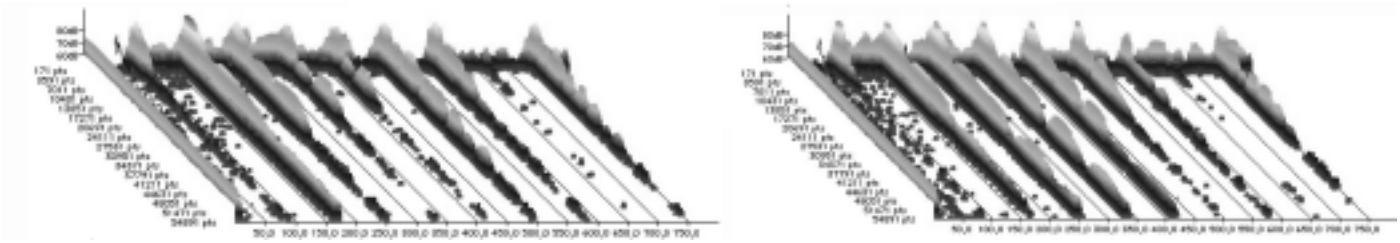

Fig.16 - MI 1 before and after the restoration: waterfall for Érard, 1852. Intensity 4. Frequency: 82,357 and 82,575 Hz. Temporal window: 9,865 s. Frequency range: 0-800 Hz.

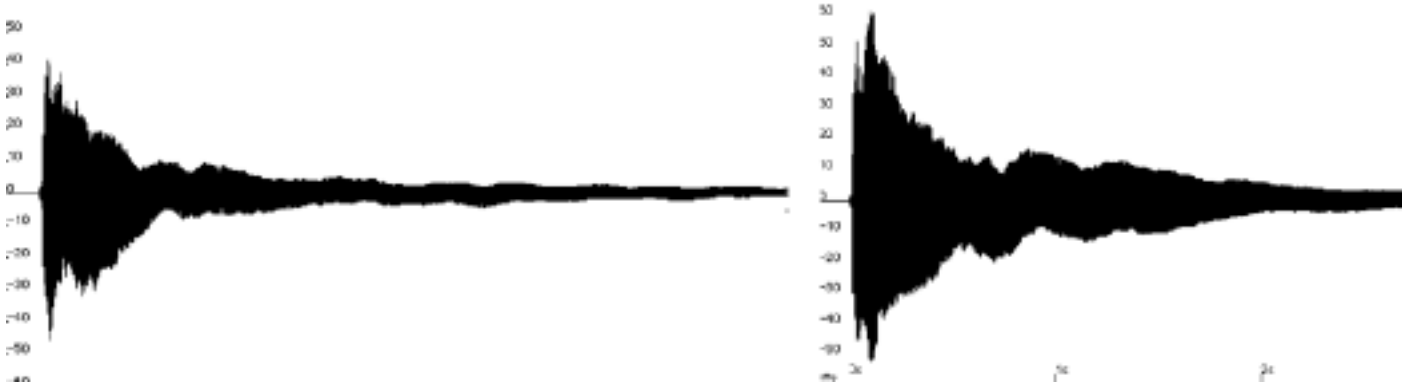

Fig. 17 - MI 2 before and after restoration: waveforms for Érard, 1852

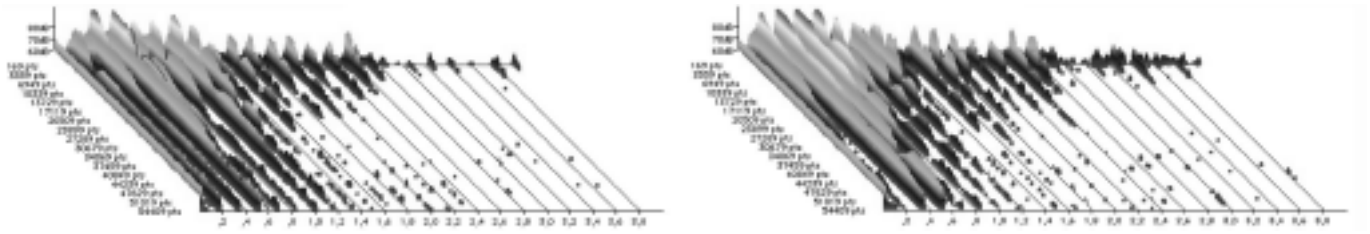

Fig. 18 - MI 2 before and after the restoration: waterfall for Érard, 1852. Intensity 4. Frequency: 164,48 and 164,98 Hz. Temporal window: 4,935 s. Frequency range 0-4000 Hz.

Of course, these first data need numerous further experimental applications, before one can formulate conclusive judgements.

5. Conclusions

The methodology of the intervention of which have been presented some aspects here, is concentrated on the quantitative verification of the executed interventions during the tone-colour restoration of the instrument, which represents in this approach the "heart of the problem" of the intervention on historical musical instruments.

The search for the "characteristic" sound of the various pianistic typologies of the nineteenth century is thus performed through, on the one hand a physical-acoustic analysis and on the other through the interpretative musical investigation with the contribution of the specialist pianistic culture of the Romantic period.

The numerous instruments restored until now within the research conducted by the Echo pianoforti storici have been used for concert-interpretation and for specialist registrations.

The meeting of the various disciplinary fields, scientific and aesthetic, can orientate the musical research on its whole, towards the restitution of a full knowledge of the tone-colour culture of the romantic piano.

6. Acknowledgements

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