ACOUSTIC AND DYNAMIC CHARACTERISATION OF DIFFERENT HAMMER-SETS IN THE ROSSINI PIANO PLEYEL "PETIT A QUEUE" RESTORATION

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1. ABSTRACT

This paper is intended as a contribution to defining the acoustic and dynamic characterisation of restored hammers of pianos of the romantic period. Many authors developed different solutions in order to achieve a general characterisation of the interaction between hammer and string, ranging from Hall to Askenfelt and Jansson [1-5]. This research has been developed from a different point of view, being developed in a close conjunction between the restorer and the acoustician, taking into account the need of the "romantic performer" to play a restored instrument that could be able to give the sound efficiency as close as possible to the original one.
The research has been carried on starting from the restoration of the pianoforte Pleyel petit à queue of G. Rossini, conserved at Municipal Musical Museum, in Bologna.
The aim of the research is to give a contribution in order to define the timbre of the piano of the romantic period. Being the Rossini's Pleyel still under restoration, the research has been extended to the hammer-set of another Pleyel petit à queue (NR. 11695) built in 1846.
The acoustic analysis has been carried out by analysing the original hammers of the Rossini's piano with a properly remade hammer-set and with the Pleyel hammer-set of 1846 recently restored in a "petit à queue Pleyel".
A compared Fourier analysis on all the notes of the keyboard between the three hammer-sets, with different degrees of excitation, has been performed. A proper questionnaire has been developed, in order to point out the differences in timbre and dynamics with the different hammers. Subjective tests have been conducted, gathering many questionnaires among trained and sharp-eared musicians after a performance of two pianists, showing an interesting difference in sound efficiency between the different hammer-sets.

2. INTRODUCTION

The Pleyel piano set-ups of that time foresee the alternative use of hammers, which reflect a transition period within the exclusive use of leather (typical of the early piano types) and the prevalent use of felt (typical of the romantic and contemporary pianos), introduced by H. Pape in 1826. Underneath an external covering in rather soft wool felt (density ranging from 0.30 to 0.40) it was applied a combination of leathers of different origins: bovine leather, elk and deer skins or even cork. Felts and the materials under them were not glued together in the areas of the hammerheads. The mutual combination of felts and various supporting materials guarantees to these instruments a peculiar nasal timbre, typical of the early piano types and allows to the

performer the fine graduation of the progressive reaction of the hardest parts of the hammers when hitting the keys. The relatively low felts' density moderates the transient's percussion effect, stressing a flute-like brightness in the trebles.
The preference for this timbric solution was linked to the relatively small dimensions of the concert halls (The Salle Pleyel, in rue de Rochechouart, and in those times a centre for the musical life of Paris, could host an audience of about 250 people) and with the importance of the "Living Room" in the cultural and social life of the period.
The feature of the felt influences many acoustical parameters. For instance, the interaction hammer-string is very sensible to the hysteresis phenomenon of felt, and influenced by the intensity of force-compression ratio. The differences between hardness and softness in hammers are characterising the non-linear acoustic behaviour of hammer, causing changes in tone ranging from bass to treble and from low to high intensity. Loud notes sound brighter than soft notes, being characterised the first by few higher harmonics, the second by a richer power spectrum. Contemporary piano are made by a wool felt, having hardness ranging from a softer value in the outer surface to an harder value in the inner one.
The contemporary hammers are built with wooden moulding covered with at least two layers of compressed wool felt. The hardness of the felt produces a gradient between the inner and the outer of the hammer markedly lower of the middle of the nineteen-century.

3. RESTORING AND REMADING THE HAMMER-SETS

In the last century piano, the hammer-sets are the least durable component, especially the felt covered ones: When the hammers strike the strings, the felt become grooved and flattened, losing material especially in the contact with the string changing the original tonal behaviour given by the piano maker.
The hammer-set of the Pleyel belonged to G. Rossini (built with a mahogany support) is covered with a very soft felt layer (the density is presumably around 0.30), wrapped around a combination of three leather types: bovine (with the same consistency of hide), very hard elk skin (even if softer than the inner layer) and deer, substantially softer than the other layers. The progression in the leather-felt layers' thickness is not proportional to the string traction. This as well contributes to the differentiating of the instrument's sound in the various tonal bands.
The upper felt layer is extremely worn, but it is possible to approximately estimate the original thickness, since on the sides the felt still has the typical concave profile, result of the cutting of the different hammers from a whole wood bar. It is hard to judge - in any case - the loss of material in the form of dust as a result of the reiterated hits of the hammers on the strings.
The thin layer of felt on the hammer's parts in contact with the strings should invoke our prudence in judging the hearing impressions and the waveforms obtained from this hammer-set. Due to the felt's conditions, it has been decided not to intervene on the original hammer-sets.
The research has been extended to the hammer-set of a Pleyel petit à queue piano (NR. 11695) manufactured in 1846. This instrument has dimensions which are nearly identical to the one belonged to Rossini and it is equipped with the same kind of action (English grand action).

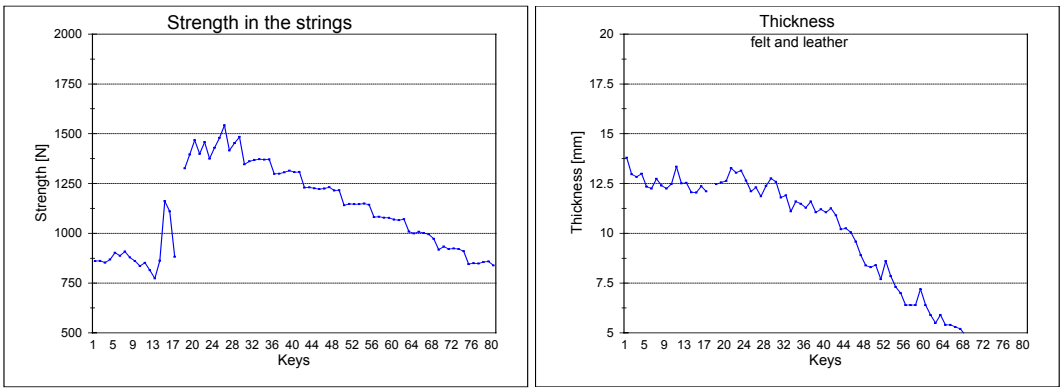

Fig. 1 Strength and felt thickness

The string traction is slightly increased, and slightly different is the hammer-set type, covered with higher density felt (about 0.40), usually employed on the Pleyel pianos of that time. The acoustical tests have been carried out on this latter instrument, which restoration had been already completed at the time of the research.
It has been decided to execute two complete and integral replicas of the eighty hammers, including rods and forks, in order to use Rossini's piano as soon as it was restored with both felt densities found in Pleyel types. For this purpose a made-to-measure machine allowing the metering of both traction and circular pressure applied to the materials.
Furthermore, the acoustical tests have been extended to the hammer-set of the other piano, restored employing the original felt on 51 of the 82 hammers and new felt on the remaining ones.

4. ACOUSTIC ANALISYS

The waveforms have been collected in different phases after the toning process, as soon as the hammer-set had been produced.
The three hammer-sets underwent the acoustical tests in equal conditions, i.e. with the escapements in direct contact with the leather cushions, and with the idle position at mm 2 approximately from the springs.
The sound samples, ranging from 3 to 7 seconds, have been obtained through the mechanical percussion of 78 keys, applying four different progressive intensity gradations at a constant humidity of 55% and at a temperature of 22° C. At the present time more than nine-hundred samples have been obtained and analysed.
The acoustical analysis confirms the hearing impressions regarding the need of conferring to the newly built hammer-set a wider range as far as the frequency response is concerned, track has been kept regarding the physical modifications executed with the first toning.

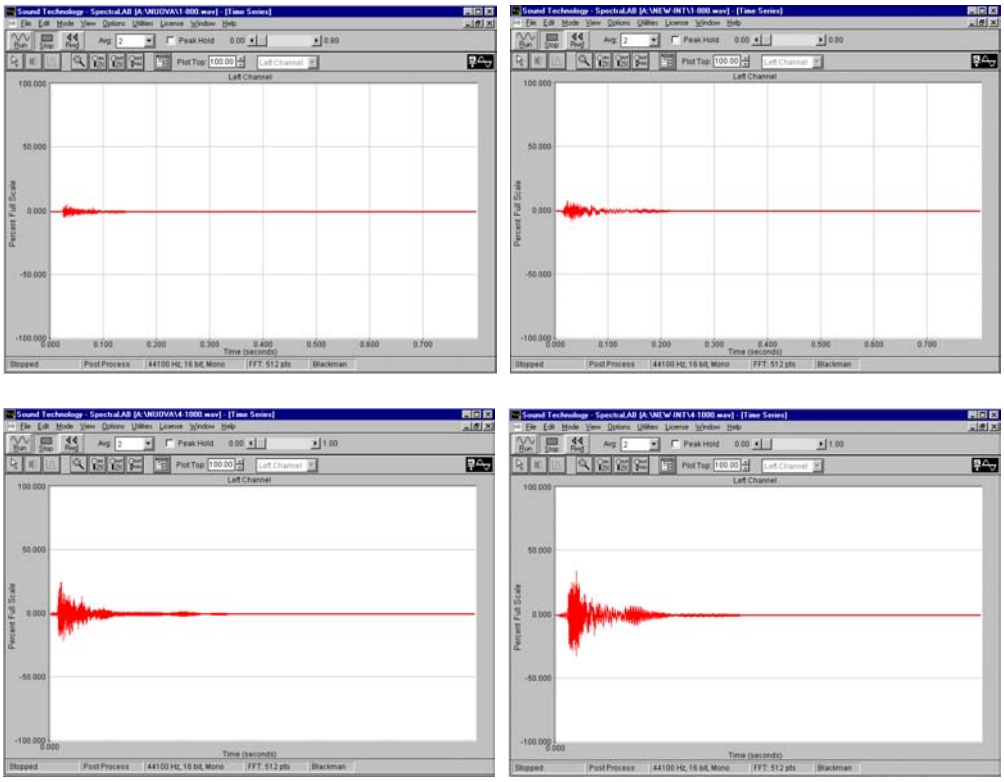

Fig. 2 Waveform for the note G 1, intensity 1 and 4

In fig. 2 the increase of width of G 1 ranging from intensity 1 to 4 is shown (up to down), with some modifications in the waveforms due to the first toning (left to right).
The first toning has been achieved by a slight heat compression of the felt together with the string print.
The toning has allowed the temporal extension of the transient, together with the amplification of the harmonic components to be found in the initial phases of the acoustical propagation.

5. SUBJECTIVE EVALUATIONS

The sound samples analysis has been combined with some psycho-acoustical tests carried out with a audience of ten musicians. Two pianists have performed some F. Chopin compositions, changing the hammer-sets.

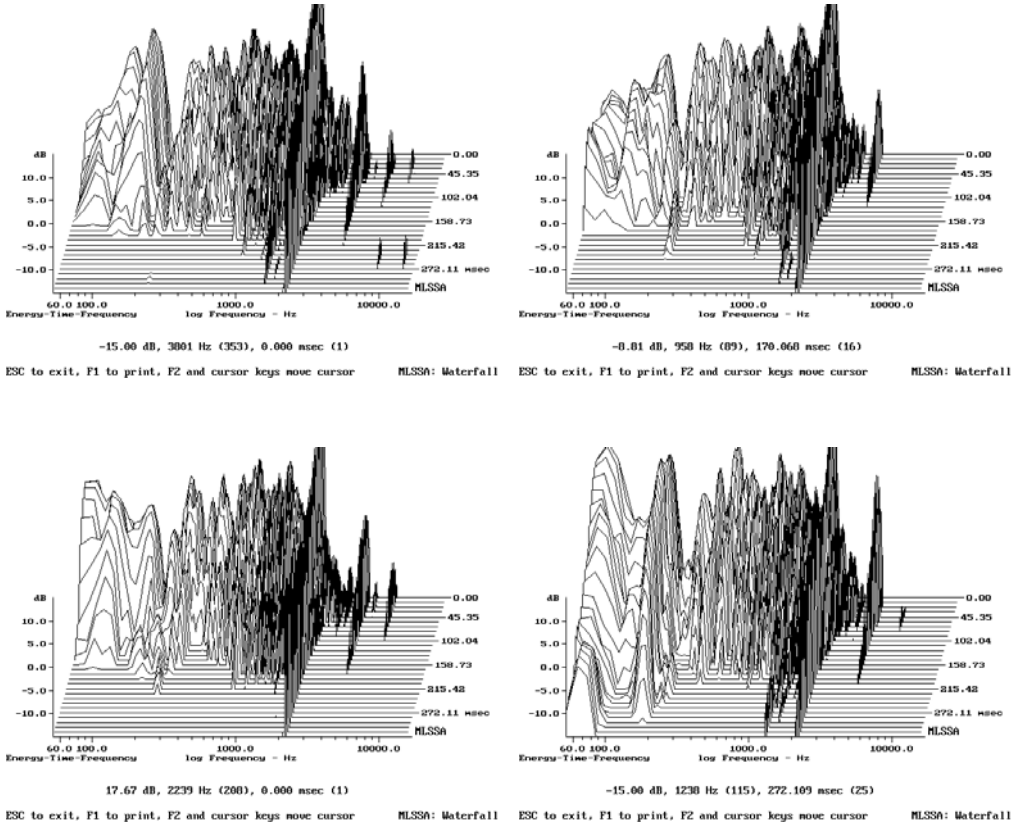

Fig. 3 Energy-time-frequency plot for the note C# 6

The tests have been carried out either with live performances either with digital recordings of the same. The trained panels of musicians have been interviewed, with the output judgements randomly shuffled between the right and the left side of the forms, to avoid visual or emotional influences linked to the result locations on the output sheets.

Following to what has been already developed by other authors [6] to the interviewed were asked to pay particular attention to the different aspects of the acoustical perception, ranging from the tonal quality to dynamic characterisation.

During the enclosed tests, carried out before the toning of the new hammer-set, the interviewed have shown a preference towards the restored one, performing a better frequency response and a wider dynamic range. Further tests will be carried out while toning the new hammer-set and the restored one.

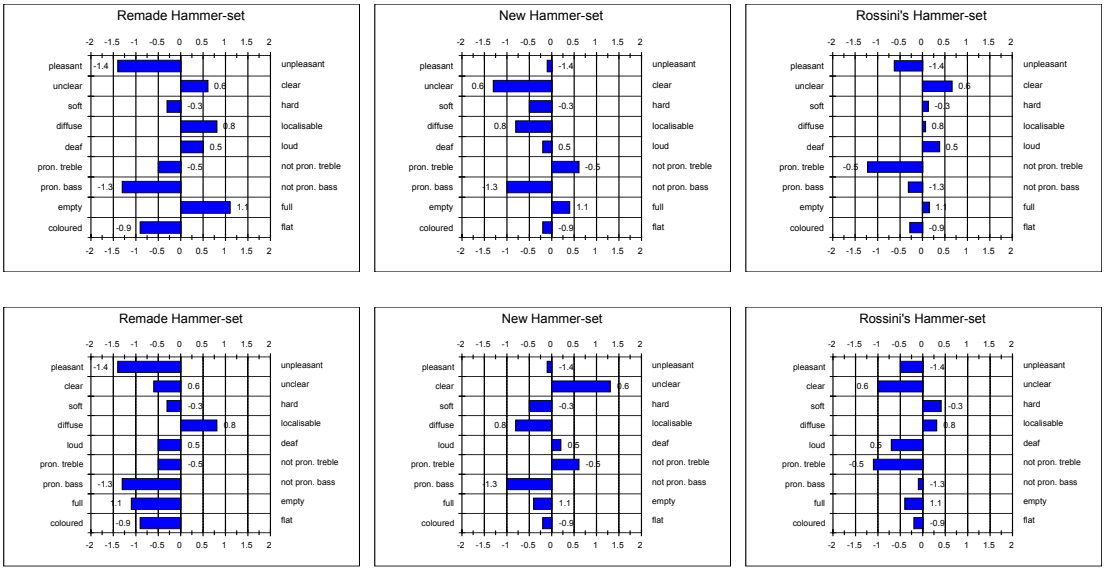

Fig. 4 Averaged subjective randomised (up) and normalised (down) results for the three hammer-sets

6. CONCLUSIONS

This contribution to defining the acoustic and dynamic characterisation of restored hammers of pianos of the romantic period allowed to define a synergetic link between the research about the restoration and the physical-acoustical research. The various waveforms obtained in each and every experimental session may contribute together with the philological and the interpretative research the consolidation of some objective data to comply with the aesthetical evaluations.

7. REFERENCES

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