Journal of Cultural Heritage xxx (2017) xxx–xxx

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Wooden Musical Instruments Special Issue

18th and 19th French harp classification using vibration analysis

Jean-Loïc Le Carrou [a,*], Sandie Le Conte [b], Joel Dugot [b]

[a] Sorbonne Universités, UPMC Univ Paris 06, CNRS, LAM/Institut d'Alembert, 4, place Jussieu, 75252 Paris cedex 05, France
[b] CRC, USR 3224-ECR Musée de la Musique, Cité de la Musique - Philharmonie de Paris, 75019 Paris, France

ARTICLE INFO

Article history:
Received 9 March 2015
Accepted 6 April 2017
Available online xxx

Keywords:
Musical instrument
Cultural heritage
Vibrational analysis
Concert harp
Erard
Cousineau
Classification

ABSTRACT

Most heritage musical instruments are not played anymore for conservation reasons. Most of the time, each instrument is the only representation left of a style or a historical period. This is coherent with the museums' task, which is to present diversity in makers, making processes, materials, etc. It is thus interesting to study not only an instrument but also its evolution according to music history or to technical evolution. Studying the whole production of a maker allows a better understanding of his know-how and his technical evolution. Nevertheless, the museum audience has no way to evaluate the acoustical properties of these historical instruments except when a copy (or fac-simile) is ordered. This paper intends to apply a global vibrational analysis on the harp corpus of the Musée de la musique to understand the consequences on the potential acoustical behaviour of the different construction techniques used by two famous harp makers, Erard and Cousineau. The idea is to survey the whole corpus, using the least invasive techniques which are still effective when applied to instruments in a conservation state and to define a vibrational descriptor able to represent different making strategies from the acoustical point of view. Whereas usual descriptive measurements do not discriminate Erard and Cousineau harps' acoustical behaviours, vibrational measurements, which are strongly influenced by construction techniques, do give this possibility.

1. Introduction

The study of historical musical instruments can be done from many different approaches. Wood scientists are interested in accessing to aged wood to understand the ageing of some species [1]. With this understanding, they hope to develop an accelerated ageing process to offer aged wood to makers. Some authors are studied the surface layers [2,3] of the musical instruments and their conservation within cases. Some others consider the static deformation of the mechanical structure due to hygrometric variations or string tension [4,5]. Most of these studies on historical string instruments [1,2,4] deal with the violin and very few deals with several instruments, which allow comparisons. In these studies, the instrument is generally considered in its static state whereas musical instruments were designed to radiate sound and therefore to vibrate. However, one study uses real historical violins to compare their spectrum in a playing configuration [6] but this kind of study requires that instruments are kept in playable conditions, which is not always the case. The pressure of cultural heritage requires replacing the playing of the instrument with alternative measurements. How is it possible to characterise the acoustic properties of instruments, which are muted because of conservation rules? Nowadays when a musical instrument joins a museum collection, it becomes a cultural heritage object that is loaded with a new cultural value in relation to its connection to history, music and culture. However, this implies changes in the criteria that attribute value and interest to the instrument: its historic role and connections, its rarity, its peculiarity of shape and material. These criteria may become more relevant than the quality and power of its sound or its usability for concert repertoire. In this context it becomes essential to think about methodology and tools of study which exclude putting those instruments under a mechanical stress such as string tension (typically more than 4500 N for a 41 strings harp) [7], and, of course, any destructive analysis. Le Conte et al. [8] applied near-field acoustical holography to track the restoration process of a famous XVIth century harpsichord by following modal frequencies. This technique allows the capturing of operating deflection shapes close to resonance frequencies. While this technique is quick in comparison to other modal analysis methods, it is still time consuming and not always easy to setup when a whole corpus has to be studied. In this context, a comparison of historical instruments requires developing methods, which have to be repeatable, reproducible, quick and independent of the acoustical environment. Mobility measurements, defined as the ratio between

* Corresponding author.
E-mail address: Jean-loic.le_carrou@upmc.fr (J.-L. Le Carrou).

http://dx.doi.org/10.1016/j.culher.2017.04.007
1296-2074/

Fig. 1. Harp exhibition in Musée de la musique.

the velocity to a force applied on the structure at a given point [9], could be good candidates. By using criteria based on these mobility measurements, classifications linked to the structural modification of a set of musical instruments were recently successfully performed [10–13]. The aim of this study is therefore to apply such vibratory measurements to a historical harp corpus and to interpret the data in relation to the structural evolution of the harps.

The Musée de la Musique in Paris preserves 31 pedal harps built in France between the 18th and the 20th centuries (Fig. 1). This interesting collection allows a deep comparative study between two famous makers of this period: Erard and Cousineau.

In the first section, the studied corpus, i.e. harps built by Erard and Cousineau, and their role in the historical evolution of the harp is presented. In the second section, a multidisciplinary method used to compare the instruments of the corpus is described: it is based on the method usually carried out by curators added with a method based on the mobility measurement classically performed by researchers. Finally, we present results obtained from these complementary approaches in order to characterise the two makers (Erard and Cousineau) and their know-how.

2. Instrument's corpus

2.1. Cousineau and Erard, famous French harp makers: the historical context

The pedal harp such as we know it today made its appearance during the first 30 years of the 18th century in South Germany. With regard to the harps which had preceded it, the novelty of the pedal harp consisted of the integration of a system to shorten the strings with "hooks", activated by 7 pedals (each pedal corresponding to a note of the scale, for example if the D pedal is pushed then all the D notes of the instrument are raised by one semi-tone). This mechanism allowed changing the key of the diatonic tuning giving a semi-chromatic instrument. The role of Queen Marie-Antoinette was important in the process of introducing this fashionable instrument, first to Paris and then to the whole country. Not only did she play the harp (as it can be seen on the painting by Gautier Dagoty, kept in the Palace of Versailles's collection), she also encouraged the establishment of German artists and craftsmen such as J.-H. Naderman in Paris. French makers, such as Cousineau, Saunier, Renault and Chatelain, etc., quickly followed in their footsteps. They were keen to compete, as they were attracted by the mechanical complexity and the delicacy of design of this new instrument, coupled with the promise of a beautiful future and corresponding economic stakes.

For the manufacturers, this complexity implied the need for a chain of different specialties: cabinetmakers, woodcarvers, mechanics, gilders and painters. Their works were coordinated by the instrument maker, who finally assembled and produced a musical instrument often brilliantly decorated.

Under the pressure of more and more virtuosos, the harp makers quickly tried to increase the possibilities of the instrument regarding its range, its chromatic capacities, its specific sound and its dynamic. The competition, which raged between makers, was also the source of numerous inventions such as the chromatic system, which contributed to the instrument the characteristics that we know today.

In this context and during the focus period (18th to 19th), two personalities seem to dominate harp making in Paris with regard to the quality and the quantity of constructed harps and especially with regard to their inventiveness of these makers: Georges Cousineau (1733–1800) and Sébastien Erard (1752–1831). Both were at the head of workshops and prosperous shops where the public could find harps and other instruments alongside manuscripts and printed music. For the purpose of this study, which is mainly dedicated to the acoustic potential of instruments, it is pertinent to mention the training of these men.

Thanks to his apprenticeship in Paris (with François Lejeune), Georges Cousineau comes from the Parisian environment of the stringed-instrument makers, holders of knowledge solidly anchored in a tradition of several centuries. During his career, he invented several mechanical systems for the harp. He was believed to be the first one to conceive and present to the Royal Academy of Sciences, in 1782, the first completely chromatic harp on which each string could produce three sounds (flat, natural, sharp), thanks to its complicated mechanism which used 14 pedals [14].

The second personality who had a profound impact within his own time is Sébastien Erard. He was not only a harp maker but also a maker of pianoforte and a brilliant inventor. Contrary to Cousineau,

Please cite this article in press as: J.-L. Le Carrou, et al., 18th and 19th French harp classification using vibration analysis, Journal of Cultural Heritage (2017), http://dx.doi.org/10.1016/j.culher.2017.04.007