Musical instrument are fundamental tools of human expression that reveal and reflect historical, technological, social and cultural aspects of times and people. These three-dimensional, polymateric objects—at times considered artworks, other times technical objects—are the most powerful way to communicate emotions and to connect people and communities with the surrounding world. The participants in WoodMusICK (WOODen MUSical Instrument Conservation and Knowledge) COST Action FP1302 have aimed to combine forces and to foster research on wooden musical instruments in order to preserve, develop and disseminate knowledge on musical instruments in Europe through inter- and transdisciplinary research. This four-year program, supported by COST (European Cooperation in Science and Technology), has involved a multidisciplinary and multi-national research group composed of curators, conservators/restorers, wood, material and mechanical scientists, chemists, acousticians, organologists and instrument makers. The goal of the COST Action was to improve the knowledge and preservation of wooden musical instruments heritage by increasing the interaction and synergy between different disciplines.

CITÉ DE LA MUSIQUE
PHILHARMONIE DE PARIS
MUSÉE DE LA MUSIQUE

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the Horizon 2020 Framework Programme of the European Union

25 €

Illustrations: Front cover © Succession Picasso;
ISBN 979-10-94642-35-1 / PRINTED IN FRANCE / OCTOBER 2018

Wooden Musical Instruments — Different Forms of Knowledge

Wooden Musical Instruments
Different Forms of Knowledge

Book of End of WoodMusICK COST Action FP1302

Edited by Marco A. Pérez and Emanuele Marconi

Wooden Musical Instruments Different Forms of Knowledge

Book of End of WoodMusICK COST Action FP1302

Edited by Marco A. Pérez and Emanuele Marconi

Cité de la Musique
Philharmonie de Paris
Musée de la Musique

cost
European Cooperation in Science & Technology

Funded by the Horizon 2020 Framework Programme of the European Union

Soutien apporté par la Fondation des Sciences du Patrimoine
LabEx Patrima (Investissements d'avenir,
réf. ANR-10-LABX-0094-01).

ISBN 979-10-94642-35-1

www.philharmoniedeparis.fr

Table of Contents

FOREWORD

The universally shared emotion caused by the loss of emblematic objects or sites of cultural patrimony, be it the unfortunate result of unstoppable degradation, or perhaps the result of deliberate political will, shows how much the knowledge, safeguarding and understanding of cultural heritage represents a virtuous element of social cohesion in the development of civilizations in democratic societies.

There is no society without music: music is a language that cannot be expressed without instruments, and it holds a special place in every cultural tradition. Not only musical and functional and/or technical objects, instruments are also often objects of art. As such, their identities cannot be deciphered without an approach combining several scientific disciplines. Among the materials from which instruments are made, wood—an exceptional technical material imbued with myths and symbols—reigns supreme in their manufacture.

The COST Association, part of the Scientific European Commission, sought to support a musical instrument-based project to strengthen the bridge between the humanities and the natural sciences, within the framework of European research and conservation of cultural heritage. The COST Action WoodMusICK (WOODen MUSical Instrument Conservation and Knowledge) was created in 2013. The network brought together different fields of research (wood sciences, history, acoustics, conservation, chemistry, ethnomusicology, etc.) and professionals from diverse backgrounds (academic researchers, instrument makers and museum professionals).

Grouped around the study of wooden musical instruments, these scientific communities were able to compare their experiences, discuss their views and invent a new form of dialogue. Within a short time, more than twenty-three countries had joined the project, evidence of a pressing need in this area which, we hope, the COST FP1302 WoodMusICK project has fulfilled.

The richness of the exchanges, focused around the annual meetings boosted by the project, the resultant number of 'short missions' initiated by young researchers, the large body of scientific works published in four years, and the continued involvement of musical instrument makers all demonstrate that COST FP1302 WoodMusICK created a new community of musical instrument researchers. Several innovative lines of research arose from the activities of this new community, combining probes into emerging digital tools (neutrons, X-rays, nanotechnology, in situ microscopy, predictive mechanics) with the issues of historical reconstruction and preservation of the musical instrument heritage within public and private collections.

This book is a selection of contributions obtained after four years of meetings and collaborations between musical instrument researchers from twenty-three European countries, and aims to summarize and present the different approaches and lines of research that constituted the essence of WoodMusICK. It does not represent the end of the project, but rather is an opportunity to promote education, and opens a second phase of periodic meetings aimed at continually improving our knowledge of musical instruments.

I am indebted to Emanuele Marconi and Marco Antonio Perez who have accepted to be in charge of this book and who have made possible the publication on time. We are grateful to the assistant editors: Gabriele Rossi Rognoni and Pascale Vandervellen who belong to the Steering Committee of this Action (see below), Daniel Konopka, Anastasia Pournou, Stéphane Vaiedelich and Simone Zopf. After this four years COST project, my deepest thanks to Pascale Vandervellen, the vice-chair of this Action who has accepted to build the bridge between humanities and natural sciences. More largely, many thanks to the Steering Committee of this Action: Iris Bremaud, Marco Fioravanti, Claudia Fritz, Michael Kaliske, David Mannes, Marco Antonio Perez (again…), Carmen Popescu, Gabriele Rossi Rognoni, and Christina Young. Lastly, I am grateful to Isabelle Hoefkens who has managed very well the financial issue of this program.

Sandie Le Conte
Chairwoman of COST Action FP1302
Musée de la musique,
Cité de la musique – Philharmonie de Paris

Instrument (Re-)construction as a Catalyst for Organological Research

Geerten Verberkmoes
Department of Art, Music and Theatre Sciences, Ghent University, Belgium
Department of Musical Instrument Making, University College Ghent, School of Arts, Belgium

Abstract

This essay discusses the pivotal role the instrument (re-)construction process can play as an initiator for new knowledge, methods and cross-connections within the field of organological research. In order to illustrate this approach, a case study is presented in the form of a Ph.D. research project on the life, instruments and construction methods of the violin-maker Benoit Joseph Boussu (1703–1773). This project comprises four distinct phases of research: a biographical study, study of surviving instruments, the creation of instrument replicas, and the application of these replicas in musical performances. For each phase, the employed approach, methodology and results are exemplified.

1. Introduction

The study of musical instruments can be approached from many different perspectives and backgrounds. Musicologists and musicians may investigate and classify instruments by their musical functionality and applications. Acousticians will be interested in the sonic properties and the way these musical tools function from a physical point of view, whereas historians and cultural sociologists may research the role of instruments in past and present communities.

A somewhat peculiar category of individuals to study musical instruments is formed by instrument-makers, since they are usually more involved in the practical side of things, the actual manufacturing, and less in scholarly activities surrounding instruments. Still, they have a very close relationship to the object, even literally in the sense that they have shaped and held in their hands each of its individual components. In order to comprehend the architecture and manufacturing process of (historical) instruments, makers are inclined to look beyond outer characteristics and musical application, trying to understand what is beneath that surface of wood, metal or ivory. Like a curious youngster dismantling an obsolete electronic device to discover the interior, makers want to look inside, or even better, through the objects of their interest, and nowadays the technical means to do so are available more than ever before.

It is from this deep incentive to understand the structure and creation process of instruments that makers can contribute their unique expertise and methodologies to the field of organology. Moreover, in making reconstructions of historical instruments, their practical activities could become the nucleus for a multi-faceted organological study project, where "workbench research" generates questions, answers and understanding, while also allowing for the practical testing of construction hypotheses. The following essay will thus discuss the pivotal role the instrument (re-)construction process can play as a catalyst for new knowledge, methods and collaborations within the field of organological research.

In order to illustrate this approach, the second part of the text presents a case study, in the form of the author's ongoing Ph.D. research project (2015 – 2020) at Ghent University and the School of Arts Ghent. This study investigates the life, instruments and working methods of the eighteenth-century violin-maker Benoit Joseph Boussu (1703–1773). Furthermore, the obtained insights are ultimately employed, and at the same time critically assessed, by building violin and cello replicas after original Boussu examples (the latter are now in a museum collection, where they are no longer allowed to be tuned or played). In the final stage of the study, these replicas are used in a musical project to perform repertoire from the original instruments' time and place, in order to assess the sonic and playing characteristics of the newly made instruments, and thus the originals on which they are based.

This essay is written from the perspective of the research on and replication or reconstruction of violin-family instruments, but the ideas and concepts expressed may also be valid for the study of other types of instruments.

2. The Instrument-Maker as Organological Researcher

According to a common generalisation, there are "thinkers", and there are "doers". Supposedly, makers of musical instruments, like other craftsmen, are exponents of the latter archetype. In order to repeatedly produce, by manual labour, physical artefacts such as musical instruments, makers must not be living too much inside their heads, but instead remain focused on completing their products without the inhibitions of too much rationalisation and reflection.

On the other hand, scientific research on musical instruments is typically performed by scholars with a thorough academic background. Even today, the majority of organological publications comes from authors with a degree in musicology, art history, art conservation or a comparable field, people that may easily be counted among the "thinkers" category, while makers are still in minority when it comes to contributions to organological publications and conferences. Perhaps hints of the old dogma of the "trade secrets" from the guild times still quietly persist within the present-day craft field. This makes one wonder if there is a place within the area of scholarly musical instrument research for practice-oriented craftsmen.

> The doers are the major thinkers.
> Steve Jobs (1990)

Yet, for several reasons, it can be argued that instrument manufacturers bring unique qualities and skills to the research table. First of all, the maker's attention to detail, sharpened by the practice of instrument construction, can allow him or her to notice things that other people may overlook. Likewise, their hands-on know-how of various construction processes allows them to interpret the smallest particularities, such as tool marks, scratch lines or signs of modifications, as clues for the making techniques employed by the original maker, or as signs of configurative changes or repairs.

Furthermore, the result-oriented approach of makers investigating an original instrument—where the examination is often aimed at documentation in service of the construction of a convincing copy—encourages them to examine not only the superficial appearance of an instrument, but also the interior. Nowadays, state-of-the-art techniques such as computed tomography (CT) scanning and digital endoscopy, enable such revealing examinations, and may even allow "virtual" measurements to be taken and construction drawings to be produced. Obviously, to make advanced investigations like this possible, a maker would have to seek collaboration with scanning facilities and radiological specialists. Similarly, a maker may want to cooperate with chemists, acousticians, wood technologists and dendrochronologists in order to collect a variety of additional information required for an instrument reconstruction or replication. In other words, the practice-oriented maker would have to enter the field of scientific research. This may be an intimidating step, but when taken, the reconstruction process could become the nucleus around which a multi-disciplinary research project would develop. This approach may even be extended to the historical, social, cultural and musicological areas, for example by studying the biography of a historical maker and the social and economic conditions under which he lived and worked, to find out if these circumstances had any influence on his production rate, creative decisions, material selection, clientele and so on, while instrument attributions (based on label texts) could be validated by comparison to biographical data. Or even more, to study the musical applications of a replica under construction. Again, to collect and interpret such contextual information, collaborations must be developed, this time with scholars in the field of humanities.

Another argument for the integration of makers into the organological community can be found in the relationship between instrument-makers and the area of musical performance. Authentic performance practice, or historically informed performance, has developed steadily since it first emerged in the twentieth century. The most important question, and one that we can never fully answer due to the "incompleteness of the evidence" [1], remains "how did the music really sound in the days when it was composed"? The use of appropriate instruments, originals or replications, closely connected to the chronological and geographical provenance of the played repertoire, is one of the fundamental prerequisites in attempting a faithful performance. In reality, even today after more than five decades of endeavour for authentic performance, it does not always seem possible or practically feasible to employ instruments exactly tailored for a specific repertoire due to unavailability of a broad spectrum of instruments, leading to compromises regarding sound, set-up, pitch and temperament. For example, the performance of a broad range of Baroque repertoire from between 1600 and 1750 on truly faithful violins would require at least three or four instruments in different configuration and setup (with corresponding bows!), an effort that not all Baroque violinists will make. According to Wilson [2], "Such practical considerations have had a bearing on what was and what was not done by way of 'historically informed performance practice'". Also, personal preferences on the part of musicians may further contribute to the use of instruments that are not fully optimized for a certain repertoire.

In addition, in more recent years, the focus of the historically informed performance practice has gradually shifted towards repertoire beyond the Baroque era. Authentic performance of music from the Classical and Romantic periods will ask for other instruments, and this opens a whole new field of instrument research and (re-)creation. As is evident from the above, the specific expertise and interest of makers regarding technical aspects—such as instrument configurations (for both original instruments, re-constructed originals or modern replicas), dimensions and string choice—calls for their participation in organological research. In the case of modern replicas and reconstructions, makers are the manufacturers of the sound-tools used by performers, and are thus providing the essential physical equipment required to convert the ideas of musicians, composers, music theorists and musicologists into a sounding musical reality. However, the tools for true "informed performance" will only be as satisfactory and reliable as possible if they were maintained, modified or newly produced according to the concept of "informed making". And this is exactly where the expertise of the instrument-maker is indispensable.

What's in a name...?

When an instrument—or any other object—is produced after a (historical) example, there are several ways to name the resulting product. The term "copy" is the more generic designation, indicating an object was produced in the image of an original, the degree of similarity to the original being more or less pronounced. In instrument-making in particular, the indication "inspired copy" implies that the copyist's intention was more to capture the spirit or concept of the original, rather than to duplicate the original as precisely as possible. Some makers even employ acoustic techniques to pursue a "tonal copy", reproducing the instrument's sound more than its appearance, or a "bench copy", normally an imitation of a famous instrument, up to the point where even the smallest scratches and dents are copied. When a maker tries to reproduce an original instrument that has been modified throughout time, with the intention to reflect in the newly made instrument a possible initial or earlier state, then the denomination "reconstruction" comes in use. An example of this is a reproduction of a modernized seventeenth-century violin, the reproduction having a "Baroque" configuration. In order to make the reconstruction as faithful as possible, research is needed to find information for the reconstructed parts. Sources such as remnant untouched instruments or iconography become indispensable. The denominations "replica" and "facsimile" indicate that a maximum degree of exactitude was envisioned, possibly also involving historical, and sometimes forgotten, production processes to achieve the highest level of similarity between copy and original. In this respect, the study of the making process can become a goal by itself. The words "imitation", "duplication" and "clone" are less often used for musical instrument copies, while the terms "fake", "forgery" or "counterfeit" are obviously employed to indicate that the maker of the copy had less than honourable intentions.

As stated earlier, the knowledgeable examination of a musical instrument will not only expose its current state and condition, but can also reveal clues regarding previous configurations or even the construction process. With the right know-how, this type of information can be used to derive the possible techniques employed by the maker of the original instrument, or even to propose a hypothesis on a construction sequence. Once such a hypothesis has been formulated, an effective way to test it is to actually execute the proposed steps, in the production of test pieces or even an entire instrument. Only someone with an instrument-making background would be able to execute such performative research, and interpret the outcome in terms of practical feasibility, expected product specifications and time-effectiveness.

Thus, from the above arguments, it may be concluded that there is certainly a role for makers within the organological community. In order to fulfil such a position, however, affinity and experience regarding systematic research appear to be essential. A researching instrument-maker would thus have to develop in dual directions, becoming a scholar in addition to being a craftsman, a "thinker" as well as a "doer", and to develop a *modus operandi* in which theory feeds practice and *vice versa*.

To achieve this duality, nonetheless, there may be several pitfalls along the way. A craftsman willing to perform organological research according to established academic principles will have to come out of his or her practice-drenched comfort zone and gain the appropriate academic attitude and competences. Theoretical knowledge, ranging from musicology to physics, and from organology to history, has to be obtained, along with competency in areas such as data acquisition and analysis, project management and writing and presentation skills. Scholarly values, such as objectivity and ethical practice must become second nature, while furthermore, the craftsman may have to put aside any ambiguity towards the theoreticism of the scholar.

What is more, in some branches of the musical instrument business, under makers and musicians alike, there appears to be a fascination with big names and a certain mythology. The violin world, where these pre-occupations appear to be strongest of all, has its "Cremona cult", leading to the belief amongst many players and listeners that a soloist can only deliver a worthwhile performance when playing a famous antique Italian instrument, and sustaining a dominant monoculture of

Stradivari-copying amongst makers. From this viewpoint, there may be strong scepticism towards organological scholarship, since its activities and opinions could be regarded as an attempt to degrade the constructed myths. The controversies surrounding the attribution of the "Messiah" violin may be illustrative in this light. Whilst these views are most common amongst violin players and makers, a similar fixation with name and fame occurs within the areas of some other instrument families too.

Another competence the researching instrument-maker will have to develop in order to transform into a full-fledged organologist, is the habit of communicating his or her research findings through the proper scientific channels. Articles written specifically by makers are hard to find in organological publications such as *The Galpin Society Journal* and the *Journal of the American Musical Instrument Society*, while makers are also under-represented at organological conferences. Indeed, the violin community has its own monthly periodical, aimed at both players and makers, which regularly features interesting contributions written by makers. Yet, this magazine does not practice the peer review process, nor does it include reference footnotes, and consequently its articles do not hold true scholarly validity. And is the information contained in leather-bound books issued by the violin business truly objective, or are these publications primarily intended as prestigious promotional material?

Last but not least, due to their backgrounds, makers may not be always properly trained to judge the fragility of historical cultural heritage objects and handle them accordingly. In addition, their pragmatic attitude may push them to take a certain measurement at all cost, losing sight of the well-being of the instrument under study. It would therefore be necessary to train researching instrument-makers in how to safely and responsibly perform their instrument investigations. An unfortunate example to illustrate this issue is provided by indentation damage on the top plates of Boussu violin MIM inv. no. 2781 and Boussu cello MIM inv. no. 1372, discovered during the course of the current research project, caused only recently by—thus far unidentified—examiners who had apparently used a profile gauge in an attempt to register the top plate archings of both instruments. These incidents demonstrate the importance of awareness of the vulnerability of old instruments and the abandoning of potentially harmful measuring methods in favour of contactless ones, such as CT scanning, to prevent similar damage to other instruments in the future.

Thus, the requirements imposed on a maker/researcher in accordance with the above viewpoints are not to be neglected. Still, if makers are prepared to make the transition from their workshop to the academic arena, they can become valuable contributors and initiators in the territory of musical instrument research, and their specific knowledge and practice-driven approach can bring new insights and élan to the field.

For the sake of illustration, the next section will present a case study—the author's research project—where an attempt was made to put some of the above ideas into practice.

3. A Case Study: The Replication of Instruments by the Eighteenth-Century Violin-Maker Benoit Joseph Boussu

The name of the violin-maker Benoit Joseph Boussu first came to my attention in the fall of 2008, when I wanted to make a copy of a "Baroque" violin still in an unmodified state. Preferably, the original instrument had to be available at a nearby geographic location, to make access to the instrument easier. To find a suitable instrument, Karel Moens—at that time curator at the Vleeshuis museum in Antwerp—was consulted, since he is regarded as one of the leading experts in the field of historical bowed stringed instruments. Moens did not have to think long about my question; according to him, the Boussu violin inv. no. 2781 from the Musical Instruments Museum (MIM) collection in Brussels was one of the few reliable, unmodified eighteenth-century instruments in Belgium, if not in the whole of Europe. Following the advice of Moens, I soon started a first study of the recommended violin, under the guidance of then MIM staff member Guy Buyse. This research yielded the required information to start the reproduction process, and during the following year, the first two copies were manufactured.

Meanwhile, my interest in the life and background of Boussu was sparked, especially since very little information on this maker was available. The existing encyclopaedias and reference books on violin-makers contained only a few lines regarding this maker—mostly repeating each other—citing that he worked around Brussels between 1750 and 1780 and built after Amati. The dates and places of his birth and death were unknown, as were his personal life and background. For me, that tiny bit of biographical data triggered my curiosity, instead of satisfying it, laying the foundation for an extensive quest into the life, instruments and working methods of the maker, which eventually resulted in the commencement of a Ph.D. project in early 2015. The following four paragraphs will discuss the four distinct research phases of this project.

3.1 Project Phase 1 – Biographical Research

In order to find out more about Boussu's life, a biographical study was undertaken, consisting mostly of research in various archives, especially the Archives départementales du Nord (Lille, France), the City and State Archives in Brussels (Belgium) and the City Archives in Amsterdam (The Netherlands). This initial archive research, carried out between 2010 and 2013, resulted in the elucidation and publication of many biographical facts [3]. Further archive studies, performed between 2014 and 2016 yielded additional insights [4]. As a result, it is now known that Boussu was born in Fourmies, in northern France, in 1703 to a family of notaries. He also worked as a notary and attorney in the town of Avesnes, in his birth area, between 1729 and 1748. A cello, built in 1749 in Liège, is the earliest known instrument by his hand. Soon after, between c.1751 and at least 1762, he worked as luthier in and near Brussels, where he was very productive given the many surviving instruments from that period. Boussu married twice and had many children, the majority of whom died in infancy. For the final part of his life, c.1765–1772, he lived and worked in Holland, possibly first in Leiden but later certainly in Amsterdam, although just one instrument, a cittern, is extant from that period. He died in his native region in 1773. Current study of over hundred legal documents concerning Boussu's transactions, such as acts from notaries and local courts of justice, at the moment being transcribed and interpreted for possible future publication, demonstrate that he maintained financial interests and rural heritage property in his birth area throughout his entire life. Law historians Prof. em. Veronique Demars-Sion and Prof. Georges Martyn have contributed their valuable help to the transcription and interpretation of these acts, from which it further becomes clear that Boussu confronted close family members and local authorities several times in the courtroom. His background as a notary and attorney may have contributed to his apparent success in these cases; by knowing some legal "loopholes" he managed to secure his rights and possessions.

Apparently, Boussu did not have an initial background as an instrument-making craftsman. Instead, he may be considered a literate, maybe even somewhat respectable citizen, due to his abilities to read and write. This makes one wonder *why* he made a career-switch in his mid-40s and *how* he learned to build bowed stringed instruments; the exact answers to these riddles remain missing so far. Anyhow, it appears that Boussu managed to attract a local clientele in Brussels, ranging from amateurs, to professional musicians, to the ensemble of the St. Michael and St. Gudula church. His many relocations demonstrate that he was of a venturous disposition, apparently constantly looking for better economic perspectives and living conditions and taking initiatives to realize his personal ambitions and visions, even if this meant abandoning his respectable status as a notary for the more humble position of craftsman.

3.2 Project Phase 2 – Instrument Research

A second main theme entwined in the Boussu project, besides the biographical research, is that of identifying this maker's surviving instruments, in order to study their aesthetic and constructional features and to hypothesize about a possible sequence for the way they were made. The MIM collection alone contains nine Boussu instruments (six violins, two cellos and one bass), with one violin and one cello in virtually untouched state—although these instruments are not allowed to be tuned or played—while another 40 or so surviving instruments have been identified in other institutional collections and private ownership. Among this latter category are many violins, half a dozen cellos, a few violas, one other bass, a dance master violin and a cittern. Most of these have been studied and documented using traditional techniques, including recording dimensions and plate thicknesses, capturing the instrument on photo and endoscopic examination of the inside of the sound box. Currently, a database of all these instruments, including the basic measurements and photos, is being set up. The study of such a vast amount of instruments by the same maker provides profound insights into his production rate and constructional and artistic characteristics and evolution.

From observations of this substantial collection of surviving instru-ments, it appears as if Boussu developed his own hybrid working system. He most likely based his approach on both familiarity with local traditions (the "through neck", where neck and upper block are made from a single piece of wood) as well as his observation of the constructional features of foreign instruments that came under his attention (ribs glued *onto* the back plate, *not* inserted *into* it, and the use of linings and corner blocks). Makers like Boussu, who did not have an apprentice/master type of formation in the craft, must have developed their own working system, since the publication of violin making manuals resulting in standardisation of making methods would still be far away.

For several violins, cellos and violas, as well as for the cittern, CT scanning was performed in cooperation with leading experts, in order to gain additional insight into their construction. In one of these studies, two Boussu violins along with several other MIM instruments by Boussu's Brussels predecessors and contemporaries were included to get a broader view of the development of violin-making techniques practised in that city. The results of this CT study—made possible through the cooperation of MIM curator Dr. Anne-Emmanuelle Ceulemans and further MIM staff, Prof. em. Danielle Balériaux (Erasmus hospital, Brussels) and Dr. Berend Stoel (Leiden University Medical Center)—were recently published [5]. For the purpose of illustration, **Fig.1(a)** to **(e)** give several examples of images acquired with CT scanning and digital endoscopy. A similar study of a 1771 Boussu cittern was published as well [6]. The resulting CT images offer detailed information on the internal architecture of the examined instruments, as well as providing the basis for accurate technical construction plans, which are indispensable for making reconstructions or replicas. Of particular note is the neck of violin MIM inv. no. 2781. This part maintains its original "post-Baroque", transitional configuration, given its dimensions (a length of 130 mm, a neck angle of 86 degrees, a protrusion over the top plate of 1 mm and a fingerboard projection at the bridge of 22 mm). The neck also holds its original short veneered fingerboard.

Fig.1

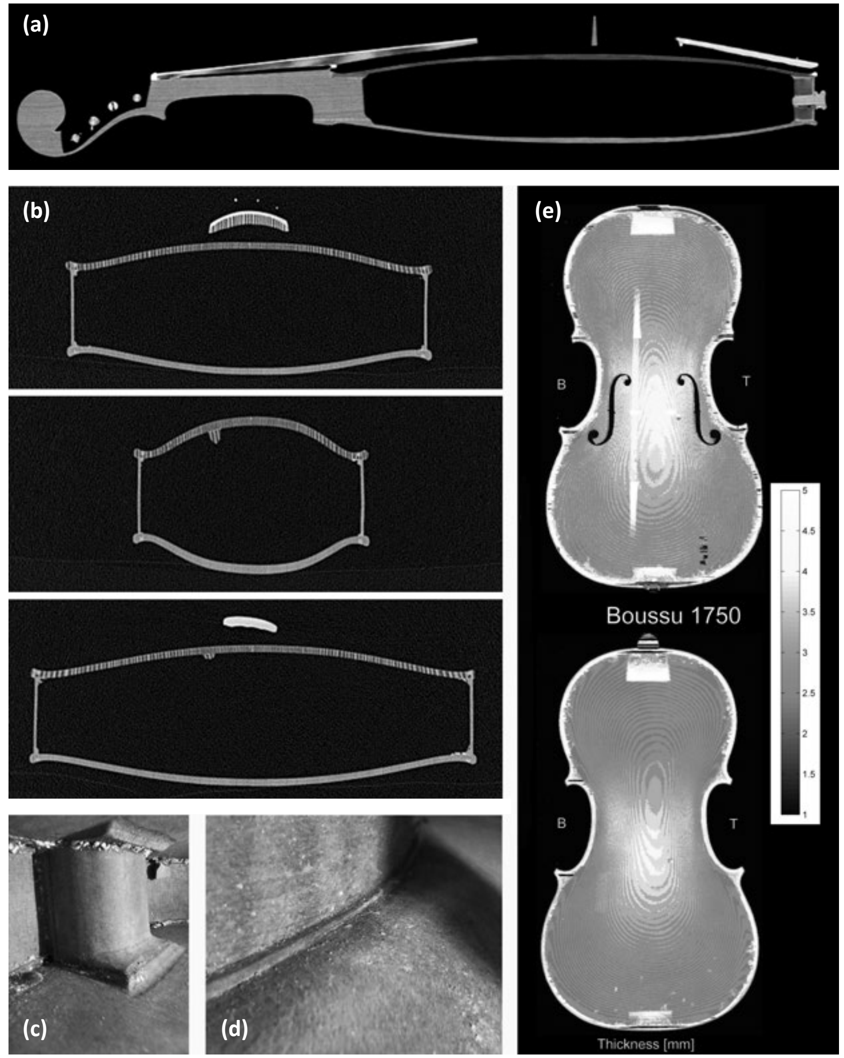


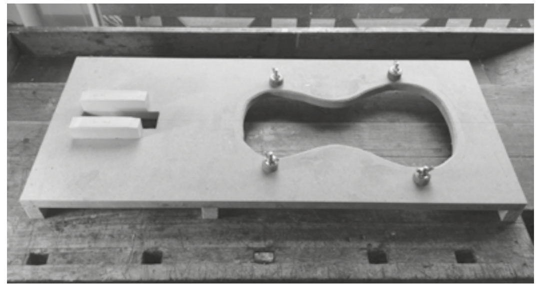
Fig.1 Examples of CT reconstruction and endoscopy images for Boussu violin MIM inv. no. 2781: (a) longitudinal CT cross section, (b) three axial CT cross sections of the sound box, (c) endoscope image of the upper block, (d) endoscope image, detail of lining, (e) thickness maps of top and back plate derived from CT data, scale in mm (maps produced by Dr. Berend Stoel, images originally in colour).

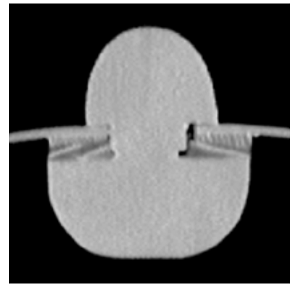
With the newly gained insights, deduction of Boussu's methods of violin- and cello-making could be attempted. Certainly, he made his instruments with a neck and upper block from a single piece of maple, as can be seen undisturbed in violin MIM inv. no. 2781 (see **Fig.1(a)**) and cello MIM inv. no. 1372. This observation, in combination with the presence of a small but noticeable foot on the upper block, supports the hypothesis of a making system without a full mould. Such irregularly pre-shaped upper block could never be temporarily glued to an inner mould, while the protruding neck would not allow the use of a full outer mould either. Instead, Boussu presumably built from the back plate upwards, using the contour of the plate as a guide for the final shape of the sound box. Given the high degree of symmetry and dimensional uniformity of the back plate contours of this maker's violins, it is most likely that the back plate's outline was drawn in the initial stage of making the plate, using a half-template that could be flipped over the central longitudinal axis of the joined and planed maple board, thus yielding perfectly identical left and right halves of uniform dimensions. After the back plate was completely formed and hollowed, the neck could be glued on, a job that had to be done with some sort of aid to ensure that the neck would be assembled in the direct extension of the back plate's central axis. Several possible versions of this aid can be imagined, although some further clues in Boussu's instruments point towards a certain variation.

A very peculiar feature of this maker's violins is the highly identical ear-to-ear width of the scrolls. For example, the five original scrolls on the instruments from the MIM collection have scroll widths of 36.5, 36.0, 36.0, 36.5 and 35.8 mm (average: 36.2 mm, standard deviation: 0.32 mm). Other violin scrolls by this maker on instruments in private ownership show very similar widths. Of course, this precision could have resulted from the maker's apparent strict routines (the back plate lengths of his many surviving violins have a typical uniform length of 361 to 363 mm), but the uniformity of the scroll widths could also have had a functional reason: this dimensional similarity made me think of an alignment table which included some sort of fixture to receive the scroll, the width of the fixture opening being the standardized scroll width of around 36.5 mm. My interpretation of such a table, or work board, is depicted in **Fig.2**. The back plate can be clamped on this table, aligned with the table's centre line, and after that, the completed neck (including upper block) can be positioned in appropriate alignment and glued on.

As a next stage in the proposed making sequence, one pre-shaped lower block and four corner blocks could have been glued on, serving as guides to help position the six rib parts during the next construction step. In this consecutive step, the pre-bent rib parts may have been glued to the blocks and the back plate, subsequently followed by

Fig.2
Fig.3





the application of linings where ribs and back plate meet. However, another observation, regarding the rib structure, made me reconsider such working order. In several of the earliest Boussu instruments, from 1749 until around 1751, very small original linings are present at the connection between the plates and ribs, whose cross sections can approach dimensions of only around 1.5 × 1.5 mm, see **Fig.1(d)**. Most violin-makers would agree that it would be impossible to apply such small-sized linings at the junction formed by the ribs and back plate, due to their tendency to warp during the gluing process, and the inability to properly clamp them. Moreover, the linings are not inserted in the corner blocks, but have feathered ends that always seem to terminate a little before touching the blocks. From these observations, another way of assembling the rib parts and linings is proposed. It may have been possible that Boussu employed "partial outer moulds": a separate mould for each rib part. A maple strip, to become a rib part, could be bent and clamped on such form, and after it maintained its curved shape upon drying, linings could be glued on. After planing the resulting rib part on either side, including linings, to the appropriate height, the stable pre-formed part could be glued upon the back plate. This procedure had to be performed six times in total to form the entire rib structure. Although in later Boussu instruments (c.1752–1761) more robust linings are observed (around 2 × 5 mm), I presume that Boussu did not change his way of making the rib structure due to the change in lining dimensions.

At the neck-to-body connection, Boussu inserted the upper rib parts into pre-sawn slots in the neck root, and secured them by two complementing wedges on either side, see **Fig.3**. At the rib corners of original instruments, the rib parts are joined in a mitre joint instead of an overlapping one. Another common feature found on almost all examined

Fig.2 Alignment table as made and used by the author for making the two 2017 violin replicas.

Fig.3 Coronal CT reconstruction of the upper block area of Boussu violin MIM inv. no. 2781, showing the inserted upper rib parts and wedges securing the rib parts into the neck root.

Fig.4

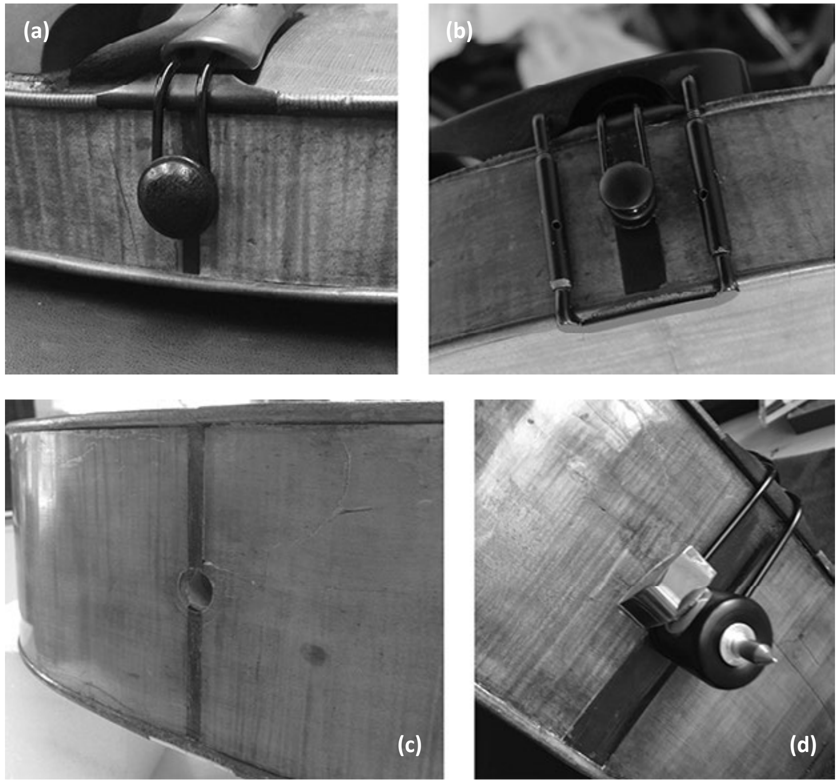


Fig.4 Examples of filler strips at the underside of original Boussu instruments: (a) violin in private ownership, (b) viola in private ownership, (c) cello MIM inv. no. 1372, (d) cello in private ownership.

original instruments is a glued-in strip, often of a dark hardwood, where the two rib parts of the lower bout meet at the bottom block, see **Fig.4** for several examples. The width of this strip varies from instrument to instrument, an indication that Boussu employed such a strip to compensate for variations in length of the pre-fabricated lower rib parts.

The violin-in-progress now contained a back plate, neck and sides, so the only part missing from the basic structure would be the top plate, which could be made and attached by Boussu in the common fashion. Regarding the bass bar of the violin MIM inv. no. 2781, an interesting observation can be made. First of all, with a maximum height of 7.0 mm, a width of 5.0 mm and a length of 234 mm, this bar is believed to be original. What is even more striking is its placement: rather angled with its longitudinal midpoint coinciding exactly with the position of the bridge, see **Fig.1(e)**. Interestingly, an identical positioning of the bass bar in respect to the bridge position is found in cello MIM inv. no. 1372. Various carefully scratched-in marking lines, applied during the construction process, for example on the back of the peg box, confirm the systematic and precise habits of this maker.

As explained earlier, the obtained CT scans provide unprecedented information regarding the internal construction of Boussu's instruments and even allow for the performance of any dimensional measurement within the CT visualisations with the use of the appropriate software (in our case the software package Osirix was used). Even more, scale 1:1 cross sections can be produced from the CT data, which in printed form could serve as accurate construction drawings, while medical imaging specialist Dr. Berend Stoel provided his kind cooperation by constructing thickness, arching height and density maps for several instruments' top and back plates (for examples, see **Fig.1(e)**). Of note are the unusually similar thickness patterns for the top and back plate, with the top being relatively thick in the centre, another concept Boussu apparently developed from being an autodidact. Maps as produced by Dr. Stoel provide indispensable information during an instrument reconstruction or replication process.

As said, the CT scan reconstructions provide plate thicknesses and longitudinal and transverse archings profiles at any cross section, while also allowing for the performance of additional "virtual" measurements, thus avoiding any physical contact with the original instrument.

3.3 Project Phase 3 – Instrument Construction

With the aid of all this new information and insight obtained, the construction of a second pair of violin replicas was commenced in early 2017. The working sequence employed during the making process was exactly as explained above; several representative steps are illustrated by the photographs in **Fig.5(a)** through **(d)** and **Fig.6**.

Fig.5

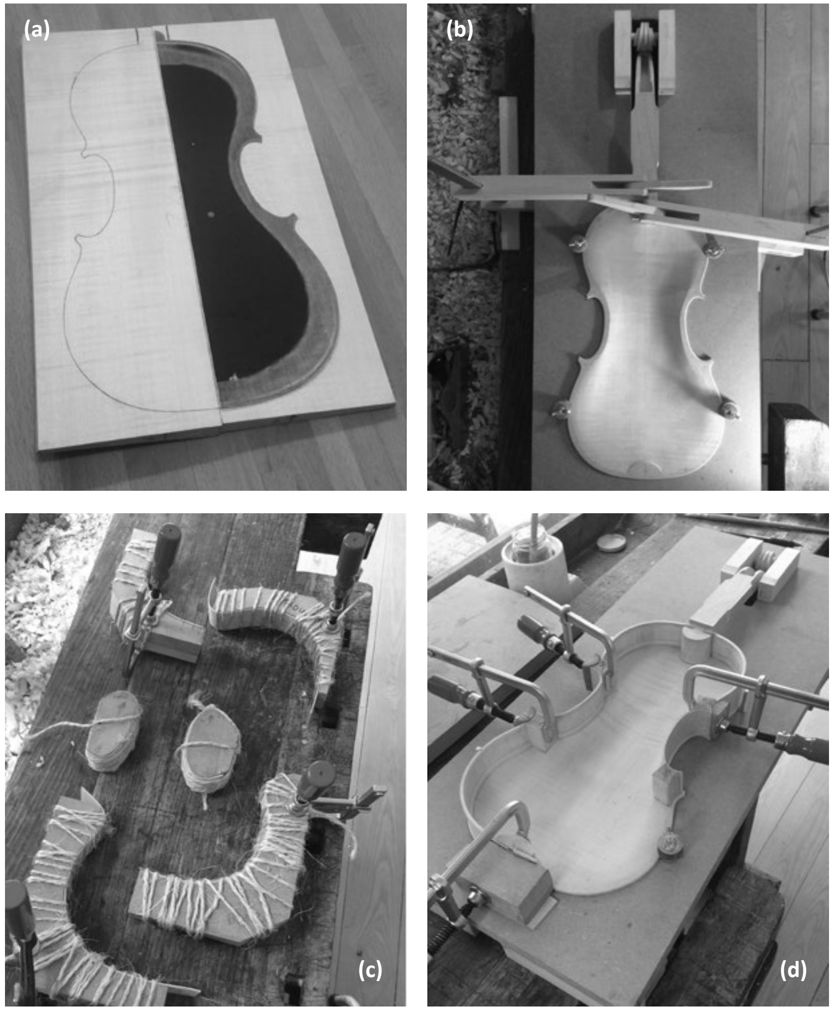
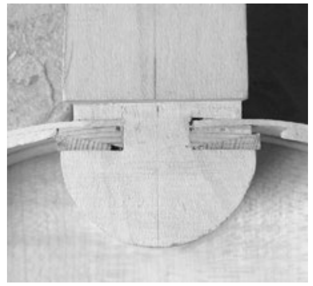


Fig.6
Fig.7



After the two new replicas were finished "in white", the appropriate varnish had to be decided. A true chemical analysis to identify the organic components of Boussu's varnish has not yet been performed, and whereas that would be an interesting exercise, it has been previously suggested that Boussu applied a shellac based varnish [7]. This assumption was confirmed by our investigations of Boussu's varnish with the use of UV light: a bright orange fluorescence, characteristic of shellac, is observed on both the entire violin MIM inv. no. 2781 (see **Fig.7**) and the cello MIM inv. no. 1372, with original varnish even still present on the necks.

Based on this observation, it was decided that the two violin replicas would be finished with a varnish based on raw sticklac, with the addition of some dragon's blood resin (for colour adjustment) and some sandarac and elemi to temper the hardness of the shellac. The golden brown colour of this varnish showed convincing similarity with the varnish on the original instrument, although it proved hard to achieve the same level of evenness in colour and surface smoothness in comparison to Boussu's examples. **Fig.8** shows both the original violin as well as one of the copies made in 2017. In late 2017 and early 2018, a cello replica after the original, unmodified Boussu cello MIM inv. no. 1372 was built, based on a CT scan (made by Prof. Coche and Prof. Danse and their team in the Brussels Saint-Luc hospital) and using a similar working sequence as was employed for the violins. For all three replicas, the making process was captured in detail on video, and an edited version of this footage has been made available on the YouTube channel "Boussu_Inside_Out"[1], in order to further disseminate knowledge regarding the construction process.

Fig.5 Several representative steps in the 2017 construction process of a violin after Boussu: (a) marking the back plate contour (template produced from CT data), (b) gluing the neck to the back plate using the alignment table, (c) making the rib parts on partial moulds, clamping is done by rope, (d) gluing the rib parts, including the linings, to the internal blocks.

1 https://www.youtube.com/channel/UChivkXPogBhUIj3X2I_DFWA

Fig.6 Detail of a violin replica in progress, showing the upper block and the wedges to secure the rib parts into the neck root.

Fig.7 UV-induced fluorescence of the varnish on original Boussu violin MIM inv. no. 2781.

Fig.8

Fig.8 Original vs. copy: (a) original Boussu violin MIM inv. no. 2781 (Photo: Musical Instruments Museum, Brussels, © KMKG), (b) violin replica made by the author in 2017 (Photo: Jan Stragier, School of Arts Ghent).

For the most part, the building sequence employed and at the same time evaluated during the making of the current violin and cello replicas proved efficient and convenient, whereas the resulting replicas showed a great similarity to the original instruments, both in overall appearance as well as regarding weight and maker-specific constructional details. In general, the construction process progressed smoothly, and the employed making sequence allowed for a logical and effective working order. In case of the cello, however, the assembly of the rib structure took more time and effort than expected, especially to ensure a symmetrical and perpendicular alignment of all rib parts. Nevertheless, this step may progress more fluently during a future cello construction, due to gained learning experiences. Furthermore, Boussu may not have employed a working table exactly resembling the one used during the current replications, but I believe it is highly likely that his workshop contained an aid with a very similar functionality. In all probability, it may thus be concluded that Boussu employed a comparable construction system as tried out during the current replication process. The parallel making of the two violin replicas, up to the unvarnished state including the veneered fingerboards, took 80 effective working days in total, thus 40 working days per instrument. For the cello replica, 70 working days were needed to complete the instrument "in white". This may seem long, especially in comparison to the output rate of Boussu (see hereafter), but with the gained experience and know-how, it should be possible to make a future copy in a somewhat shorter time span. Moreover, as will be explained below, Boussu most certainly did not work alone in his workshop.

As said before, the dimensions of original instruments show a very high degree of uniformity. Furthermore, especially in his earlier instruments, Boussu included an internal inscription containing detailed information such as his name, the date of signature to the day, the place of production and a serial number. Such precise, almost obsessive habits could have resulted from his personality, which may have been somewhat compulsive, but also from his background as a notary.

In his notary profession, which he practised for almost 20 years, precision and punctuality must have been valued qualifications. Additionally, the uniform dimensions of Boussu's instruments may also point towards a standardized and even modular production process. Given Boussu's high production rate, especially during his initial years as a luthier (according to the numbering on his labels, between 1749 and late 1752 he produced 36 violins and at least 6 cellos), it is unlikely that he worked all by himself. More plausibly, he headed a workshop with a few employees, maybe two or three persons, who all had more or less fixed subtasks within the production process, such as preparing the boards and blocks for plates and necks, pre-bending the rib parts (as explained above), and varnishing. His two eldest sons, Pierre Antoine and Jean François, both in their teen years during the 1750s, could very likely have been amongst the workshop personnel. Both these sons became silversmiths in their later life, so we know they must have been able to perform craftwork. The more refined tasks, such as carving the scrolls, shaping the plate contours and archings, as well as purfling and finishing, may have been done by Boussu senior himself, since we consequently observe a single, highly recognizable and secure hand in these more aesthetic aspects of his instruments. It may be noteworthy that he was familiar with the advantages of modular and serial working from his days as a notary, where handwritten acts were often copied in advance from formula books, leaving specific information such as client names and dates open to be filled in later.

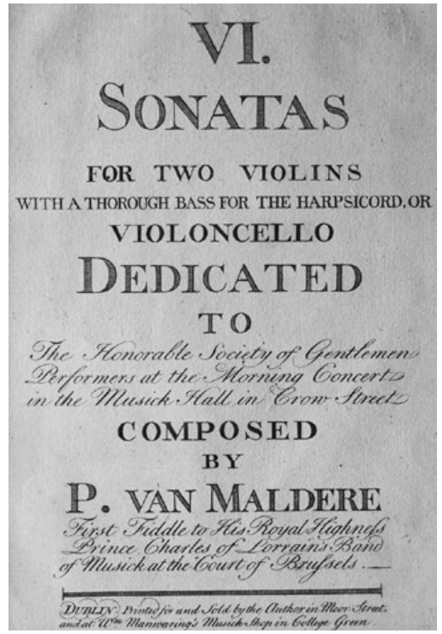
The use of such efficient modular and cooperative methods ensured prolific output, with a high degree of quality and uniformity. In this respect, it must be remembered that during the middle of the eighteenth century, under the influence of the rationalism of the Enlightenment and on the verge of the industrial revolution, strong developments were about to happen in all branches of product manufacturing. In this climate, with the introduction of Watt's first commercial steam engine just decades away, the instrument-making sector may have undergone changes as well, towards a more industrialized mode of production. These prosperous economic and social conditions aside, Boussu's entrepreneurial spirit may also have helped him achieve commercial success in the violin trade, although he must have had financial security and backup in the form of proceeds from investments in his native region.

3.4 Project Phase 4 – Musical Performance

In the final stage of the current research project, in progress during 2018 and 2019, the three instrument replicas will be set up in collaboration with Ann Cnop, Shiho Ono and Mathilde Wolfs (see **Fig.9**), experienced performers of eighteenth-century music, and these musicians will subsequently use the instruments to perform Brussels repertoire from the time of Boussu, in order to assess playability and musical and sonic possibilities. Performances during this final phase will be captured by both audio and video recordings, and public concerts will be organised. Examples of recordings of the musicians playing the replica instruments are available on the YouTube channel "Boussu_Inside_Out".

With respect to the repertoire to be performed during this concluding phase, we selected little-known and rarely performed Brussels chamber music of the mid-eighteenth century, such as trio sonatas by Henri-Jacques De Croes, Pieter Van Maldere and Eugène Godecharle. Additional repertoire will be collected through research in Belgian

Fig.9
Fig.10


VI.
SONATAS
FOR TWO VIOLINS
WITH A THOROUGH BASS FOR THE HARPSICORD, OR
VIOLONCELLO
DEDICATED
TO
The Honorable Society of Gentlemen
Performers at the Morning Concerts
in the Musick Hall in Crow Street
COMPOSED
BY
P. VAN MALDERE
First Fiddle to His Royal Highness
Prince Charles of Lorrain's Band
of Musick at the Court of Brussels.
DUBLIN Printed for and Sold by the Author in Moor Street.
and at Wm Manwaring's Musick Shop in College Green

music archives and private collections, in collaboration with Dr. Bruno Forment and Dr. Anne-Emmanuelle Ceulemans.

One specific musical focus relates to the performance of the Brussels trio sonata repertoire with only three bowed stringed instruments. Although many present-day performances of similar, more well-known repertoire are, as an unwritten rule, performed with the accompaniment of a polyphonic instrument—mostly a harpsichord—the current study aims at performance experiments with the cello as sole accompanying instrument. A substantial number of original mid-eighteenth-century trio sonata editions prescribe a basso continuo of "harpsichord *or* violoncello", as is the case, for example, with the c.1752 edition of Van Maldere's "VI. Sonatas for two violins with a thorough bass" [8, 9] (see **Fig.10**). This implies a forgotten performance practice featuring only the cello as accompanying instrument, as also put forward by Watkin [10]. Possibly, the publishers of such printed music hoped to sell more copies by also addressing musicians that did not have access to a harpsichord. By performing the music with just a bowed string trio, we want to explore the sonic and harmonic implications of choosing that particular, currently overlooked setting.

Fig.9 Musicians Ann Cnop (left), Mathilde Wolfs (middle) and Shiho Ono (right) with the replicas.

Fig.10 Title page of the first edition of Pieter Van Maldere's "VI. Sonatas for two violins with a thorough bass for the harpsicord, or violoncello" (Willy Van Rompaey collection).

The musical performance phase provides a sensible, sounding and satisfying way to round off this study on the life and creative output of the maker Boussu. With respect to a possible future continuation of the research, various additional scientific investigations, such as a true chemical analysis of his varnish using gas chromatography methodology and wood dating through dendrochronology, could be performed to further complement the knowledge regarding the instruments of Boussu.

4. Conclusion

In the past, makers have been firmly involved in examining and copying historical instruments. This tendency only grew stronger with the emergence of the "Early Music revival" in the middle of the twentieth century, when the demand for truly faithful instrument replicas increased. Although makers thus developed many initiatives, written scientific output documenting their efforts remains scanty, a few exceptions aside.

This essay has advocated for the emancipation of makers towards full-fledged organological scholars, or at least for bridging the gap between the worlds of academia and craft. The makers' unique understandings, experiences and practical abilities can be beneficial additions to the field of musical instrument research, if only they were prepared to strengthen their academic competences, including the adaptation of scientific methods and practices and the publication of results through the appropriate channels.

As argued, a maker's "workbench research"—the production of actual reconstructions or replicas including the assessment of proposed making techniques and procedures—is especially valuable, since makers form the only group within the instrument-studying community capable of conducting these kinds of performative methodologies. Such activities, comparable to those performed during experimental archaeology, will always evoke new questions, and therefore, the making process itself is just as important as the tangible products it creates or studies; practical experimentation enables the liberation of embedded or silent information contained within the objects under examination. The knowledge thus unleashed will partly manifest itself immediately, and partly precipitate slowly in years to come.

The case study presented is intended to illustrate the concept of "informed instrument making", where eventually replicas (or reconstructions) are built based on a profound and multi-faceted research of instruments, methods and biography of a maker, ultimately in function of the musical performance practice. Judging from this presented case, the many resulting and fruitful collaborations with leading experts in various fields—radiologists, law historians, musicologists, performers—confirm that instrument (re-)construction can indeed act as the catalyst as well as the adhesive for multi-disciplinary organological research projects. One may even go so far as to state that an exertion delving so deeply and comprehensively into the life and output of an original maker will not merely produce a replica, but a "new original", as if the present-day re-constructor had the opportunity to apprentice—seemingly beyond time-barriers—with the original maker. Following this reasoning, the resulting product of such a process should be the ultimate "authentic performance tool".

Furthermore, by performing and publishing such multi-faceted study on a relatively unknown maker like Boussu—who may be considered a mere footnote in instrument-making history by those who are commonly more attracted to the famous stars of the trade—the author hopes to inspire future research into the lives and work of some other minor gods of lutherie, to be able to bring the whole story, not just the glamorous side.

On a personal note, my own academic formation in chemistry may have helped in the adoption of a scientific approach in instrument research and making. Would things have been different without this background? That question is hard to answer. Maybe curiosity, dedication, perseverance, an open and analytic mind and the willingness to generate and distribute new knowledge are much more important than any form of academic education. And the luck of being both a bit of a "doer" and a bit of a "thinker" by nature…

ACKNOWLEDGEMENTS: My thanks go to my promotors, Dr. Francis Maes (Ghent University) and Dr. Geert Dhondt (School of Arts Ghent), for their supportive guidance during my Ph.D. research project "Boussu Inside Out". I also want to thank the MIM staff for providing access to the Boussu instruments and assistance during the instrument examinations, with special mention of stringed instruments curator Dr. Anne-Emmanuelle Ceulemans, who also provided her expertly and encouraging advice and guidance in the Ph.D. project, and Joris De Valck, Simon Egan and former staff members Guy Buyse and Manu Frederickx. My gratitude further goes to co-promotor Dr. Bruno Forment and musicians Ann Cnop, Shiho Ono and Mathilde Wolfs for their wonderful contributions to the research project "The sound of Brussels anno 1760". Karel Moens recommended me to study the Boussu violin MIM inv. no. 2781, which marked the beginning of my quest for its maker's biography and output. I thank the many private owners, musicians as well as collectors and dealers of Boussu instruments for allowing me to study their treasured possession. CT scanning and data interpretation would not have been possible without the expertise and generous support of Prof. em. Danielle Balériaux, Dr. Berend Stoel, Dr. Tom Van Hoof, Dr. Emmanuel Coche, Dr. Etienne Danse and their hospital staffs. During the biographical research, Prof. em. Véronique Demars-Sion, Dr. Georges Martyn, Alexis Donetzkoff and Romain Le Gendre kind-heartedly provided their valuable help and advice. I also thank Willy Van Rompaey for giving me access to his personal sheet music library. The research project involving the performance on the instrument replicas has received a two-year research grant from the School of Arts Ghent. WoodMusICK COST Action FP1302 provided a STSM grant to support part of the archive research. I am grateful for both grants.

References

[1] B. D. Sherman, "Authenticity in Music," in M. Kelly, Ed., *Encyclopedia of Aesthetics, Vol. 1.*, 1st ed. Oxford: Oxford University Press, 1998, p. 167.

[2] N. Wilson, *The Art of Re-enchantment – Making Early Music in the Modern Age*, 1st ed. Oxford: Oxford University Press, 2014, p. 72.

[3] G. Verberkmoes, "Benoit Joseph Boussu (1703–1773): Violin Maker and Notary," *The Galpin Society Journal*, vol. 66, pp. 117–138, 262–264, 2013.

[4] G. Verberkmoes, "Made in Amsterdam: A Cittern by Benoit Joseph Boussu," *Early Music*, vol. 44, no. 4, pp. 628–630, 2016.

[5] G. Verberkmoes, A. E. Ceulemans, D. Balériaux and B. Stoel, "An Inside Look at Four Historical Violins by Brussels Makers," *The Galpin Society Journal*, vol. 69, pp. 109–136, 159–165, 2016.

[6] G. Verberkmoes, "Made in Amsterdam: A Cittern by Benoit Joseph Boussu," *Early Music*, vol. 44, no. 4, pp. 635–638, 2016.

[7] K. Moens, "Vioolbouw in de Oostenrijkse Nederlanden," *Arca Lovaniensis*, vol. 10/b, p. 152, 1983.

[8] P. Van Maldere, *VI. Sonatas for Two Violins with a Thorough Bass for the Harpsicord, or Violoncello.* Dublin: author, c.1752.

[9] W. Van Rompaey, *P. Van Maldere – Thematische Catalogus van de Instrumentale Werken*, 1st ed. Aartselaar: author, 1990, p. 23.

[10] D. Watkin, "Corelli's Op.5 Sonatas: 'Violino e Violone o Cimbale'?," *Early Music*, vol. 24, no. 4, pp. 645–663, 1996.

This publication is based upon work from COST Action FP1302 WoodMusICK
(WOODen MUSical Instrument Conservation and Knowledge), supported by COST
(European Cooperation in Science and Technology).
COST is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation. www.cost.eu

Illustrations: Front cover, Picasso, *Violon*, 1913-1914 (C) RMN-Grand Palais (Musée national Picasso-Paris) / Béatrice Hatala / Succession Picasso 2018;
Back cover, Spruce soundboard of classical guitar (3D-reflected-light microscopy image, fig.7 p.149) © Volker Haag
Layout: Lilli Lacombe
Printed in October 2018 by Présence Graphique, 37260 Monts
Printed in France