WoodMusICK

FPS COST Action FP1302

COST FP1302 WOODMUSICK:

SECOND ANNUAL CONFERENCE

EFFECTS OF PLAYING ON EARLY AND MODERN MUSICAL INSTRUMENTS

SEPTEMBER 9-10, 2015

THE ROYAL COLLEGE OF MUSIC, LONDON

CONFERENCE GUIDE

AND

ABSTRACTS

Conference organisation:

Lydia Cracknell, Conference Co-ordinator (Lydia.Cracknell@rcm.ac.uk)

Erin McHugh, Editorial and Administrative Assistant (Erin.McHugh@rcm.ac.uk)

Richard Martin, Conference Technology Assistant (Richard.Martin@rcm.ac.uk)

Royal College of Music Student Assistants:

Elia Benhamou
Keith Bowen
Anais Boyadjieva
Isobel Clarke
Charlotte Evans
Tiago Gomes de Matos
Elspeth Marrow

A sincere thank you to all the RCM staff who have been involved in the organisation of the conference and particularly the Estates Department, RCM Studios, Marketing and Communication, Box Office, Finance, ICT, Performance and Programming, Reception, the Heads of Undergraduate and Postgraduate programmes, and the Head of Historical Performance.

TABLE OF CONTENTS

COST Action committees	1
Call for papers	3
General Information	4
Venue Map	5
Conference Agenda	6
Abstracts	11
Presenter Biographies	66

COST ACTION COMMITTEES

COST ACTION WEBPAGE: www.woodmusick.org

http://www.cost.eu/COST_Actions/fps/Actions/FP1302

COST ACTION STEERING GROUP:

Chair: Sandie LECONTE (sleconte@cite-musique.fr)
Vice Chair: Pascale VANDERVELLEN (p.vandervellen@mim.be)

Claudia FRITZ (claudia.fritz@upmc.fr)
Marco FIORAVANTI (marco.fioravanti@unifi.it)
Michael KALISKE (michael.kaliske@tu-dresden.de)
David MANNES (david.mannes@psi.ch)
Marco A. PEREZ (marco.antonio.perez@upc.edu)
Carmen-Mihaela POPESCU mihaela_cpop@yahoo.co.uk
Gabriele ROSSI ROGNONI (g.rossirognoni@rcm.ac.uk)
Christina YOUNG (Christina.Young@courtauld.ac.uk)

COST MANAGEMENT COMMITTEE:

Chair: Sandie LE CONTE (sleconte@cite-musique.fr)
Vice Chair: Pascale VANDERVELLEN (p.vandervellen@mim.be)

Austria
Gregor WIDHOLM (widholm@mdw.ac.at)
Prof Simone ZOPF (simone.zopf@gmx.at)

Belgium
Pascale VANDERVELLEN (p.vandervellen@mim.be)
Manu FREDERICKX (manu.frederickx@hogent.be)

Bulgaria
Sotir GLUSCHKOV (sotirgluschkoff@abv.bg)

Czech Republic
Jan TIPPNER (jan.tippner@mendelu.cz)

Denmark
Stefania SERAFIN (sts@media.aau.dk)
Ture BERGSTROM (ture@bergstrom.dk)

Finland
Paula NISKANEN (paula.niskanen@metropolia.fi)

France
Iris BREMAUD (iris.bremaud@univ-montp2.fr)
Anne-Julie ETTER (anne-julie.etter@u-cergy.fr)
Claudia FRITZ(claudia.fritz@upmc.fr)
Stphane VAIEDELICH (svaiedelich@cite-musique.fr)

Germany

Michael KALISKE (michael.kaliske@tu-dresden.de)

Frank BAR (f.baer@gnm.de)

Greece

Anastasia POURNOU (pournoua@teiath.gr)

Dr Dionysios KATERELOS (d.katerelos@gmail.com)

Hungary

Ferenc DIVOS (ferenc.divos@skk.nyme.hu)

Denes VARGA (vargadenes@nyme.hu)

Ireland

Mauro FERREIRA (ferreirm@tcd.ie)

Italy

Marco FIORAVANTI (marco.fioravanti@unifi.it)

Renato MEUCCI (renato.meucci@gmail.com)

Netherlands

Jouke VERLINDEN (j.c.verlinden@tudelft.nl)

Erik TEMPELMAN (E.Tempelman@tudelft.nl)

Norway

Vera DE BRUYN-OUBOTER (vera.de.bruyn@ringve.no)

Peder GJERDRUM (pedergj@online.no)

Andreas TREU (ant@skogoglandskap.no)

Jan TRO (jan.tro@ntnu.no)

Poland

Piotr BORYSIUK (piotr_borysiuk@sggw.pl)

Portugal

Jos XAVIER(jxavier3@gmail.com)

Patricia BASTOS (plopesbastos@gmail.com)

Maria Carolina VARELA (maria_carolina_varela@hotmail.com)

Romania

Carmen-Mihaela POPESCU (mihapop@icmpp.ro)

Serbia

Dragana SUMARAC-PAVLOVIC (dsumarac@etf.rs)

Slovenia

Andreja KUTNAR (andreja.kutnar@upr.si)

Katarina CUFAR (Katarina.Cufar@bf.uni-lj.si)

Spain

Marco A. PEREZ (marco.antonio.perez@upc.edu)

Enric GUAUS (enric.guaus@esmuc.cat)

Switzerland

David MANNES (david.mannes@psi.ch)

Marjan GILANI (Marjan.Gilani@empa.ch)

United Kingdom

Gabriele ROSSI ROGNONI (g.rossirognoni@rcm.ac.uk)

Christina YOUNG (Christina.Young@courtauld.ac.uk)

2015 COST FP1302 Woodmusick

EFFECTS OF PLAYING ON EARLY AND MODERN MUSICAL INSTRUMENTS

London, Royal College of Music, 9-10 September 2015

Aside from a few exceptions, musical instruments are very efficient tools, designed and built with the aim of combining the best musical result with ergonomic and economic considerations. However, as with many tools, their durability is closely connected to high structural tension, the reaction of materials to wear, chemical and humidity changes, and many other technical issues. The situation is further complicated by cultural expectations to experience the sound of musical instruments both passively and actively, regardless of their age.

It is sometimes the case that some instruments, for example those of the violin family, are used almost continuously for three hundred years or more. Their cultural appeal goes far beyond consideration of their sound, eventually leading to the idea that use is vital for their long term conservation. On the other hand there exist instruments, particularly from the keyboard or woodwind family, which have been restored to playing condition after long periods of rest due to increased interest in performing early music on original instruments over the course of the twentieth century. Conversely, other instruments are considered too fragile to be used and are therefore preserved for their cultural and aesthetic value, sometimes being used as models for the creation of functional copies. In all these cases, issues arise with regard to the effects of use and the choices of makers, the taste of performers, as well as with changing conservation policies and techniques: how is sound affected by continuous use, what effects does it have on the short and long term conservation of the materials, how does this affect decisions concerning modern replicas, how can preventive techniques help to minimise risks connected to use and improve musical performance?

Issues related to the use of instruments are also a primary concern for contemporary makers – both historical and present day, who are continuously experimenting with new materials and practical techniques in order to improve the performance and resilience of newly constructed instruments. While there are several elements that guide the choice of materials and working techniques, the reaction of the instrument to performance under a variety of conditions is certainly one of the leading ones. How do traditional and innovative materials react to playing? How much are cultural choices led by issues related to performance? How does the choice of different materials affect the performer and the audience?

This conference aims to broadly address the implications of playing on original and contemporary instruments and on replicas, with particular attention to:

- Historical and contemporary approaches to the choice of materials in musical instrument construction and the implications of such choices for performance.
- Monitoring and predicting the short and long term reactions of instruments to being played/not played.
- Acoustical and perception analysis of early musical instruments in action, also in comparison with replicas.

USEFUL INFORMATION

Delegate pack

Your delegate pack contains the following:

- Name badge
- Conference booklet
- Notebook
- Tube map
- Pen and pencil
- RCM leaflets

Lunch and refreshments

Refreshments (tea/coffee) and lunch will be available in the Britten Theatre foyer during breaks in the scheduled programme, see the conference timetable for details.

Internet facilities

Internet access is available with the following log-in details:

SSID - **Events**

Password – **wonderworld2015**

Assistants

Several RCM students are kindly assisting with the event. Identifiable by "student assistant" badges, they are available to answer questions and provide general assistance.

Emergencies

In the event of an emergency, please notify a student assistant or member of the RCM staff. In case of a fire, an alarm will sound and all delegates and members of staff will be asked to leave the building through designated emergency exits.

Please see the map on the following page to identify the shortest way to the emergency exit.

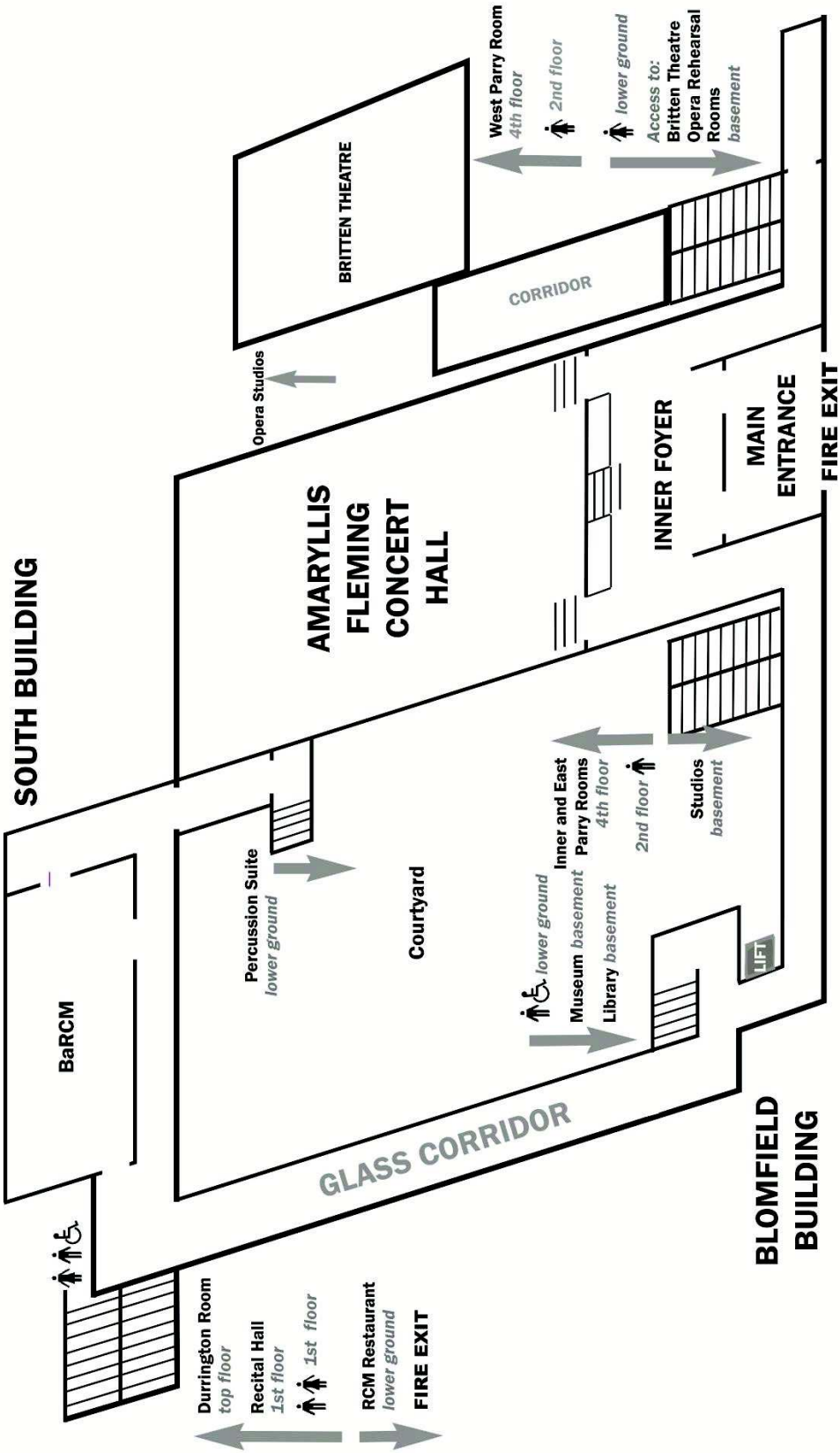
Instructions for presenters

Due to the busy conference schedule, it is vital that sessions keep to time. Speakers should ensure that their equipment needs are met before the start of the session. If you have not sent your presentation ahead of the conference, please report to the technology assistant at the conference table at the beginning of the coffee break before your session.

Restrooms

The nearest restrooms are located adjacent to the mezzanine level of the Britten theatre Foyer. Accessible toilets are located on the lower level next to the bar.

MAP OF RCM/VENUES



COST FP1302 WoodMusICK: Second Annual Conference

THE EFFECTS OF PLAYING ON EARLY AND MODERN MUSICAL INSTRUMENTS

CONFERENCE AGENDA

Wednesday 9th September 2015

08:15 Registration Begins (RCM main entrance, Prince Consort Road)

09:00 *Welcome address*, Kevin Porter (Deputy Director, Royal College of Music, London)

09:15 Perspectives from a Changing Culture: One Hundred Years of Debate on the Role of Musical Instruments

Gabriele Rossi Rognoni (Royal College of Music, London)

Session 1a, *Britten Theatre,* Chairs: Giovanni Paolo Di Stefano

09:35 The Effects and Consequences of Playing on Historical Keyboard and Stringed Instruments

Oliver Sandig, Barbara Meyer (Royal Academy of Music, London)

10:00 Playing on Old Stringed Keyboard Instruments in the Museum Vleeshuis

Karel Moens (Museum Vleeshuis, Antwerp)

10:25 Preventing the Played Instrument's Suicide

Vera de Bruyn-Ouboter (Ringve Music Museum, Trondheim)

10:50 **Coffee break, *Britten Theatre Foyer***

Session 1b, *Britten Theatre,* Chair: Anastasia Pornou

11:10 Recommendations for Accessing Musical Instruments in Public Collections: 1985-2015

Renato Meucci (Conservatorio di Musica G. Cantelli, Novara)

11:35 Guitars in Different States

Heidi Von Ruden (Staatliches Institut für Musikforschung, Berlin)

Poster sessions, *Britten Theatre,* Chair: Claudia Fritz

12:00 Towards a Standard for 3D-computed Tomography: the MUSICES Project

Frank P. Bär[(1)] , Theobald Fuchs[(2)] , Sebastian Kirsch [(1)] , Christian Kretzer[(2)] , Markus Raquet [(1)] , Gabriele Scholz [(2)] , Rebecca Wagner [(2)] , Meike Wolters-Rosbach [(1)] (1. Germanisches Nationalmuseum, Nürnberg; 2. Entwicklungszentrum Röntgentechnologie, Fürth)

12:05 Play and Loose! A Study of the Oil Varnish's Modification by Different Aging Processes

Claudio Canevari [(1)] , Giusj V. Fichera [(2)] , Arianna Legnani [(3)] , Maurizio Licchelli [(2,3)] , Marco Malagodi [(2,3)] (1. Civica Scuola di Liuteria, Milano; 2. Università di Pavia, Laboratorio Arvedi, Cremona; 3. Università di Pavia, Dipartimento di Chimica, Pavia)

12:10 The Role of Tonewood Selection and Aging in Instrument "Quality" as Viewed by Violin Makers

Capucine Carlier, Iris Brémaud, Joseph Gril (University of Montpellier, Montpellier)

12:15 Automatic Detection of Worn Areas on Stradivari Violin Back Plates

Piercarlo Dondi ([1,2]), Luca Lombardi [(1)] , Maurizio Licchelli [(2,3)] , Marco Malagodi [(2,3)] Fausto Cacciatori [(4)] (1. Università di Pavia, Dipartimento di Ingegneria Industriale e dell'Informazione, Pavia; 2. Università di Pavia, Laboratorio Arvedi, Cremona; 3. Università di Pavia, Dipartimento di Chimica, Pavia; 4. Fondazione Museo del Violino Antonio Stradivari, Cremona)

12:20 Evolution in the Manufacture of the Basset Horn D'amour

Henri Boutin [(1)] , Gilles Thomé [(2)] , Sandie Le Conte [(1)] (1. Musée de la musique, Paris; 2. Independent Musician and Instrument maker, Paris)

12:25 Removal of Iron Oxidation Products Using Chelators: A Preliminary Application on a Wooden Guitar

Stavroula Rapti, Maria Petrou, Anastasia Pournou (Technological Educational Institute of Athens, Athens)

12:30 The Art and Science of the Rediscovery of an Eighteenth-Century Recorder

Gabriele Ricchiardi [(1)] , Luca De Paolis [(2)] , Lorenzo Cavasanti [(3)] , Manuel Staropoli [(4)] (1.University of Turin, Turin; 2. LDP Recorders, L'Aquila; 3. Conservatorio "Claudio Monteverdi" di Bolzano, Bolzano Bozen, 4. Conservatorio di Musica "N. Piccinni di Bari", Bari)

12:35 Levels and Angulations of the Left Hand: A Contribution to Violinistic Techique

Eliseu Silva [(1)] , Christopher Bochmann [(1)] , José Xavier [(2,)], Pedro Fonseca [(2)], Rui Garganta[(2)] (1. Evora University, Evora 2. University of Porto, Porto)

12:40 Characterization of Stiffness Components of Wood of Heterogeneous Plate Bending Tests

J. *Xavier[1,2], W. Cruz [1] , F. Pierron [3] , J. Morais [1] (1. University of Trás-os-Montes and Alto Douro, Vila Real; 2. University of Porto, Porto; 3. University of Southampton, Southampton)*

12:45 **Lunch, *Britten Theatre Foyer***

Session 2a, *Britten Theatre,* Chair: Miyuki Matsuo

14.00 Bringing back the 'Davidoff' Stradivari Violin to Playing Condition: Measuring Changes,

Stéphane Vaiedelich [1] , Sandie Le Conte [1] , Sylvie Le Moyne [2] , François Ollivier [2] , Camille Simon-Chane [1] , Florian Moreno [3] , Jean-Philippe Echard [1] (1. Musée de la musique, Paris; 2. UPMC, Saint-Cyr l'École; 3. Art Graphique & Patrimoine, Joinville-le-Pont)

14.30 Effects of Playing on the Practical Performance of Reed Used for Woodwind Instruments

Hikaru Akahoshi, Ryo Nakanishi, Eiichi Obataya (University of Tsukuba, Tsukuba)

14.50 Influence of the Surface Condition in Bore of Woodwind Instruments on the Acoustic Impedance

Henri Boutin [1] , Sandie Le Conte [1] , Benoit Fabre [2,3] , Jean-Loïc Le Carrou [2,3] (1. Musée de la musique, Paris 2. Univ. Paris, Paris 3. Institut d'Alembert, Paris)

15.15 Effects of Continuous Vibration on the Dynamic Viscoelastic Properties of Wood

Hikaru Akahoshi, Shuoye Chen, Eiichi Obataya (University of Tsukuba, Tsukuba)

15:40 **Coffee break, *Britten Theatre Foyer***

Session 2b, *Britten Theatre,* Chair: Joseph Gril

16.15 Effect of Transitional Moisture Change

Iris Brémaud (Université Montpellier, Montpellier)

16.40 Hygro-Thermal Behaviour of a Historical Violin during Concerts

Giacomo Goli [1] , Bertrand Marcon [1], Lorenzo Busoni [2] , Paola Mazzanti [1] , Alberto Giordano [3] ,Pio Montanari [4] , Bruce Carlson [5] Marco Fioravanti [1] (1. University of Florence, Florence; 2. Osservatorio Astrofisico di Arcetri, Florence; 3. Alberto Giordano & C.; 4. Pio Montanari, Genova; 5. Carlson and Neumann, Cremona)

17.05 Hygro-Mechanical Fe-Analysis of Wooden Objects: Importance of Reliable Prediction of Water Transport

Daniel Konopka, Michael Kaliske (Technische Universität Dresden, Dresden)

17.30 Activity reports: Short Term Scientific Missions, FM, Training Schools, Chair: Sandie Leconte

18.15 Visit to the Royal College of Music Museum

19.00 Conference Dinner

20.30 Concert, *Ensemble Florilegium*, ***Britten Theatre***

Thursday 10th September 2015

Session 3a, *Britten Theatre*, Chair: Pierre-André Taillard

09.00 Playing Historical Clarinets: Quantifying the Risk

Christina Young, Gabriele Rossi Rognoni (Courtauld Institute of Art, London; Royal College of Music, London)

09.25 Humidity in Woodwind Instruments Due to Playing: Effects and Risks for the Wooden Structure

Ilona Stein (Germanisches Nationalmuseum, Nuremberg)

09.50 Numerical Simulation of Piano Soundboard Strain

Jan Tippner, Václav Sebera (Mendel University in Brno, Brno)

10.15 Experimental Investigation of Non-Invasive Intervention

Marco Perez (Universitat Politècnica de Catalunya, Terassa)

10:40 Coffee break, *Britten Theatre Foyer*

Session 3b, *Britten Theatre*, Chair: Murray Campbell

11.15 3d Emendatio: Digital Improvement and Printing Of Musical Instruments

V. Lorenzoni [(1)] , Z. Doubrovsky [(2)] and J. Verlinden [(2)] (1. Foundation Estrade, The Netherlands; 2. Delft University of Technology, Delft)

11.40 Acoustical Performance of Original and Replica Baroque and Classical Bassoons: Design and Coupling of Contemporary Bocals and Reeds

David Rachor [(1)], Bryant Hichwa [(2)] (1. Professor University of Northern Iowa, Cedar Falls; 2. Sonoma State University, Rohnert Park)

12.05 The Next Generation Concert Piano

Chris Maene and Wolf Leye

12.30 Perceptive Study of Touch on a Pleyel Piano from the Collection of the Paris Museum of Music

Benoît Navarret, Maurice Rousteau (Musée de la musique, Paris)

13:00 Lunch, *Britten Theatre Foyer*

14.30 Management Committee Meeting, *Parry Room,* Chair: Sandie Le Conte

HYGRO-THERMAL BEHAVIOUR OF AN HISTRICAL VIOLIN DURING CONCERTS

Giacomo Goli (1), Bertrand Marcon (1), Lorenzo Busoni (2), Paola Mazzanti, (1), Alberto Giordano (3),Pio Montanari (4), Bruce Carlson (5), Marco Fioravanti (1)

1. GESAAF – University of Florence, Italy; 2. Osser vatorio Astrofisico di Arcetri, Italy; 3. Alberto Giordano & C., Italy; 4. Pio Montanari, Italy; 5. Carlson and Neumann, Italy

Introduction

Hygro-thermo-mechanical behaviour of an historical wooden instrument is an essential requirement to understand its behaviour under conservative conditions and during playing when it is allowed/allowable. The use of an instrument without short-time consequences depends first on the state of conservation of its structure (it should be strong enough) and second on the hygro-thermal stresses during its use or displaying. Swelling and shrinkage produce significant stresses, especially in transversal direction, that could damage the object integrity. To investigate the state of conservation as well as the playability of the Guarneri "del Gesù" violin (1743) known as the "Cannone", several experimentations were performed. A structural assessment and the computation of the deformative field under load were achieved in [Fioravanti et al. 2012]. The hygro-thermal conditions of conservation were assessed in [Goli et al. 2012] and the mechanical time-dependant behaviour in constant and variable relative humidity studied in [Fioravanti et al. 2013]. A hygro-thermal survey of the internal and external conditions of the violin during concerts was performed as well and some results are presented in this paper.

Method

To assess the hygro-thermal impact of a concert on the violin, effect of an exposition to a new environment and effect of the musician, a series of nine concerts was monitored. The violin mass was measured immediately before and at the end of each concert. The environmental conditions of the concert room were measured as well as the microclimatic conditions inside the violin itself. The measure of the environmental conditions was performed with a conventional data-logger, while for the violin interior a special wireless chinrest was developed as from [Goli et al. 2011]. The specially designed and instrumented chinrest is shown in Figure 1.

Figure 1: The dedicated designed and sensors equipped chinrest.

Results

The average conservation conditions inside the display case were 52.5% of relative humidity (*RH*) and a temperature (*T*) of 22°C. In Table 1 are reported the average values of relative humidity and temperature inside and outside the violin during each monitored concert.

#	*T ext (°C)*	*T int (°C)*	*RH ext (%)*	*RH int (%)*
1	*24.2*	*28.9*	*61.1*	*55.9*
2	*26.4*	*27.9*	*40.8*	*46.8*
3	*26.1*	*29.0*	*41.4*	*45.8*
4	*24.4*	*26.8*	*42.9*	*44.2*
5	*24.4*	*26.3*	*47.4*	*50.1*
6	*23.5*	*26.5*	*61.7*	*54.5*
7	*23.3*	*25.4*	*50.9*	*53.2*
8	*16.5*	*19.4*	*55.3*	*52.2*
9	*17.0*	*22.1*	*38.8*	*42.6*

Table 1: Average violin internal and external temperature and relative humidity during nine concerts.

In terms of equilibrium moisture content (*EMC*), the average conservation condition is estimated at 9.65% of moisture content according to [Simpson 1998]. In Table 2 are reported the computed average values of *EMC* inside and outside the violin during each monitored concert as well as the mass

variation between the start and the end of the concert. The time the instrument was kept out of indication of the time of exposure to a different thermos-hygrometric condition.

#	*EMC int (%)*	*EMC ext (%)*	*M (g)*	*TOC (hh:mm)*
1	*11.1*	*10.0*	*0.38*	*3:00*
2	*7.7*	*8.5*	*-0.65*	*2:45*
3	*7.8*	*8.4*	*-0.37*	*2:45*
4	*8.1*	*8.2*	*-0.39*	*2:00*
5	*8.7*	*9.1*	*-0.25*	*4:00*
6	*11.2*	*9.8*	*0.47*	*3:15*
7	*9.3*	*9.6*	*-0.15*	*4:15*
8	*10.2*	*9.6*	*0.08*	*4:00*
9	*7.6*	*8.1*	*-0.86*	*4:30*

Table 2: Average violin internal and external EMC, violin mass variation and Time Out of display Case (TOC) for the nine concerts.

Discussion

In order to verify the possibility to model the global hygro-thermal behaviour of the violin during concerts, it was studied the mass variation during the different concerts as a consequence of the following parameters:

- *RH* as the difference between the average conservation *RH* and the violin internal averaged *RH* during a concert (1);
- *RH* as the difference between the average conservation *RH* and the environmental averaged *RH* during a concert (2);
- *EMC* as the difference between the average conservation *EMC* and the violin internal averaged *EMC* during a concert (3);
- *EMC* as the difference between the average conservation *EMC* and the environmental averaged RH during a concert (4).

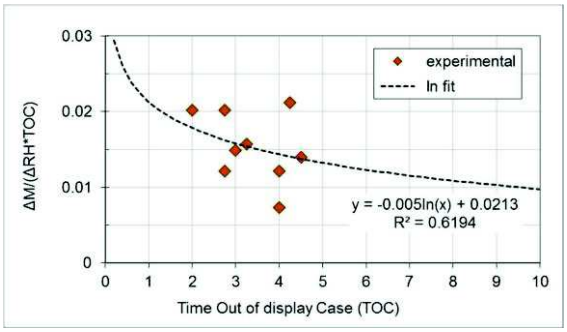


Figure 2: Mass variation in time referred to a variation of 1% between the RH inside the display case and the environment RH during concerts.

the display case (*TOC*) is also reported as a direct

The phenomena was studied in terms of being able to result in a reasonable logarithmic fit. This kind of regression is the one expected to explain the phenomena (deriving from Fick's law diffusion of water vapour). Among the whole cases the best fit resulted between the conservation *RH* and the environmental *RH* during the concerts with a normalised root-mean-square deviation (CVRMSD) of 26.1% (case 2). The experimental data and the logarithmic fit are shown in Figure 2.

Conclusions

In the present work the mass variation of an historical violin measured at the display case opening and at the end of the concert was studied. The general principle is that the mass variation is widely dependent on the difference between the hygro-thermal conditions inside the display case and the conditions measured during the concert. During playing the environmental conditions of the room were monitored as well as the conditions inside the violin. The fitting of the data with a logarithmic trend, being the one expected, has sown that among the various parameters considered (*RH*, *EMC*, inside and outside the violin) the difference between the average *RH* inside the display case and the average environmental *RH* is the parameter that better describes the mass variation. This research is a first step in the study of predictors of mass variation of a violin during a concert. Other step needs to be performed in order to associate to a given mass variation a potential risk for the instrument and thus guidelines for the conservation.

Acknowledgements

Authors would like to thank Dr. Laura Malfatto and Anna Rita Certo both working at Genoa Municipality for their cooperation and willing to perform this research. All our gratitude to the violin players Feng Ning, Mario Trabucco, Peter Sheppard Skærved, and Salvatore Accardo for having accepted to monitor their performances. Bogaro & Clemente had manufactured the dedicated chinrest. Mr. Danilo Dini was a valuable help to adapt the electronic and the sensors to the chinrest.

References

Fioravanti M, Goli G, Carlson B, Structural assessment and measurement of the elastic deformation of historical violins: The case study of the Guarneri "del Gesù" violin (1743) known as the "Cannone." J Cult Herit 13:145–

153, 2012. doi: 10.1016/j.culher.2011.07.005.
Fioravanti M, Goli G, Carlson B, Viscoelastic and mechano-sorptive studies applied to the conservation of historical violins: A case study of the Guarneri “d el Gesù” violin (1743) known as the “Cannone.” J Cult Herit 14:297–303, 2013. doi: 10.1016/j.culher.2012.08.004.
Goli G, Fioravanti M, Busoni L, Giordano A, Wireless monitoring of the internal hygro-thermal variations in a historical violin during playing: device design and first results. In: Krüger M (ed) Cult. Herit. Preserv. EWCH P-2011 Proc. Eur. Work. Cult. Herit. Preserv. Berlin, Ger. Sept. 26 to 28, 2011. Fraunhofer IRB Verlag, pp 195– 199, 2011.
Goli G, Fioravanti M, Busoni S, et al, Measurement and modelling of mass and dimensional variations of historic violins subjected to thermo-hygrometric variations: The case study of the Guarneri “del Gesù” violin (1743) known as the “Cannone.” J Cult Herit 13:S154–S160, 2012. doi: 10.1016/j.culher.2012.04.007
Simpson WT, Equilibrium Moisture Content of Wood in Outdoor Locations in the United States and Worldwide. 11, 1998.