



Berner Fachhochschule
Haute école spécialisée bernoise

Hochschule der Künste Bern
HKB - Konservierung und Restaurierung
Haute école des arts de Berne
HEAB - Conservation et restauration

Scientific Report

Project: COST- STSM IE 0601- 4854

Applicant:

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Host:

Prof. Marco Fioravanti
University of Florence
Department of Forest Environmental Sciences and Technologies (DISTAF)
Sect. Wood Technology

Duration of the stage:

3. - 9.5. 2009

Purpose of the visit:

Recently Bern University of Applied Sciences has become involved in a project aiming to improve preventive conservation and restoration of Wooden Cultural Heritage. The main objective of this project, which is funded by the Swiss National Science Foundation (SNF), is to investigate the physical and chemical deterioration of wood and paint layers as well as the study of the effects of long term environmental variations on the mechanical behaviour of panel paintings. One part of this project involves the numerical modelling of the hygroscopic behaviour of panel paintings and the subsequent verification of the model by experimental measurements of the dimensional movements of panel paintings exposed to different environmental conditions.

During the project it is necessary to develop a new method or adapt an existing one, which can measure three-dimensional movements of wooden panels with high precision.

The team of Prof. Marco Fioravanti at the University of Florence has nearly 20 years of experience in this field. In particular, they have developed several methods and instruments for measuring the relevant parameters in different experimental and applied situations. To profit from this knowledge I visited Prof. Marco Fioravanti's team at the University of Florence with the aim of discussing and learning of the methods they have developed.

Description of the work carried out during my one week stay in Florence

Oper / Opéra • Theater / Théâtre • Kunst / Arts visuels • Visuelle Kommunikation / Communication visuelle • Musik / Musique • Musik und Medienkunst / Musique et arts médiatiques • Jazz • Konservierung und Restaurierung / Conservation et restauration • Bildnerisches Gestalten / Enseignement des arts visuels • Y (Institut für Transdisziplinarität) / Y (Institut de transdisciplinarité) • Rhythmik / Rythmique

First, I received an introduction by Prof. Marco Fioravanti and Dr. Paola Mazzanti into DISTAF's most important past and current research, related to our project's objectives.

This includes measurements of dimensional movements during:

- experimental laboratory tests for basic research on hygroscopic behaviour of panel paintings
- long-term monitoring of real paintings in situ prior to or during restoration treatments
- evaluation of new restoration methods in close collaboration with conservator-restorers, e.g. of the Opificio delle Pietre Dure in Florence

Most of these studies rely on an electronic instrument, a so-called "linear displacement transducer" (LDT). Depending on the length of the extension of its "nucleus", the resistance of the transducer and the voltage output changes. Because the correlation of the length extension and the voltage output is linear, a precise measurement of the voltage allows for the calculation of the changes in length. This way, a resolution of up to 0.01 - 0.001 mm can be obtained, depending on the data-logger's resolution. In addition, electromagnetically transducers without any friction are used for special purposes. By combining several of the LTDs, different measurement setups can be build that allow for the investigation of a large variety of research questions.

The first application of a transducer-system was the monitoring of the "Maestà" di Giotto, Uffizi Gallery, published in 1992¹. In later studies the so called "Deformometric Kit" was developed for long-term-monitoring projects independent from external power supply². This instrument consists of a pair of transducers mounted on a special device, which provides a constant geometrical position of the transducers. The data are collected by a small data logger, which can register temperature and humidity simultaneously and work as the power supply for the whole system for up to one year.

The use of the Deformometric Kit, its calibration and the data processing was presented to me by the MA-Students Linda Cocchi and Damian Zazzeri, who use this instrument in their ongoing joint research project "Monitoring of the Triptychon „St. Pietro Martyre“ by Beato Angelico, Museo di San Marco, Firenze". Prof. Luca Uzielli and director Dr. Magnolia Scudieri kindly presented me the ongoing in-situ measurements at the Museum of San Marco.

I also received a short introduction by Dr. Paola Mazzanti into more complex transducer- systems such as the Monitoring Cross Beam³.

¹ Uzielli, L.; Fioravanti, M.; Casazza, O.; Perucca, G.: *A technique for double sided monitoring of the deformations of the wooden supports of panel paintings: the experience of Giotto's „Maetsà di Ognissanti“* in: 3rd International Conference on Non-Destructive Testing, Microanalytical Methods and environment for Study and Conservation of works of Art, Viterbo 1992 p. 501-514

² Dionisi Vici, P.; Fioravanti, M.; Uzielli, L.: *Monitoring moisture-induced deformations of panel paintings: reasons, requirements and a suggested equipment*. Unpublished manuscript from a talk presented at the Art 2002 7th International Conference on "Non-destructive Testing and Microanalysis for the Diagnostics and Conservation of the Cultural and Environmental Heritage, Antwerp 2002

³ Uzielli, L.; Dionisi Vici, P.; Ciatti, M.; Casazza, O.; Togni, M.: *A new approach for studying the restrained deformations of painted panels: the Monitoring Cross-Beam*. In: Proceedings of the 2nd International Congress for the Safeguard of Cultural Heritage in the Mediterranean Basin, Paris 1999

All these devices have in common that they require a permanent fixation on the object which is not possible for all panel paintings. For the measurement of more sensitive objects three methods without fixation are available:

- 1) Manual measurement were used, e.g. during the restoration work of “Madonna in Trono con Bambino” by Maestro di Panzano, Museo Civico di Montalcino in Siena, where it could be proved that the unusual bowing phenomenon was caused by a new cross-beam and that the removal of this cross-beam from the painting allowed the painting to regain its normal shape⁴. Using a similar method, the deformation of the “Mona Lisa” was investigated⁵.
- 2) A transducer-based system combined with a special device with slide bearings without any fixation to the panel painting was developed for the monitoring of the “Medusa”-shield by Caravaggio⁶.
- 3) An optical system based on optical interferometry was used to measure the dimensional changes in historical important music instruments in particular for historical violins⁷

From this variety of methods I focused on learning the theory and practice of:

- Different levels of precision during measurements
- Requirements for the different transducer Types (LDT)
- Details for planning the mechanical parts of the mounting devices
- Data logger types and requirements for an independent system (“Deformometric Kit”)
- Use and programming of the data logger
- Adaption of the electronic components for individual purposes
- Calibration of the transducers
- Geometrical principles of the calculations
- Raw data processing in Excel and calculation of the relevant parameters

This basic knowledge will enable me to establish different measurement devices at the HKB in Berne designed for the requirements of our research project.

⁴ Allegretti, O.; Bertini, P.; Casazza, O.; Fioravanti, M.; Uzielli, L.: *Dimensional stability of the wooden support of a Middle Age panel painting: Laboratory tests on the influence of the cross beams*. In: Proceedings of 1st International Congress on Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin, Catania 1995 S. 751-757

⁵ Uzielli, L.; Dionisi Vici, P.; Gril, J.: *Mechanische Charakterisierung des Bildträgers*. In: Im Herzen der Mona Lisa – Dekodierung eines Meisterwerkes. Paris, München 2006, S. 52-53

⁶ Uzielli, L.; Cardinali, E.; Dionisi Vici, P.; Fioravanti, M.; Salvioli, N.: *Structure, mock-up model and environment-induced deformations of Italian laminated wood parade shields from the 16th century*. Paper presented at the COST Action IE0601/ESWM-International Conference, Braga 2008

<http://www.woodculther.com/wp-content/uploads/2008/11/uzielli.pdf>

⁷ Fioravanti, M.; Mazzanti, P.; Goli, G.; Rossi Rognoni, G.: *Physical and mechanical characterization of ancient wooden musical instruments for their conservation*. Paper presented at the COST Action IE0601/ESWM-International Conference, Braga 2008

<http://www.woodculther.com/wp-content/uploads/2008/10/fioravanti.pdf>

Network building:

In addition to the project orientated questions I had the opportunity to establish a contact to the Opificio delle Pietre Dure (OPD), the international renowned restoration institution in Florence where we discussed possible future student exchanges. Dr. Marco Ciatti, director of the section for restoration of mobile paintings, wall-paintings and textiles kindly showed me the restoration workshops where I had the possibility to get a detailed impression of ongoing or recently finished restoration work, including:

- Triptychon by Mantegna, Pala di San Zeno, Verona
- Tabernacolo dei Linaioli by Beato Angelico, San Marco Museum, Florence
- Crucifix by Brunelleschi, Santa Maria Novella, Florence
- Canvas Paintings "The lady in the blue robe" by Tizian, Galeria Palatina, Florence
- Cruzifix by Giotto from the Church of Ognissanti, Florence
- The earliest Canvas Painting from Tuscany

I also had the opportunity to meet Dr. Alessandra Griffo, Head of the school of restoration of the OPD.

Future Collaboration with host institution:

Based on the knowledge obtained during my stay in Florence we will soon start with the practical experiments with a LDT transducer system at the HKB Bern.

A further development of this system for the more challenging topics of our project will be performed in close collaboration with Prof. Marco Fioravanti and his team, who is collaboration partner during the next three years of our joint Swiss National Foundation (SNF) research project. Further exchange meetings with members of both working groups are intended.

For measurements of real panel paintings that do not allow for any invasive treatment, the adaptation of optical measuring methods is necessary in the future. A further exchange on this topic with Prof. Marco Fioravanti is planned.

Projected publications /articles:

Implementing measurements with a Transducer-System will be a starting point for a whole range of experiments concerning hygroscopic behaviour of wood at the HKB in Berne.

The first experiments are ready to start in early June 2009. They will evaluate the predictions made by the numerical model of the behaviour of a spruce panel under different humidity conditions, which is part of the MA-Thesis of Julien Froideveaux, EPFL Lausanne. After these first steps have been finished, which is scheduled for the end of August 2009, a publication is planned.

Further experiments on the modelled behaviour of fresh, old, and artificially aged panels -either with or without paint layer-coating on one side - will be carried out during the next three years of the SNF project. Publications of these results are planned as well.

Bern, 2.6.2009

