Conserving culture

Associate Professor Nathalie Bäschlin and **Matthias Läuchli** both work at the Bern University of the Arts, Bern University of Applied Sciences, Switzerland, which encourages interdisciplinary research between the arts and the sciences. Here, they expound upon the importance of their fragile artwork conservation project

What impacts are you specifically hoping to protect fragile artworks against?

NB: We are convinced that the exposure of paintings to continual vibrations, which arise from the quality of roads, from the engines or wheels of trucks and trolleys, has hitherto received too little attention. Vibration levels are relatively low, but in the case of long distance and repeated transportation, paintings are impacted by a great number of stress cycles. Fragile paintings are especially in danger of being damaged due to layers of paint having become, to an extent, brittle or loose. Additionally, long-term damage can result because the materials can, as a consequence, age more quickly.

Could you explain the effects that shock absorption and vibration damping may have on such valuable items? How will you be monitoring the damping process?

NB: You have to understand a painting as a multilayered and inhomogeneous system comprising a great diversity of different materials: fabric or rigid supports with ground layers, paint layers and sometimes varnishes made of binding media, pigments, and often filler and other additives. The mechanical stresses, especially in combination with variations in temperature and relative humidity, induce strain that can lead to the paint layers cracking and lifting.

By monitoring the actual transportation of paintings, we compare measurements of vehicle movement in transporting the artworks and movement of the paintings. This allows us to judge the damping characteristics of various forms of packaging. According to the field of application, different sensors and loggers are used, which triaxially measure and record acceleration at a rate of 1,600 Hz.

Have you employed any innovative methods or techniques to conduct your field and laboratory tests?

ML: The paintings and their complex and inhomogeneous materiality demand innovative approaches and solutions. The focus must not only be restricted to the choice of measurement or investigative methods, but also how they should be adapted to the experimental setup. The cultural significance and often great economic value of the paintings forbid us the use of real paintings as test objects.

Production of representative test paintings for a selection of damage phenomena or the development of a simulation device by engineers in the research group; the adaptation and implementation of extremely sensitive measuring technology to assess the impact on fragile paintings during international transportation; and documentation of their mechanical properties (data gathering) – this all demands innovative approaches that enable us, for the very first time, to provide scientifically founded specific values and statistically relevant data for this research problem.

With whom are you collaborating? How important is an interdisciplinary approach to your work, and what does each member contribute to the team?

NB: The research project follows an interdisciplinary approach comprising experts in conservation and restoration from Bern University of the Arts, and engineers from the Institute for Mechatronic Systems, Bern University of Applied Sciences. Furthermore, conservation experts from museums are also involved in the project as research partners. They make a fruitful contribution to the research team through their practical experience and provide important opportunities for obtaining field measurements during the actual transportation of fragile paintings. Another main pillar of the project is our four business partners: a Swiss insurer and three major Swiss art transporting companies are collaborating in order to guarantee the transfer of research results into practice.

What challenges or limitations have presented themselves during the project, and how have you overcome them?

ML: Assessment of the fragility of paintings is based on the knowledge of the properties of a variety of possible materials and their interaction in the equally wide scope of techniques employed – there are no standard techniques.

Increasing degradation of materials and material structures generally leads to increased fragility. As such, and in contrast to industrial production, the mechanical characteristics of artworks can only be monitored in a very limited way. Particularly in the case of specific vibration damping, characteristics can only be determined if we know the eigenfrequency of the painting. In transportation practice, it is impossible to monitor such complex data in every individual case. A possible solution to this problem is for us to compile a large collection of mechanical data in order to evaluate our laboratory and field tests and use them as empirically established values for development plans.

To **preserve** and **protect**

In the 21st Century, the need to protect valuable cultural objects from the pressures of globalisation is ever more apparent. An interdisciplinary team based in Switzerland aims to do just that, by understanding and mitigating the effects of travel on canvas

AS EMERGING MIDDLE classes in China and other developing countries begin to demand art exhibitions, increasing numbers of exhibitions are international, and destinations are becoming more far flung. This movement towards art globalisation is clearly incredibly important in fostering for the future in many ways, such as encouraging cross-pollination of artistic ideas and a global sense of community, but it also has its costs for art's past. International travel is not ideal for fragile canvasses that are often hundreds of years old. Works of art can be worth untold amounts of money, and their cultural importance is priceless, so protecting them from the dangers presented by long journeys to exhibitions is a priority.

BEYOND BORDERS

The problem is an interdisciplinary one, and goes even further than the relatively narrow interdisciplinary collaboration that happens when scientists begin to talk – aspects from engineering, conservation, history of art and economics come into play. This is the range of experience from which the team behind several important papers on this issue draws. Comprising Swiss researchers, the project 'Transport of fragile paintings' is led by Associate Professor Nathalie Bäschlin and Matthias Läuchli from Bern University of the Arts, Bern University of Applied Sciences; two experts in conservation and restoration who bring together specialists from academia, museums, freighting and insurance companies.

Special insulated box for a very fragile painting with important brittle and low cohesion impasto.

The team aims to use this expertise to better characterise the forces that act upon paintings when in transit between exhibitions, providing a better understanding of the risks involved for curators and insurers by defining the amount of force that different artistic objects can withstand, and also to suggest better methods for safeguarding them in transit.

A SCIENTIFIC APPROACH

A key difficulty the researchers face is reliability. Paintings have to go through a diverse range of different transport routes and will therefore undergo a variety of forces. It is unfeasible to take complex readings in a real vehicle, and so the team has built a transport simulator, which can induce and measure linear acceleration in all three axes, at values up to 50 ms^{-2}. Furthermore, the simulator is able to create vibrations of up to 100 Hz that can be directly read from measurements taken from real journeys. These vibrations are filtered so there is nothing below 1 Hz, as this cannot be replicated by the simulator and such vibrations are unlikely to be a serious cause of damage.

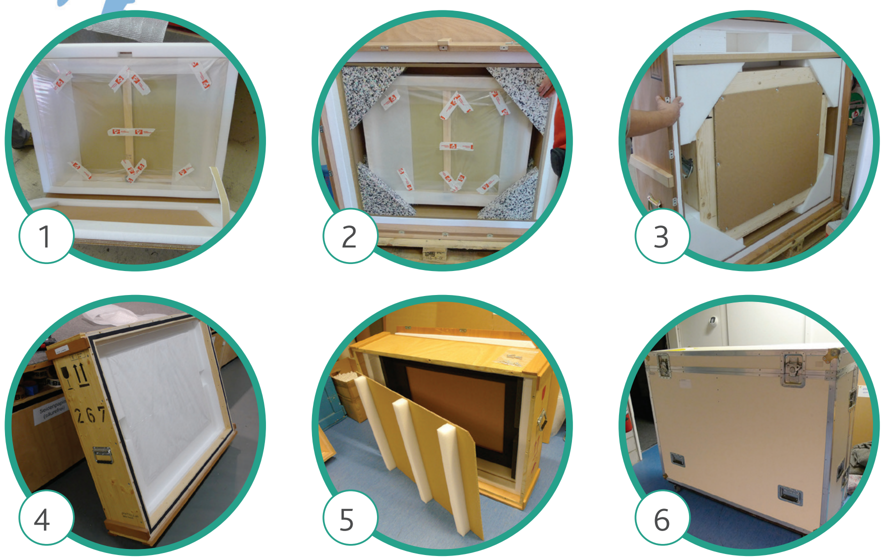
The paintings tested have a wide variety of potential shielding materials, comprising different thicknesses of corrugated cardboard for backing, vibration protection with combinations of polyester, cardboard and different types of foam, and glass glazings. Whilst it may seem apparent that the best option is to simply protect each painting with as thick and as many layers as possible, vibrating systems with multiple parts often exhibit hard to predict resonating behaviour, with particular frequencies inducing very high vibration amplitudes. In order to mitigate the effects of vibration properly, the resonating behaviour of the different parts of the system must first be characterised independently and then in concert.

Two collision events were used to test these protection systems. Both were captured from sensors mounted to a real painting undergoing transport. The first simulated a bumpy journey in a two-axle vehicle, and the second a shock event caused when a painting being transported in a wheeled carry case collides with a door frame. It was found that the majority of the displacement in the vehicle travel sequence was in the *z*-direction (perpendicular to the painting's surface), and this was attributed to pot holes, whilst the carry case collision had acceleration concentrated in the *x*-direction (perpendicular to the street surface).

CHARACTERISING COLLISION

Frequency spectra characterisation was undertaken using Fourier analysis, finding that the trolley journey comprised of largely low frequency vibration punctuated by the single collision, and the truck journey was made up of continuous high-frequency vibration. The differences in these environments lead to different protection systems being more effective, and so an interesting potential area of study is in systems that can act selectively and damp only when they are most appropriate.

When the sample painting was damped with the protective systems, it was found that the glazing-canvas-backing board system indeed had very different vibrational properties to each individual component. This has important implications, as tuning the resonant frequencies of the system could lead to a highly vibration-resistant system. The final results showed that certain backings



Selection of packaging systems tested.

had better properties, with rigid corrugated or honeycomb shapes producing the best results. Backings were also found to be more effective than glazings, and a 5 mm gap between the canvas and polyester fleece was optimal. An important result of the study was also to show that some of the backing board materials, used as a common practice, can actually enhance rather than dampen vibrations, due to coupling effects between backing board material and canvas.

ON THE ROAD

After examining these preliminary systems and showing the ability of their simulation to characterise how well different protection systems withstand vibration, the next step was to test systems used in real transport. Several different insulating boxes were chosen for this test, including standard insulated transport frames, a full flight case and a simple cardboard box commonly used for short-distance transport.

The characteristics of these boxes were tested by mounting them with data loggers and placing them in trucks. These trucks were then driven through a variety of environments to analyse the differences caused by varying road conditions. They were also put through more extreme tests, such as an emergency stop and being driven through a quarry for a short time. By simultaneously placing a data logger in the truck outside the insulating boxes, it was possible to evaluate the impact of the damping mechanisms. Furthermore, the accelerative landscape of the interior of the trucks could be mapped, revealing that the loading area is subjected to less force than the walls and that shock events tend to have most force above the rear axle.

Although one of the greatest concerns – shocks – were damped well by all packaging methods, none damped vibrations successfully. In fact, the insulating boxes were found to amplify the vibrations over an extremely broad range of frequencies. The team postulates that this is because the insulating foams are not loaded to the correct levels, meaning their vibrational insulating behaviour is mitigated, or even reversed.

TOWARDS PROTECTION

The progress already made by Bäschlin and Läuchli's group shows that a scientific approach has the potential to change standard ideas. Art galleries had a good understanding of how to package paintings, drawing from their extensive and valuable experience and their customer's preferences, but scientific testing has shown that there is still much to learn.

The fact that most literature values for acceptable levels of strain to be placed on paintings are based on modern materials rather than fragile canvasses that are hundreds of years old underscores the immediate necessity of a better understanding of strain levels. The new recommendations made by the group – for different materials and a better understanding of the coupling behaviour of composite systems, as well as their new emphasis on gathering data – will make for safer transport for some of our most valuable pieces of culture.

INTELLIGENCE

TRANSPORTATION OF FRAGILE PAINTINGS – NEW DEVELOPMENTS FOR EFFECTIVE DAMPING TECHNIQUES

OBJECTIVES

To document the scale of shock and vibration experienced during transit of paintings, assess the risk, set tolerance levels and develop new effective damping strategies.

KEY TEAM MEMBERS

Matthias Läuchli, Conservator, Project Co-manager, research associate • **Cornelius Palmbach**, Conservator, research associate • **Thomas Fankhauser**, engineer, research associate (until 2013) • **Marcel Ryser**, engineer, research associate (since 2013) • **Anita Hoess**, Conservator, research associate • **Dr Giovanna di Pietro**, physicist, research associate (until 2010) • **Claudia Bäschlin**, Art historian, Assistant project manager

KEY PARTNERS

Institute for Mechatronic Systems, Bern University of Applied Sciences (BUAS) • **Gaston Latscha; Pascal Müller**, Nationale Suisse • **Peter Haas**, Möbeltransport • **Vinicio Cassani**, VIA MAT ARTCARE AG • **Josi Kraft**, KRAFT ELS. AG • **Aargauer Kunsthaus Aarau • Kunstmuseum Basel • Kunstmuseum Bern • Zentrum Paul Klee Bern • Museo d'Arte Lugano • Kunstmuseum Luzern • Fondation Beyeler Riehen • Kunsthaus Zürich** • until 2011: **Institute of Electronic Structure and Laser**, Foundation for Research and Technology – Hellas (IESL-FORTH)

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NATHALIE BÄSCHLIN graduated in conservation and restoration at Bern University of the Arts, BUAS in 1992. She has been Conservator at the Museum of Fine Arts Bern since 2000, and Associate Professor for Conservation and Restoration, Bern University of the Arts, BUAS since 2002.

MATTHIAS LÄUCHLI graduated in conservation and restoration at Bern University of the Arts, BUAS in 2004, and has worked as a conservator, researcher and project co-manager at the Atelier für Konservierung und Restaurierung Kaufmann, Muri AG since 2007. He has been a member of the academic staff at Bern University of the Arts, BUAS since 2010.