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Beckmann's Carnival in motion

– restoration work on Beckmann's Carnival is backed up by accompanying vibration measurements –

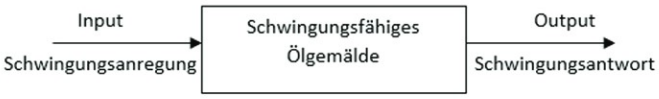
Katrin Radermacher, Daniela Hedinger, Kerstin Kracht

Vibration-reducing measures for paintings: there are a thousand questions but many have no answers yet. Now, though, the vibration measurements made during restoration of Beckmann's Carnival have made some aspects clearer.

When it comes to reducing the effects of vibrations in a painting, the object's intrinsic vibration behaviour is the key element.

However, "intrinsic" also means taking account of a multitude of combinations of picture support, format, painting background, pigment, condition, glass front, vibration protection and so forth. Restorers and curators have decades of empirical experience. Quantitative evidence is lacking in many respects, though. One example is the questions relating to vibration protection, such as which material should be used, how thick or thin should it be, should vibration protection also be applied at frame cross-pieces, when does vibration protection really make sense, and can it also be counterproductive?

To answer these questions, the vibration behaviour of Max Beckmann's painting Carnival was investigated in various configurations before and after the restoration. The restoration work on Beckmann's Carnival was carried out as part of a larger restoration project started by Kunsthalle Mannheim in January 2017. This project was associated with an imminent move of the collection into the new building. Katrin Radermacher was responsible for the project management and Daniela Hedinger for the restoration work. Dr Kerstin Kracht carried out the vibration measurements and the evaluation, with TU Berlin providing the technology for the measurements.



Input-output model for vibration engineering

Carnival by Max Beckmann before restoration, © D. Hedinger, K. Radermacher

Detail, oblique light from the left, significant unevenness and departures from the plane, © D. Hedinger, K. Radermacher

Max Beckmann has depicted himself and his second wife, Quappi, in the costumes of Italian comedy characters – a double portrait, dressed for Mardi Gras. Beckmann's Pierrette and Clown is one of a series of carnival depictions in which the artist portrays himself.

Why was Beckmann's Carnival chosen? On the one hand, it is one of Kunsthalle Mannheim's most important works. On the other, preliminary examinations of the painting showed that it was an ideal test case for metrological examination and answering the questions posed above. Before the restoration, this painting was a poorly tensioned portrait-format canvas, incorrectly stretched at the edges, with cracks and holes at the bottom corners and poor paint layer adhesion in places.

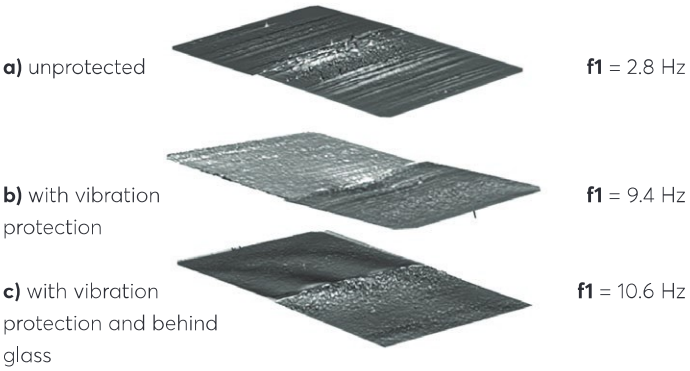
The vibration behaviour of the painting before the restoration was largely determined by the condition of the canvas and the clamps. The canvas is a plain woven flax fibre type. Given the dimensions of the painting, at 160 x 100 cm, it is very fine at about 36 x 30 threads per cm . It is assumed that the warp (36 threads/cm) runs in the longitudinal direction, i.e. vertically. The threads are Z-twisted and are on average 0.14 and 0.16 cm thick. The fabric fill (according to B.J. Rouba) is AV = 50.4%, AH = 48%, AHV = 74.2%. There are various irregularities in the threads of the canvas, such as knots, thicker parts and weaving errors. In the area of Quappi's face, for example, some weft threads are missing. The tension was generally insufficient and uneven, the canvas sagged and flapped about as it moved and there were clear indentations (especially along the edges). The staples stretching it were at distances of up to 12 cm apart. The stretcher frame was not aligned perpendicularly before clamping but was instead shifted to the left to create a parallelogram; additionally, it is warped so that the upper right corner has moved about 1 cm backwards.

As far as the paint layers are concerned, the water-soluble, cream-coloured primer was applied mechanically. The oil-bound paint (no analysis) is predominantly thin and matt, but applied in parts impasto, such as in the flesh tones and the white. The canvas structure is largely visible through the many areas with thin layers of paint. The painting shows only a little incipient craquelure due to shrinkage and it was not varnished. In a few areas the paint layer has come away from the substrate, especially in the partly brittle and splintery green. Both here and in the blue dress, some paint layer flaking could be found. Interestingly, that flaking was found precisely in the central areas of the picture, which were later shown to be particularly susceptible to movement. In addition, protrusion damage was found throughout the entire paint layer.

As is typical for much-travelled paintings, the paint layer had suffered friction in several places and showed various kinds of partial staining. The paint layer had, as a later addition, been given a thin coat of wax over the entire surface. The entire painting was covered with a very thick layer of surface contamination that was black, comprising finely divided particles, oily and tackily sticky. Underneath the wax was another layer of dirt, directly on the paint.

Before restoration, along with the restoration work and the documentation of its condition, the vibration behaviour of the painting was examined in three different configurations: a) framed, without vibration protection and not behind glass; b) framed, with vibration protection; and c) framed with vibration protection and behind glass. The test rig used for the vibration measurements was developed and constructed by Dr Kracht as part of her doctoral research at TU Berlin. This involves a predefined, very small excitation of the frame using a shaker and recording the vibrations in the painting over its entire plane that are generated by the excitation.

Characteristic vibration frequencies and vibration modes are determined from the measurement data. These two sets of parameters are specific to the individual object and depend inter alia on the weight distribution of the frame and stretching, the elasticity and the damping of the material. As shown by the results of the measurements on the painting without glass and protective backing, the stretching is the dominant factor in canvases. This can be seen from the lowest natural resonant frequencies, e.g. 2.8 Hz for configuration (a). The corresponding characteristic waveform of the vibration shows irregular and very large amplitudes in the middle of the picture. This is due to locally chaotic vibrations that arise because of insufficient tensioning of the canvas.



Characteristic vibration modes of the three configurations, showing the fundamental vibration frequency in each case, © Dr Kracht Vibration Management

Both the vibration protection and the glass elevate the lowest vibration frequency and reduce the amplitude of the vibration. The typical waveform of the vibration was also successfully flattened out. These three effects are all desirable because measures to reduce vibration, such as vibration insulation, require a minimum frequency. The smaller the amplitude of the vibration and the less curved the first vibration pattern is, the lower the internal mechanical stresses. However, even in configuration (c) the midsection responds with random oscillations to the excitation.

To sum up: Although the vibration protection and glass had positive effects, the condition of the painting was unsatisfactory in terms of aesthetics, heavy contamination and vibration behaviour. The aim was therefore to carry out conservation and restoration measures that would also improve the aesthetics. Work was commenced in February 2018.

First, the back of the stretched canvas was cleaned several times in multiple layers. The unevenness of the canvas was levelled several times. Smoothing out the incorrectly kinked edges where it had been stretched was done through the slow action of moderate direct moisture and weighting. Threads around the nail holes were put back in place and glued according to Heiber's method. A 65 µm thick Beva film was applied to the edges of the canvas strips (10 cm wide, washed, stretched and ironed). After alignment, the painting was first stretched by hand with pins on the restored stretcher frame. The tension of the picture support was carefully increased step by step with a collet and finally fixed in place using the existing nails (the rust had been mechanically removed from them and they had been covered with Cosmoloid) as well as blackened tacks. Using all the existing holes in the clamping edge allowed excellent uniform canvas tension to be achieved, which was also reflected in the subsequent measurements.

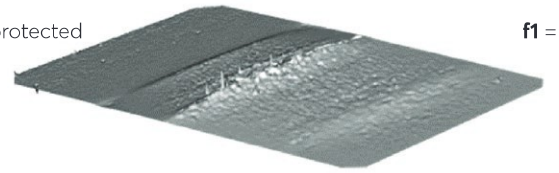
The heavily contaminated surface of the paint layer was first cleaned under dry conditions. After consolidating layers of paint that were coming loose using rabbit-skin glue and a heating spatula, the solid dirt deposits were removed from the surface with cotton swabs and (because it proved highly effective) the restorer's very own saliva. The wax coating was removed with Shellsol T and the impasto areas were brushed off with a small hair dabbing brush. The layer of dirt under the wax was again removed with saliva. Final cleaning was done with distilled water. Finally, mastic work and structuring were done with chalk mastic, followed by retouching using watercolours of the mastic, minor flaking, friction areas and numerous small round protrusion blisters in the paint layer.

Detail of the face of Quappi during surface cleaning, © D. Hedinger, K. Radermacher

After the restoration, the vibration behaviour of the painting was again examined in three configurations: a) framed, without vibration protection; b) framed, with glass and full-surface vibration protection only in the frame compartments; and c) framed with glass and full-surface vibration protection, including under the central transverse support.

The vibration tests of the painting in configuration (a) give information about the effects of the strengthening of the paint layer, as well as the corrected alignment and re-tensioning.

a) unprotected **f1** = 6.6 Hz

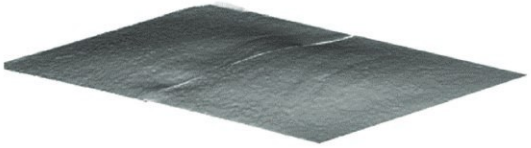


Characteristic vibration pattern of the painting at the fundamental vibration frequency of 6.6 Hz in configuration (a), © Dr Kracht Vibration Management

The increase of the first characteristic vibration frequency from 2.8 to 6.6 Hz and the flattening of the vibration waveform results in part from the increased stiffness of the reinforced paint layer, but mainly from the new clamping (= greater pre-tensioning and increased number of nails).

Given the positive experience with the measurements made before restoration, glass and vibration protection should of course also be applied after the restoration. Vibration protection made of polyester fleece has been added to the two compartments of the stretcher frame and sewn with polyester twine to the back protection, cut to shape and made of acid-free cardboard. The holes in the cardboard were drilled in a chessboard pattern, ensuring that the fleece will stay nicely in place. The part under the central strut was not supported with the fleece at first.

b) behind glass and with vibration protection in the plane, away from the centre **f1** = 15 Hz

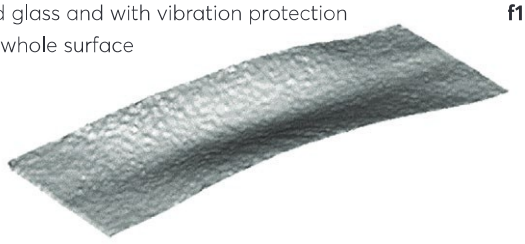


Characteristic vibration pattern of the painting at the fundamental vibration frequency of 15 Hz in configuration (b), © Dr Kracht Vibration Management

The results of the vibration measurements on configuration (b) show a very positive increase of the lowest resonant frequency and a correspondingly very smooth vibration waveform. However, unevenness was still evident in the middle area, which needed to be reduced.

Accordingly, correspondingly thinner polyester fleece was inserted under the transverse central strut and tied in place with polyester thread. With the backing cardboard laid in place, the fleece touches the canvas very gently. Slight contact with the painted support as well as the stretching of the canvas (where still justifiable in terms of the restoration) give extremely positive effects in the vibration measurement results.

c) Behind glass and with vibration protection over the whole surface **f1** = 15 Hz



Characteristic vibration waveform of the central area of the painting at the fundamental vibration frequency of 15 Hz in configuration (c), © Dr Kracht Vibration Management

The lowest characteristic vibration frequency remained the same, at 15 Hz, but the waveform measured at high resolution in the middle of the painting is smooth and flattened. In configuration (c), the amplitudes of the oscillatory response are less than 1% of the amplitudes in configuration (a) before restoration; this is primarily due to the full-surface vibration protection.

In summary, installing vibration protection is an extremely effective method for reducing the vibration response of paintings and should therefore be considered and used as a standard measure. This is especially true for larger formats, in which flapping movements of the textile support can be detected during short transports. It remains to be clarified whether sewing on the fleece and the resulting slight "quilt effect" have unfavourable effects on the painting, and which method of attachment is best. Further investigations should be carried out into the selection of the various polyester fleeces available, depending on the condition of the painting as well as a study of the chemical ageing properties of the material, as it has not been designed to meet restorers' requirements. Comparative research into how the various types of vibration protection work would also be desirable.

Final status, front and back, © D. Hedinger, K. Radermacher

About the authors:

Katrin Radermacher is a qualified restorer and the initiator of the restoration work on Beckmann's Carnival. She studied painting restoration at the College of Fine Arts in Bern and has been working as a restorer at Kunsthalle Mannheim for over twenty years.
Contact: katrin.radermacher@mannheim.de

Daniela Hedinger is a qualified, self-employed restorer in Stuttgart. She specializes in repairing cracks in paintings using surgical suturing material. Contact: d.hedinger@web.de

Dr Kerstin Kracht is an independent expert in vibration technology, specializing in the preservation of works of art and cultural assets. Contact: kerstin.kracht@artsandwaves.com