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Editors: P.B. Hallebeek, J.A. Mosk
DTP: J.A. Mosk
Word processing: S.F. Fontijn

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First Experiences with a Light Metal Stretching Frame-system for Leather Tapestries in Climatically Instable Rooms

Andreas Schulze
Landesamt für Denkmapflege Sachsen
Augustusstrasse 2
D-01067 Dresden

It is not new, that the success of all efforts for the preservation of the material evidences of human culture depends very strongly on the environmental conditions surrounding the objects. Therefore it is very important to provide for optimal conditions to exclude harmful influences.

This is mostly possible in modern museums with air-conditioning. There are a lot of problems, however, if sensitive objects are integral parts of monumental buildings. Stabilization of the climatic conditions in monuments is nearly impossible because of deep interferences in the historical substance.

So it was an important point in the concept for the conservation and restoration of the gilt leather wall-hangings in the castle Moritzburg near Dresden to find an advantageous method to remount the tapestries.

I. The starting-points for the concept

In the case of tapestries with sewn bindings between the panels, these clearly visible seams belong to the original appearance. So it is possible to divide big wall-hangings into different smaller sections, well-known as the 'Dutch Method' for the mounting of gilt leather tapestries.

But large, nearly seamless planes are characteristic of wall-hangings with glued bindings. Therefore the preservation of these large objects without any splitting in smaller formats was one intention of the restoration concept.

The wall-hangings in the so-called 'Damenbildniszimmer' were fixed with a lot of nails on wooden reglets, which were solidly connected to the walls. Research shows, that the very similar construction from the baroque was removed in the beginning of this century and was substituted by new wood.

This kind of mounting was the cause of a lot of incriminating damages on the leather.
Remounting the works in different periods in the past and the attack of wood-worms had weakened or damaged the edges of the tapestries.

The stiff fixing of these edges on the ground blocked up all natural motions. So on some edges the nails tore out and this was the cause for countless large deformations.

The 'Damenbildniszimmer' is located in the northwest corner of the castle between a stair-house and the chapel, is the room with the most instable climatic conditions in the castle. It has the largest and quickest changes of Relative Humidity.

Profound investigations of the climatic situation in the castle already in 1973/74 and of the reactions on the leather tapestries drew attention to this situation and to the scale of the natural reactions on the wall-hangings.

On a 2.65 m high tapestry very fast changes of the dimensions by more than 15 mm were measurable as a reaction to changes in the Relative Humidity in the room.

Therefore the following demands were to be made upon the mounting-system:
1. The tapestries should be removable for later conservational checks and treatments without additional damage to the edges.
2. The fixing of the tapestry-edges to the frames should be in such a way, that compensation of all tensions in the leather will be possible.
3. The construction of the frames should not block up the normal motions of the material and should prevent an overcharging of the leather through shrinkage in low air-humidity.
4. The climatic situation around the tapestries should be stabilized without any interferences in the historical substance of the building.

II. Technical execution

Stabilization of the climatic conditions around the wall-hangings was very important. The walls of the room bear a lot of information about
decoration systems from the time before the major reconstruction of the castle in the years between 1723 and 1730 and about the baroque design of this room, respectively about the original mounting system of the tapestries. So it was impossible to use the normal modern methods of air-conditioning, for instance through a temperature-insulation or through the installation of air-conditioning equipment. Also it was impossible to change the shape of this room. The space 5 to 6 cm between the wall surface and back of the tapestry had to be sufficient for all technical solutions.

A stimulus for the solution of this problem was the situation in the two main halls of the castle. In these halls the walls are covered with 6.50 m high paintings on gilt leather. These enormous sizes of the seamless, glued gilt leather areas (some walls of 90 m² tapestries) normally allow to expect very large changes of the dimensions. This was prevented in 1730 during the mounting of these tapestries in the following way: all walls were covered with wooden panels of about 30 mm thick pine. This gigantic quantity of wood buffered nearly all changes of the Relative Humidity on the flesh-side and can thus prevent the short-term reactions of the leather. This construction has been working for more than 250 years as a passively operating air-conditioning equipment without any disturbances, service or energy application and has prevented till today any damages through the shrinkage and expansion of the leather.

Following these experiences we have planned to cover the walls with wooden panels for the 'Damenbildniszimmer' too.

To get removable tapestries, it was necessary to create a frame-system, built of aluminium profiles, to be light but also stable enough. Round wooden edges - fixed on the metal profiles - prevent contact between the leather and the metal. The tapestry is fixed on the frame with little hooks of stainless steel. These hooks are riveted on adapted stripes of vegetable-tanned calf-leather. The stabilizing stanchions of the frame also serve to mount the frame on the wall.

A device at the bottom of the frame is to compensate the dimensional changes (Fig. 1).

In the case of broader wall-hanging formats it is necessary to use such devices on one or both sides of the frame. Because the width of the first, completely conserved and restored tapestry was only 92 cm, this was not necessary here. The compensation of the changes in length is brought about by a pivoted tube. One end of the tube holds a spring case with a spiral spring (Fig. 2). This spring was made after appropriate calculations and is 157 cm long, 3 cm wide and 0.35 mm thick. The hooks of the tapestry are fastened on the mounted rail (Fig. 3).

So the spring has a low spring-constant: the change of the elasticity per unit of length is relatively low. This shall prevent a permanent extension of the leather, as it is known from other spring-stretchers, for instance for canvas paintings. If the leather is shrinking due to low relative humidity, this spring - which is stretched only by very low power - gives way.

So there is never any danger that the leather, the edges and the glued seams could crack or tear. If the tapestry is enlarged due to a high RH, the spring can prevent too big deformations. The main task for this compensator is to enable the normal reactions of the leather in times with lower Relative Humidity.

Fig. 3 illustrates this system further: the wooden panels for the buffering of the humidity also work as a temperature-insulation to the wall and will be mounted at first separately with hooks. Then the frame will be fixed over these panels only on the stabilizing stanchions, also with screw-hooks. The profiles of the frame seize over the panels, so the distance between the surface of the wood and the back of the tapestry is only 6 to 8 mm. The little steel hooks on the edges of the tapestry can glide along the frame-sides and do not block up the compensations of occurring tensions and of the expansion - and shrinkage - of the leather.

The restored tapestry-width was exposed on the frame over one year in the air-conditioned rooms of our atelier, to be able to exclude all permanent extensions. Parts of an old hygrograph were used to record all changes of the length of the tapestry.

In February 1994 the frame was mounted on the primary place on the outside wall between a window and a corner in the 'Damenbildniszimmer'. It was only necessary to remove the wooden reglets. The plaster with all remains of earlier decoration systems etc. was left on the wall. Over the wooden panels, the tapestry-frame was hung up. It is very important, that the surface of the plaster has not any contact in
any place with the frame or with the hooks. At last the covering reglets were fixed with some millimeters distance in front of the surface of the tapestry. The panels and the frame are inserted completely in the interspace between wall and tapestry, which had also existed before.

III. The efficiency of this system; first test-results

The registration of the dimensional changes of the leather along with the recordings of the values of the Relative Humidity and the temperature allowed the first conclusions about the efficiency of the frame-system. During the exposure to the stable humidity of our atelier over more than a year no signs of permanent extensions were visible. After the mounting in the castle Moritzburg distinct reactions to the climatic conditions were recorded. It was striking, that in spite of corresponding values of the Relative Humidity the recorded length values were located in the middle range in the time of spring and autumn, but in summer in the upper and in winter in the lower half of the diagrams.

In 1973 and 1974 research into the climatic situation and into the reactions of the gilt leather were undertaken. In this time very strong and short-term changes of the dimensions were recorded on a 2.65 m high tapestry, which was hung in the way which is typical for the ornamentally decorated gilt leather in Moritzburg, at a distance of some centimeters between wall surface and leather. These changes amount to 16 mm.

To compare the results of both recordings (the tapestries in the ‘Damenbildniszimmer’ are 3.27 m high), it was necessary to convert all recorded values into percentages to the proportion of the different lengths. Together with the curves of temperature and Relative Humidity these values were transposed graphically (Fig. 4 and 5).

Fig. 4 shows the values for the period November 01, 1973 until the end of July 1974. Fig. 5 represents the period from May 09, 1994 until January 29, 1995. These periods do not cover exactly the same seasons and the measurement methods do not agree totally, but something is striking:

Despite of similar curves of the Relative Humidity we see very large and rapid changes in length around a uniform average value on the diagram in the case of the tapestry without wooden back panels. On the other hand the reactions of the gilt leather wall-hanging with wooden panels on the back are much more damped and show another, seasonal curve. This effect appears to come from the buffering effect of the wood, which was to be observed also in both halls. It is well-known, that the moisture content of wood attains always a defined state of equilibrium to the Relative Humidity. This adaptation process runs - depending on the kind and the thickness of the wood - relatively slowly. Short-term changes of the Relative Humidity do not have major influences on the moisture content of the wood. The wood emits moisture to dry air, in moist air wood picks up moisture. Thus a micro climate will arise in the small space between the wood surface and the open, unprotected flesh side of the leather, on which the changes of the Relative Humidity in the room in front of the silvered and painted surface has not so much influence. More significant are the changes of the balance of the moisture content in the wood relative to the seasonal average-value of the Relative Humidity. So this moisture content in the summer time is lower than in winter. This again will be transferred over the microclimate in the interspace on the moisture content of the leather tapestries and thus influence their expanding and shrinking reactions.

In summary it is possible to state, that the wooden panels can damp the short-term reactions of the leather effectively, but the maximum and minimum values of the dimensional changes over the year are the same as the values of the first measurements of about 0.6% of their total length. The compensation mechanism allows to prevent an overcharging of the wall-hangings and also damages on the leather, the edges or the bindings between the leather panels. Therefore we have decided to use this system for all wall-hangings of the ‘Damenbildniszimmer’.

Certainly it is impossible to transmit this solution unmodified on other objects and problems. This paper should rather be understood as a stimulus for complex reflections on the particular situation around a specific object.
Fig. 1. Construction and measures of the panel. Details of the corners; I: Upper right corner, viewed from the back; II: Lower right corner, frontal view.
Fig. 2. Construction of the pivoted tube with its spiral springs and ball-bearings.
Fig. 3. Scheme of the method of fastening of the leather to the frame and the pivoted tube; fastening of the frame to the wooden panel and of the wooden panel to the wall.
Fig. 4. Plot of the temperature and the RH in the period indicated together with the plot of the proportional change in the length ($\Delta L$). Leather wall-hanging without wooden back panel.
Fig. 5. Plot of the temperature and the RH in the period indicated together with the plot of the proportional change in the length ($\Delta L$). Leather wall-hanging with wooden back panel.