Conservation Strategies

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A. Material-Specific Conservation Considerations

"Please Don't Touch": More than 100 Square Meters of Sensitive Rust Surface

All visible surfaces of the steel construction were deliberately corroded with an acid solution when the work was made, resulting in a sensitive, predominantly matte rust surface whose coloration varies between bright rust red and brownish black. The consistency of the rust surfaces ranges from stable to fine powder and encrusted areas with pronounced, small, loose lamellae.
The surface is, in general, very sensitive to being touched, which causes difficulties above all when the installation is being assembled and disassembled and during maintenance.
Mechanical actions grind the corrosion layer into fine rust dust, and bright red wipe traces emerge. The loss of rust particles in extremely corroded areas already poses a threat as in places these particles are only loosely connected to the surface. Along exposed edges the corrosion layer has rubbed off and the shine of the metal is exposed.

Fig. 1: Channel component III showing damage by abrasion of rust surface (bright red wipe traces) (March 2006) (photo: ZKM)

Fig. 2: Detail of the channel's outside with lightly adhering encrusted areas and loose rust particles (September 2004) (photo: ZKM)

Lighter areas of abraded rust can be seen in fig. 1. The mainly vertical traces were caused by visitors, despite the advisory signs.
As a result, it is not permitted to touch the object in the exhibition, and advisory signs have to be put up for the visitors. The guards are to be instructed accordingly. It also means, however, that assembly and disassembly have to be done with extreme care. Latex gloves must be worn and all surfaces to be touched must be padded and covered with a smooth material.

3,500 Litres of Water on Wood Parquet Floors

A system filled with water can only be operated in a museum when particular safety precautions are met.
In 1997 extensive modifications were already undertaken to isolate the water circulation.
A double-walled foil tank catches the water in the interior of the channel. Moreover, the entire work of art rests on a continuous waterproof foil. Potential weak points of the water circulation are: the gaskets of the pipes and of the pump housing as well as the places where the intake pipe is led through the foil tank.
Two electronic water sensors were placed in the substructure during the installation in 2004 to identify immediately any water escaping. When they come in contact with water, these sensors give off an acoustic alarm, and the alarm signal is sent directly to the security centre of the museum so that twenty-four-hour monitoring is guaranteed.

Water Quality: Calcium Content, Biological Growth

The system's water circulation is filled with circa 3,500 litres of water. There is a constant loss of water from evaporation, so that water must be replenished at regular intervals in order to maintain the necessary water level at the intake socket of the pump.
Evaporation also causes the mineral salts contained in water - primarily calcium carbonate- to accumulate. They collect in the water channel as a mineral layer. Fig. 3 from August 2004 shows calcium carbonate deposits still remaining from the first three presentations. They adhere on the brown protective coating of the water channel, which is normally covered by grilles. An attempt was made during the 2004 installation to chip the calcium encrustation off mechanically. This was, however, successful only in a few small areas. The idea of removing calcium deposits with acid was rejected out of concern for the protective coating.

Fig. 3: Detail of water channel component V showing old calcium carbonate deposits from 1993 (August 2004) (photo: ZKM)

Fig. 4: Detail of the water channel with a strong layer of calcium carbonate after two years presentation (October 2006) (photo: ZKM)

The drinking water in Karlsruhe has a degree of hardness of 18° dH ("deutscher Härte" or German degree of hardness). This corresponds to a content of 180 mg of CaO ions per one litre of water. In order to minimize the salt content of the water from the outset, partially demineralized water with a hardness of 5° dH has been used since 2004; it is processed at the ZKM in larger quantities for use in the air conditioning system and kitchen operations.

A further problem is the contamination of the water and subsequent germ formation. The running water takes in dust from the air, and this dust becomes a breeding ground for germs.
Six weeks after putting the work into operation a biological report of the water quality was ordered and a clear presence of germs established. (It was possible, however, to eliminate any health risk to museum visitors.)
Different possibilities for keeping the water clean were evaluated and two possibilities emerged:
1. Replacing the water regularly
2. Controlling biological growth with biocide water additives.

The additives in question were based on the following active substances:
- Surface active agents, or surfactants
- Copper (II) sulfate pentahydrate (cytotoxins for microorganisms)
- Purification agent containing peroxide
- Water hygiene agent with chlorine

In the end, the idea of biocide water additives was rejected, since it could not be ruled out that they would interact with the object (increased corrosion). It has been decided to replace the water completely and to clean the channel at regular intervals (every six weeks).

Steel and Water: The Corrosion Problem

The deliberately rusted surfaces of the steel construction continue to rust under the influence of humidity. Records on the climate at various places in and around the work of art are kept over a period of several weeks in order to register the effects of the running water on the environment. The exhibition space in the atrium of the ZKM / Media Museum is very large. Evaporating water from the water channel is quickly distributed in the exhibition space via the general movement of air and is compensated for by the air conditioning. For this reason, in general, no noticeable effects on the climate of the space are detected. However, microclimate zones with increased air humidity form in direct proximity of the flowing water.

A special climate situation forms in the interior of the steel construction (base) where in 1997 all surfaces were provided with an antirust coating. In this enclosed air space the waste heat from the motor and pump leads to a rise in temperature. During operation, within circa six to eight hours, there is regularly a rise in temperature in the interior from 20° C to 23° C and an increase of the relative humidity from circa 65 % to circa 85 %. In each case the values return to their initial levels over night. These increased climate values and strong, daily fluctuations represent conditions that can accelerate corrosion. During the two-year period of operation, however, no substantial changes have been detected - the protective coating from 1997 has thus fulfilled its function well.
The zone in the tank channel beneath the grilles into which the water flows is likewise protected by a brown protective coating.

In places rust areas emerge at the struts that carry the tank elements. Water runs over these during operation, and their protective coating shows minor damage that becomes rusty. This damage should be repaired before the next reinstallation of the work.

Fig. 5: Space underneath the tank panels: during operation water runs through the joints between the tank panels (photo: ZKM)

One special problem zone is the channel area beneath the wheel. Here the water bubbles into the channel and splash water on both sides regularly wets the unprotected tank panels above the grille. If the system is switched off, these areas dry out again. This alternation led, over the long exhibition period, to a considerable progressing of corrosion in the splash water area. One arched zone is particularly affected; this area is also exposed during operation to a constant short-term alteration of wetting and drying (see figs. 6 - 9). The area beneath the arch, which is constantly wet during operation and dries only once a day, is noticeably less corroded.
As the illustrations show, the development of the corrosion is alarming. In order to be able to find approaches for the handling of the corrosion, external specialists as well as metal conservators must be consulted.

Fig. 6: Channel component V, splash water area beneath the wheel after ten months of presentation: compared to fig. 3 the development of corrosion become apparent (August 2005) (photo: ZKM)

Fig. 7: as fig. 6 after 24 months of presentation: considerable augmentation of corrosion. (October 2006) (photo: ZKM)

Fig. 8: Detail from fig. 6 (August 2005) (photo: ZKM)

Fig. 9: Detail of splash water area, right side of water tank: Partial loss of corrosion layer (March 2006) (photo: ZKM)

Fig. 10: Detail of grille and tank panel (March 2006) (photo: ZKM)

Fig. 11: Detail of the grille: detached corrosion layers (March 2006) (photo: ZKM)

B. Conservation Considerations Regarding the Electrical Equipment

Safety of Electrical Components

Before putting the system into operation in September 2004 it was inspected by TÜV (the German Technical Control Board), which required several safety-related improvements.
First, a reversible protective grille was put in above the motor to prevent direct access to the chain and the drive sprocket. Second, the original distributor box, from which all electrical components are supplied, had to be replaced with a modern unit. All cable runs were firmly anchored in galvanized metal tubes to the struts of the base. All original parts were placed in storage with the work. In addition, lighting was built into the base.

Transmission of the Video Signal via the Slip Ring Unit

The slip ring unit is one of the heart components of the work. It is placed on the axle between the static basic construction and the kinetic parts - the moving wheel (see fig.13). The inner part of the unit is connected to the turning axle of the wheel the outer housing is held by the static steel construction. The unit consists of ten slip rings (fig. 12).
The two poles of the video signal are each led only over one slip ring while for each pole of electricity supply two rings are available thus halving the potential for error during transmission.

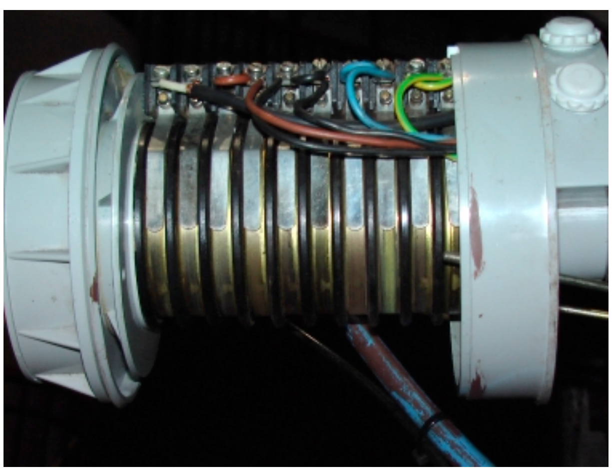

Fig. 12: Original slip ring unit without cover: The photo shows the ten slip rings and contacts inside the unit (August 2004) (photo: ZKM)

Fig. 13: Original slip ring unit and its connection to the wheel axle (August 2004) (photo: ZKM)

The slip ring unit functioned reliably during the first six months. Afterward wear and tear on the contacts (hard nonferrous metal alloy) and contaminations through abrasion led more and more frequently to interruptions in the transmission. The video signal was particularly affected.

It became necessary to clean the slip ring unit more and more frequently.
For this the protective grille on the wheel supports had to be dismantled and the housing of the slip ring unit disassembled. The contacts could then be cleaned with compressed air and cloths. This treatment was very time consuming. At some times the housing of the slip ring unit had to be removed twice a week for cleaning the contacts.

Because of this, solutions had to be considered how to transmit the video signal independently from the slip rings. Earlier attempts to transmit the signal via radio had failed (1997). The radio signal was disturbed by the moving steel structure of the wheel and the numerous electric cables. Another possibility considered was to integrate the playback equipment into the wheel. As there was not enough space available, the laserdisc player didn't fit. Also, the sensitive player probably would not have functioned properly while constantly turning around 360 ° degrees. Therefore it was finally decided to digitize the video and to use a flashcard-player (see next topic). This modification lead to a significant reduction of maintenance treatments.

Nevertheless more and more problems occur due to breaks and peaks of power supply also caused by unstable transmission via the slip rings. Finally the contacts were so worn-out that there was a very real fear that they would break off.

In July 2006 the decision was taken to replace the original slip ring unit by a new one. Contemporary technique has developed much smaller units with much higher security. The new slip rings are polished and special hard gold plated. This combination of gold to gold provides resistance to corrosion and ensures the highest quality of contact.

A new slip ring was conceived in collaboration with a specialist company. In this way a solution was sought that changes the original appearance as little as possible. The new slip ring body was successfully integrated into the housing of the original so that the external changes were minimal. The cables are hidden in the new connecting tube (see figs. 14 and 15).

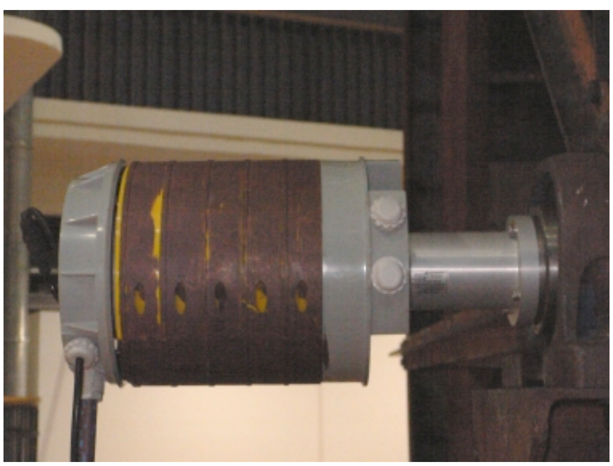

Fig. 14: New slip ring unit is hidden in the original housing. (October 2006) (photo: ZKM)

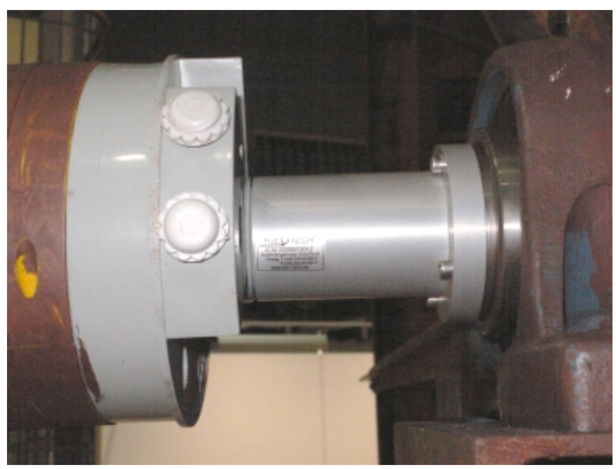

Fig. 15: The new connecting tube houses the cables. (October 2006) (photo: ZKM)

Transfer of the Video Technology: Signal Digitization

In order to be able to replace the Laserdisc player with a flashcard player in 2005 the video material of the Laserdisc had to be digitized and converted to a playable format.

The video information of the laserdisc was digitized at the Laboratory for Antique Video Systems and saved on a flashcard as mpeg2 file. A Bässgen flashcard player was chosen as a player as it is relatively small and robust (Compact Flash Player MM1002). It is possible to conceal it in the wheel construction.

In May 2005 we started testing this solution, which turned out to be very promising. The video signal is stable and the televisions show a clear image. Interferences of the image have become noticeably fewer than before. The remaining faults were caused by unstable wiring and loose connections.

Fig. 16: View of one of the wheel segments where the new flash card player (silver) and two of the new video distributors (grey) are fixed during testing phase.
(May 2005) (photo: ZKM)

120 Plug-in Connectors and 21 TV Monitors in Rotation

The rotation of the wheel subjects all of the parts to constantly changing mechanical stress. This affects above all the sensitive electrical equipment and the devices in the wheel.

In 1997 the equipment for the video transmission and electrical supply in the wheel were replaced, since even during relatively short operating periods (IFA 93 and MultiMediale - about ten days each) there had been numerous breakdowns in 1993.

Typical damage or malfunctions with which the maintenance personnel have been confronted include:

- Loose plug-in connections, both with the BNC and SCART plugs and with the electrical plugs. The existing setup of the SCART plugs (connection to the monitor) is limited to just the two or three pins required. As a consequent, the mechanical anchoring in the monitor box is inadequate and slightly loose. Individual BNC plug-in connections also repeatedly become loose. Consequently the electrical plugs sometimes smoulder as a result of poor contact, so that the plug and outlet have to be replaced.
- The demands of rotation also mean that the soldered joints on the BNC plugs and electronic components (e.g., the circuit boards of the monitors) often break.
- Damage to the cable cords has also been found.

Fault diagnostics and repairs are often labour-intensive because some of the components in the wheel are very difficult to access.

Because the BNC connections on the old video distributors from 1997 had frequently proved to be a weak point, new video distributors have been employed as replacements since summer 2005 (ProCon Technology, 3515-01 Composite Video Distribution Amplifier). This new system for the video signals has provided nearly trouble-free operation, and maintenance expenses have been considerably reduced.

Reconception of the Video and Electrical Wiring

Because of the difficulties noted above, and the many potential sources of errors, in 2006 a decision was made to modify and largely replace again the wiring for future reassembly. A plan for the necessary measures was produced that contains the selection of the systems, the materials required, and the exact arrangement of the components. This is to provide the basis for rewiring the next time the work is assembled.

The following changes are planned:
The video signal is output from the flashcard player that is fastened and concealed in the wheel. It has two power supplies (12V and 24V, respectively, with current provided by a standard European electrical outlet in the wheel segment), and from there the signal is passed on to the first video distributor VD1 (ProCon Technology, 3520-01 Composite Video Distribution Amplifier with ten outputs, 12V power supply via power strip in the wheel).

The video distributors will be hooked up as follows:

Video Distributor VD1 (ProCon Technology, 3520-01 Composite Video Distribution Amplifier with **ten** outputs, 12V power supply)
- **Input**: Video signal from flashcard player
- **Output 1**: potential equalisation (connected to wheel structure)
- **Output 2**: Forwards video signal to video distributor 2 (VD2)
- **Outputs 3–10**: Video signal to eight monitors

Video Distributor VD2 (ProCon Technology, 3520-01 Composite Video Distribution Amplifier with **ten** outputs, 12V power supply)
- **Input**: Video signal from Output 2 of Video Distributor 1 (VD1)
- **Output 1**: Forwards video signal to video distributor 3 (VD3)
- **Outputs 2–10:** Video signal to nine monitors

Video Distributor VD3 (ProCon Technology, 3520-01 Composite Video Distribution Amplifier with **five** outputs, 12V power supply)
- **Input**: Video signal from Output 1 of Video Distributor 2 (VD2)
- **Outputs 2–4:** Video signal to four monitors
- **Output 5:** Open for another potential equalisation

This represents a change to the artist's original concept in that the slip ring unit will no longer be used to transmit the video signal. The advantage of this variation, however, will be that the video signal would not be affected by problems with the slip ring unit.

To optimize the mechanical anchoring at the TV monitors in the future, the video cables will be fitted with SCART plugs that have the maximum number of pins.
To simplify the replacement of broken monitors, moreover, the connectors of the monitors will be modified. The cables will be fitted with a coupling piece in an appropriate place (not to far from the housing) that will make it easy to unplug the monitors.

The current will be distributed via hardwired switchboxes fitted with prefab cables. This will make it possible to replace the fault-prone Wieland outlets from 1997.

If the flashcard player should be damaged by the moving of the wheel, there is a second option:
The flashcard player can be installed in the base of the object, and the feed to the video distributors can be run, as the artist originally conceived it, via two free contacts on the new slip ring unit. The advantage of this system would be that the player could be accessed directly if problems occurred.

Limited Life of the TV Monitors

The rotation of the wheel poses problems for the TV monitors as well. The mechanical strain causes the soldered joints of the electronic parts to break and causes wear on the plastic housings.

For the 21 monitor stands in the wheel there are 23 TV monitors available, all of which have been used and show signs of wear and tear.
So far, damaged electronic components of the TV monitors have either been repaired by external specialists or replaced with an identical part-for example, the internal power supplies.

Production of the Philips 25 ML 8500 Matchline Color Television ceased in the mid-1990s, and the availability of these units and replacement parts for them is dwindling. Along with the units themselves, the technical know-how of television technicians regarding this already "historic" technology is also fading. This raises the question of the possibilities for long-term preservation there are to be found. For it should be assumed that, sooner or later, parts of the TV monitors will be irreparably damaged, and no replacements will be available. One day too, essential elements, like the CRTs (cathode ray tubes), will be worn out or damaged by age. The available options for action include:

1. Purchase of sufficient replacement units of the same model (at least twenty-one units)
2. Purchase of suitable replacement CRTs (cathode ray tubes) and parts
3. Purchase of replacement units of a different type, representing an alternative model

The criteria for selecting possible alternative models are highly constraining:
The size of the housing is limited by the steel construction of the monitor compartments in the wheel segments. Any deviation from the dimensions of the original housing could possibly make it more difficult to attach the units to the fastening fixtures in the wheel.
At the same time the dimensions (diagonal of the screen and aspect ratio) of the CRTs and its position in the housing have to correspond to the openings of the monitor shades.
The TV monitor's housings are largely covered on the sides by the wheel construction, only parts of their backs are visible, so that the design of the new TV housings would have limited visual consequences. Ideally, the replacement units should be CRT monitors, since they would offer similar picture quality. That, however, is no guarantee of long life and long term preservation.
The use of contemporary flat-screen monitors is out of the question for *Liquid Time II*, since this technology would significantly affect the monitor image. As the wheel turns, the viewer sees the monitors from a wide variety of angles. Particularly when seen from the side, the picture quality, and most especially the brightness, of flat-screen monitors compare still poorly with traditional CRT screens.

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