

TEMPERED ROOMS PROTECT OBJECTS IN MUSEUMS LIKE ‘GIANT DISPLAY CASES’

Michael Kotterer, Henning Großes Schmidt, and Frederick P. Boody

Although it is the building shell that directly causes room climate problems, treatment of room air is normally considered the simplest solution, in museums and archives and even in historic conservation. Although a building loses heat only through its shell, it is considered sensible to heat the room air at individual locations, leaving heat distribution to natural convection. This is the basis for the functioning of convectors (‘radiators’) and central air heating. Floor heating and church pew heating cause the same mistaken air movement. Soiling of the room walls shows the error of heating with air circulation.

Wall-base heating produces warm air over the whole length of outer walls from below, and thus heats them uniformly. With other heating methods, this is not possible. In winter large wall areas and the objects near them cool off and accumulate moisture from the room air, causing the Ranacher ‘cold wall problem’. This threatens paintings on the cold outer walls of museums, churches, etc. with mildew, and, for example, decomposition of sizing. Condensation on painted surfaces can occur due to air humidification in museums or during church services.

This is a particular disadvantage in buildings where the building shell, wall surfaces, and furnishings form a unified whole, such as in palaces, churches, and cloisters, where heating is generally not recommended. However, all unheated buildings suffer, e.g. with sudden temperature rises after a period of freezing, the absolute air humidity rises strongly and the cold materials in the whole building become damp. In midsummer, this is true of all locations that do not reach 20°C.

Similarly, with enclosed excavations, during the entire year rising moisture and fluctuating air humidity destroy the original surfaces of the colder remains of the building. Here, as in rooms with structural elements in contact with soil, dehumidification (whether caused by dehumidifiers, ventilation controlled by absolute humidity comparison, or air conditioning) or heating of the air lead to increased damage due to salt crystallization.

To avoid these problems, the Bavarian Museum Service has been developing ‘tempering’ since the 1980s. This method of heat distribution, using heating pipes at the wall bases (15–22 mm outside diameter), is suitable for both old and new construction, and allows any desired room furnishings, with 15 mm spacing from the wall, with minimal installation effort. In excavations, single pipes in joints, at transitions to recent material, and under ceilings are sufficient. Buildings in open-air museums receive a pipe ring at the base of the outer walls on all floors. At the same location in museums, two pipes (supply and return) are installed just above the floor, over the plaster (but in wall contact and painted) or beneath 15 ± 5 mm of plaster. Additionally single pipes are installed on both sides of inner wall bases on the ground. The greater heat loss at windows is compensated by re-routing the return pipe to form an additional loop in the reveals, or else a small grid (4–6 rows high) under the window. Outside doors have a loop in front of them under a mineral (not wooden) cover, possibly aided by a return line rerouted into the reveals. The pipes are continuously heated by water with temperatures between 30 and 65°C that slowly change with the season — in rooms in contact with earth all year, in other rooms only during the heating season.

The heating pipes create three primary effects:

- Radial transport of heat around the pipe creating cylindrical isotherms and causing heat accumulation after the wall

material has dried out. With a thin coating of plaster and a mean water temperature of 60°C, a 4 cm (1 pipe) to 10 cm (2 pipes) wide strip of plaster with temperatures of up to 45°C is produced. Only a few centimetres above the strip, the surface temperature is already that of the room air or lies a small amount below it.

- The hot strip radiates thermally into the room.
- It produces a continuous, warm air current that is attached to the wall (Coanda effect), which uniformly heats the rest of the wall surface, aided by re-radiation of heat from partition walls.

Heating the building shell has many effects (friendly heating). The first four justify the term ‘giant display case’:

- Optimal room heating in buildings of all construction types, uses, and room height, including churches.
- No air or dust movement due to heating, other than the air flow attached to the wall, which does not transport dust due to its low velocity.
- Stable (short-term) room climate (after sealing joints and limiting heat gain from solar radiation and artificial lighting).
- Homogeneous room temperature and relative humidity (thanks to low air temperature indoors, there is only a small requirement for air humidification in winter).
- Protection of room surfaces from condensation. ‘Air dehumidification’ is achieved by raising surface temperatures.
- Prevention of rising moisture (‘thermal horizontal barrier’).
- Drying out of inner surfaces of soil contacting building parts; moisture barriers, thermal insulation, or additional heating pipes in the floor are not necessary. Normal plaster is sufficient for renovation instead of special renovation plaster.
- Inactivation of damaging salts by driving out moisture, forming string-shaped crystals in capillaries (whiskers), preventing cyclical recrystallization. The effects are independent of salt type: neither salt analysis nor preset relative air humidity near the wall are necessary.
- Prevention of corrosion and mildew. Existing bacterial and fungal infestations become inactive. With dry rot, no toxic materials need be applied to timbers or masonry. Wood replacement is required only in infested areas. In storerooms, objects stored with excessive moisture content slowly release the extra moisture as they come into thermal equilibrium with the walls. Mobile compact storage units can be closed later, to provide protection from dust and light.
- Energy savings for the heating of existing and new buildings. ‘Thermal building renovation’ can be achieved by tempering walls instead of through thermal insulation. As building materials dry out, there is a reduction of heat loss by thermal conduction through the building shell, and an improvement of heat storage capacity. Due to the lower air temperature, there is reduced heat loss caused by air exchange through ventilation or joints.
- Even historic windows can be retained after repair and sealing.

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Front cover: the *Lansdowne Leda* from the J. Paul Getty Museum, Los Angeles (JPGM 70.AA.110) after the removal of all previous restorations. *Photo: © J. Paul Getty Museum.*

Back cover: the *Lansdowne Leda* after recent re-restoration to incorporate historic additions. *Photo: © J. Paul Getty Museum.*

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