Impact of daily and seasonal Temperature and Relative Humidity cycles on wooden artworks.

Dario Camuffo, Emanuela Pagan
CNR, ISAC, Padova, Italy

Museums, galleries, and other exhibition rooms suffer from cycles in T and RH, which are responsible for dimensional changes and internal tensions to artefacts, which in the long run may have a cumulative effect, or even in some occasions may exceed some thresholds after which some structural parts may break. This is relevant for hygroscopic and fragile materials, and especially when the artefact is composed of a number of such parts bound each other. A threshold has been established for chemical pollution in museums, not yet for microclimate cycles. By definition, the interval of allowed variability in T and RH between 0 and a safety level below an established threshold in T and RH is considered of "well being" for the conservation. The values falling outside this interval might be considered in a risky area. Several authors have faced this problem under different hypotheses and points of view, with laboratory tests or case studies. Although any choice of values might be controversial, an empirical approach is here presented.

Due to the extreme complexity of the problem, and the variety of artefacts, it is impossible to establish precise limits for daily cycles in temperature and relative humidity. In order to make easier this problem, a reasonable approach is based on two assumptions: to suppose that (i) the room temperature and RH is representative for all of the artefacts preserved there, and (ii) the allowed thresholds for the amplitude of cycles coincide with the natural variability in T and RH. In the case the artefacts had a lower threshold, the natural variability would already have generated cracks to create the necessary degrees of freedom for their dimensional changes. In the case the critical threshold would be higher, it is impossible to establish by tests the actual threshold, as reaching the threshold means to irreversibly damage the artefact. Therefore, a good practice is to keep variability in the known safe region, avoiding the risk area between the safe region and the unknown thresholds for damage. At the same time, this practice will reduce the cumulative effect as much as possible. This means to preserve artefacts in appropriate microclimate conditions.

In a diagram RH versus T, by plotting per each day a point which has the daily variation in RH as ordinate, and the daily variation in T as abscissa, one obtains scatter diagrams which represent the history of the past T and RH cycle that have interacted with the artwork.

A reasonable interval for the safe indoor daily variability in historical buildings does not exceed too much the mode of the observed data because these have been experienced many times. In the case they were not sustainable, they caused some cracks in the critical constraints to adapt the artwork to the environmental T and RH cycles and create new degrees of freedom to respond to the environmental variability. Cycles twice the mode may be sustainable, but fall in the attention area because they are not so frequent. They might still deepen existing cracks not yet concluded and fatigue may be accumulated for new ones. Daily cycles reaching three times these values are quite exceptional and may be responsible for the largest cracks that are visible, or may provoke new ones.

A similar procedure can be applied for the seasonal cycles.

The practical "safety area" is not based on laboratory tests on new samples, but considers not yet concluded the adaptation of artworks to their past T and RH variability. A fundamental role is played by the frequency of the largest cycles,

supposing that the rare extremes have not yet concluded their action to adapt the material to their repetition.