New generation of monitoring systems for heritage guardians: detection of a larger range of undesired situations and corresponding material behaviour

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A new heating system is recently installed
In a church with precious artworks
But what is the impact on the furniture?

And how do we measure that impact?
We tend to measure environmental parameters

How to get an insight in degradation rates from such measurements?
We wanted to see more

Environmental parameters
- Ozone sensor
- TVOC sensor
- PM sensor

Material behaviour
- Electrical resistance (ER) probe for Ag
- Strain gage glued on wood

Hazard related parameters
- Motion sensor
- CO₂ (and T & RH)

There is a huge amount of sensors available on the market
And build our own monitoring system

Measurement nodes
- There are many available sensors
- Some of them need a power supply

Data acquisition system
- Temporary storage of data
- Define data acquisition method

Data transfer
- Long-range communication
- Data read out

Central base station
- Storage of data
- Postprocessing of data
- Generate graphs

Complex combination of off-the-shelf technologies and wires
We installed it in an open rack
We monitored environmental parameters

Graphs contain a huge amount of information
We monitored environmental parameters

Graphs contain a huge amount of information
And less common environmental parameters

A large amount of peaks can be seen with mid-price sensors.
And less common environmental parameters

Peaks are moments of elevated risk for accelerated degradation.
We also monitored hazard related parameters.

Moments of enhanced human activity are hazards.
Known periods of exposure helps the recognition process of hazards
But also material behaviour

We are able to see the material behaviour.
But also material behaviour

There is a fast response of materials to changing conditions!
Conclusions
How should we look at all these data?

- Instantaneous risk is determined by:
  - **Exposure**: Position of peaks are periods with elevated levels of risk
  - **Hazard intensity**: Height of peaks/drops

- By monitoring more parameters, many more peaks can be seen
- The same hazard can reoccur in the future
- We can couple risk analysis to indoor air quality monitoring

**Improve preservation conditions by removing hazards that cause peaks**
What can you do with our monitoring unit?

Many more parameters can be monitored simultaneously with mid-price sensors.

Behaviour of many parameters can be described as peaks superposed on a baseline.

Monitoring only T & RH might overestimate the environmental appropriateness.

We see much more, but it does not make much sense.