New generation monitoring devices for heritage guardians to detect multiple events and hazards

O Schalm, W Anaf, J Callier and D Leyva Pernia
Goal: Extend lifetime of collections

By improving preservation conditions
Goal: Extend lifetime of collections

Degradation must be as slow as possible

People want to slow down degradation rates
Goal: Extend lifetime of collections

This is what you measure

Degradation must be as slow as possible

But we measure something else
Are T & RH measurements sufficient?

This is what you measure

How are they related?

Degradation must be as slow as possible

Describe relation between input & output of a model
Model 1: Determine output from mechanism

The relation is determined from well-controlled experiments.
Model 2: Consider degradation mechanism as black box

Relation is determined from well-controlled experiments
Model 3: Risk management approach

Inspections are snapshots of the history of collections.
Model 4: Use limited knowledge about mechanism

Estimate current condition using rules of thumb
Use of methods to improve preservation conditions

- White box: $Y = f(X_1, X_2, \ldots)$
- Black box: $Y = f(X_1, X_2, \ldots)$
- Grey box: $Y = f(X_1, X_2, \ldots)$

Estimate output from rules of thumb
Use of methods to improve preservation conditions

We still do not know all the details inside the box
Use of methods to improve preservation conditions

That knowledge is usually not available
Use of methods to improve preservation conditions

This method works fine
Use of methods to improve preservation conditions

New approach to look at data

But cannot be used to process data streams

New approach to look at data
Application of method 4

1. Rules of thumb
   - Peaks are identifiable periods of enhanced risk for damage
   - Threshold values are rules of thumb to distinguish good from bad
   - Peaks should be avoided

2. Peaks with different levels of risk

But can we use that method in practice?
Measuring campaign
What is the indoor air quality?
Our approach

Build our own data logger system
Our approach

All sensors are read out simultaneously
Our prototype

1. Wireless system
   Height 3.1 m

2. Wireless system
   Height 12.5 m

3. Monitoring system
   Height 7 m
Traditional parameters

Do we see all undesirable situations?
Traditional parameters

Should we not look at all parameters that affect degradation?
Additional parameters

Pollution can be monitored using mid-price sensors.
Additional parameters

Peaks can be used to analyse undesirable situations.
1. Undesired situations do occur as short periods of time

Visualization of undesirable situations

2. Identify events by comparing data with target values

Undesirable situations are shown as well-defined periods
Conclusions
What can you do with it?

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

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

Use rule of thumb: Peaks are undesired situations than can reoccur in the future.

Enhance the meaning/interpretation of the data streams.

Improve preservation conditions by removing hazards that cause peaks.
Same data processed by data mining techniques
See Diana Leyva Pernia on May 17 at 17:50

“A Data Mining Approach For Indoor Air Assessment: An Alternative Tool For Cultural Heritage Conservation”
Undesirable situations can also be seen in material behaviour.