Preventive conservation of metal collections

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June 5th, Worcester
What is preventive conservation?
Damage factors
Detect
Avoid
Block
How do you make decisions?
A case study
Conclusions
Collection management

Risk management

Risk assessment

Identify Risk

Analyse Risk

Evaluate Risk

Mitigate Risk
Acceptable levels?

Minimal loss in value

Which value?

Current state of collection

Future state of collection
DAMAGE FACTORS
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23 August 2004
DAMAGE FACTORS
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10 agents of deterioration

Thieves, Vandals, Displacers
Valuable: Au / Ag etc

Direct Physical Forces
Soft: Sn / Ag etc

Fire
Low Mp: Sn / Pb etc

Water
Corrosive: Fe etc

Pests

Contaminants
Corrosive: Ag etc

Radiation

Incorrect Temperature
Sn

Incorrect Relative Humidity
Corrosive: Fe etc

Loss
D-Objects
Rate of change?

Loss in value?
Outside: \( \text{SO}_2 \) / \( \text{NO}_2 \) / \( \text{O}_3 \) / \( \text{SCO} \) / dust

Inside: \( \text{H}_2\text{S} \) / formaldehyde / acetic acid / formic acid / dust
Analyse environment: precise / indicative

- absorbents
- sulfide
- organic acids
- formaldehyde

SPME
<table>
<thead>
<tr>
<th>Class</th>
<th>Air Quality Classification</th>
<th>Reactivity Rate (30 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Extremely Pure</td>
<td>COPPER: &lt; 90 Å, SILVER: &lt; 40 Å</td>
</tr>
<tr>
<td></td>
<td></td>
<td>? Hz, ? Hz</td>
</tr>
</tbody>
</table>
Rijskmuseum in Amsterdam

Outside: 370 ppt
Gallery: 165-250 ppt
Display case: 50-100 ppt
H$_2$S / SCO CONCENTRATIONS IN A ROOM
CONCLUSIONS

H₂S concentrations vary:

- seasonably
- location
- in an exhibition (showcases)
- in a room (no showcases)
$\text{NaN}_3 + \text{I}_2$ gives $\text{N}_2$ in presence of $\text{S}^{2-}$
Silver & H₂S as function of RH

Weight increase (ug/cm²)

RH (%)
Dry air into display case

Membrane parameters

Air pressure pump
- Thickness of tubing
- Flowmeter setpoint

Case parameters

Volume

Air exchange rate of case
uptake
Hoeveelheid gas opgenomen

concentratie

2 1 3

Hoeveelheid gas opgenomen

concentratie
[H2S] MODEL

\[ C(L) = C_\infty (1 - \frac{R}{L}) \]
DECISION MAKING
WHAT IS A RISK?

Estimation of damage

Frequency  Speed  Type of traffic
Risk Assessment

- Objects
- Environment
- Material
- Agents of Deterioration

Risk
Magnitude of Risk

LV x P x FS x E

Rate

Collection

Object

Part of object

Knowledge

Corrosion

Cracks

Loss

etc
Knowhow of deterioration rate of metal

Prediction of deterioration of (mixed) collection

Estimation of magnitude of risk

Acceptable

Action = Ranking
Focus is on material changes

Reduce loss in value to a minimum

structure
DETECTION MAKING

STRUCTURE OF THE PRESERVATION FRAMEWORK

9 Agents of Deterioration

Building
store / displ / trans

Portable fittings
store / displ / trans

Procedures
Avoid: Avoid materials and finishes that are sources of contaminants
Block: Block external contaminants by using airtight cabinets, barrier coatings, and barrier films (e.g., bags, shelf liners).
Detect: Detect contaminants by using gas, particulate, and aerosol dosimeters.
Respond: Place absorbant in cabinets. Supply filtered air to cabinets. Use portable filter/fan units for small rooms.
Recover/Treat: Provide conservation laboratory equipment to treat damaged artifacts.
CASE STUDY: SILVER
Showcase in outer wall: silver tarnishing
CASE STUDY: SILVER

Showcase II: no tarnishing
Why a tarnishing rate difference?

Amount of silver?

Construction materials?

Leakages in showcases?
CASE STUDY: SILVER

DAMAGE

Time of exposure

Gas concentration

Air flow
CASE STUDY: SILVER

2 YEARS

DAMAGE

PPT LEVEL

EXCHANGE RATE
Concentration measurement

116 ppt

50 ppt

31 ppt
silver

85 ppt
ceramics
Summer temperature in showcase
From Monday morning 09:00 hr until Monday morning 09:00 hr
CASE STUDY: SILVER

**ppm CO2**

- **ppm CO2 wall display case**
- **ppm CO2 stand alone display**

4 \( \leq N \leq 7 \)

25 \( \leq N \leq 35 \)
CASE STUDY: SILVER

Inert materials

TEMPERATURE GRADIENTS
Reduced sulfides
CONCLUSIONS

Transport of gas into or out of display case

Preventive measures

- Closing / ventilation of display case
- Use of absorbents inside display case
- Climate control (in- and outside display case)
H₂S concentrations vary

Objects can act as sensors!

What is showcase geometry (leakage)?

Measuring H₂S / SCO has no meaning
What is the risk reduction?