BRAIN-be
Belgian Research Action through Interdisciplinary Networks

AIRCHECQ

Air Identification Registration for Cultural Heritage: Enhancing Climate Quality

DURATION
01/12/2013 - 30/09/2018

BUDGET
949.024 €

PROJECT DESCRIPTION

1. What is the project about?
Preventive conservation methods are based upon the principle that deterioration and damage to works of art can be controlled or slowed down by managing the environmental conditions under which collections are housed and safeguarded. Therefore, it is possible to prolong the lifespan of objects by improving the indoor air quality (IAQ). For that reason, collection caretakers have great interest in improving the environmental conditions by performing the following tasks:

- **Routine monitoring:** Determine the IAQ as a function of time and detect an increase in one of the damaging parameters well before art objects have the time to respond to it;
- **Diagnostic monitoring:** Identify the largest risks related to the environmental parameters or investigate a specific degradation problem;
- **Performance monitoring:** Evaluate the performance of mitigation measures (ex. apply air purifiers) and optimize the taken actions in order to enhance the IAQ.

The problem with environmental control in museums is that they are usually limited to temperature and relative humidity. In some cases, this is supplemented with light and UV measurements. It is known that many other airborne substances such as particulate matter and reactive gases (ex., H_2S, O_3 or organic acids) play a crucial role in the deterioration processes of historical materials. However, in many cases these parameters are not monitored. Additional problems that hamper the evaluation of mitigation measures are:

- **Complex relation between environmental parameters and transformation rates:** It is the intention of preventive conservation to slow down the transformation rates of historical materials (see set B in Fig. 1) by mitigating the environmental parameters (in set A of Fig. 1). The relations between the causes of transformation and their consequences are visualized in Fig. 1, which are to a large extent unknown. By measuring the transformation rates of a series of materials it should be possible to evaluate how harmful the environmental parameters are for a mixed collection;
- **How to measure IAQ:** The IAQ is not only determined by temperature and relative humidity but by a much larger variation of parameters. Although it is not realistic to monitor all possible parameters simultaneously, the selected parameters should at least cover all the levels mentioned in Fig. 2;
- **IAQ for mixed collections:** The same environmental conditions might be suitable for some materials in a mixed collection but can be harmful for other materials in the same collection. Therefore, the IAQ is not only determined by environmental parameters but also by the materials and objects present in the mixed collection and by the properties of the building itself. Inspection of the collection and building is needed to evaluate their impact on the IAQ;
- **Human decisions vs. analytical results:** For all measured parameters a threshold value is needed that defines whether a magnitude is harmful or not. Defining threshold values is not always an analytical result but is sometimes a human decision. A methodology needs to be developed in how threshold values have to be defined.

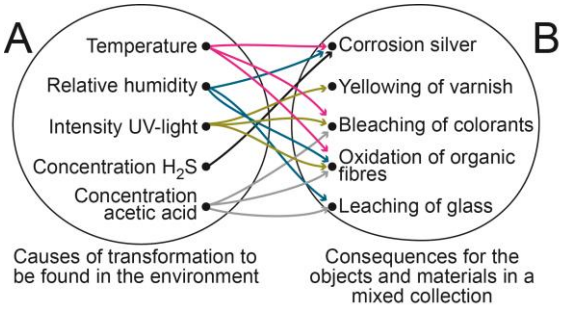

Fig. 1: Complex relation between environmental parameters describing the IAQ (set A) and transformation rates of materials exposed to that air (set B) is illustrated by arrows

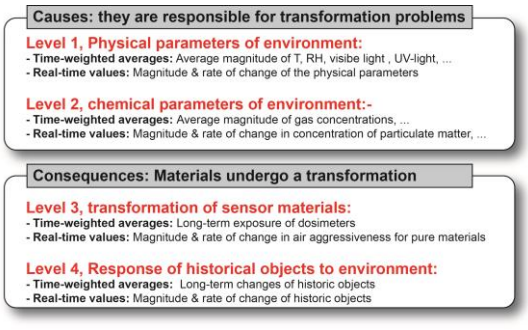

Fig. 2: Overview of all the different parameters that can be monitored, classified in 4 different levels

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2. How to evaluate mitigation actions?

The project aims to develop a monitoring kit for the analysis of the parameters shown in Fig. 2. The huge amount of generated data will be transformed into a single parameter: the IAQ index. This index will be able to describe the 'global' environmental risk for a mixed collection in a specific room. The index will not only be determined by the parameters but also by the sensitivity of the collection towards transformation. The real-time measurements can be processed with the IAQ monitoring software that calculates the IAQ index as a function of time. Besides the development of a monitoring kit and software to process data streams, the project will also develop a performance monitoring workflow as shown in Fig. 3.

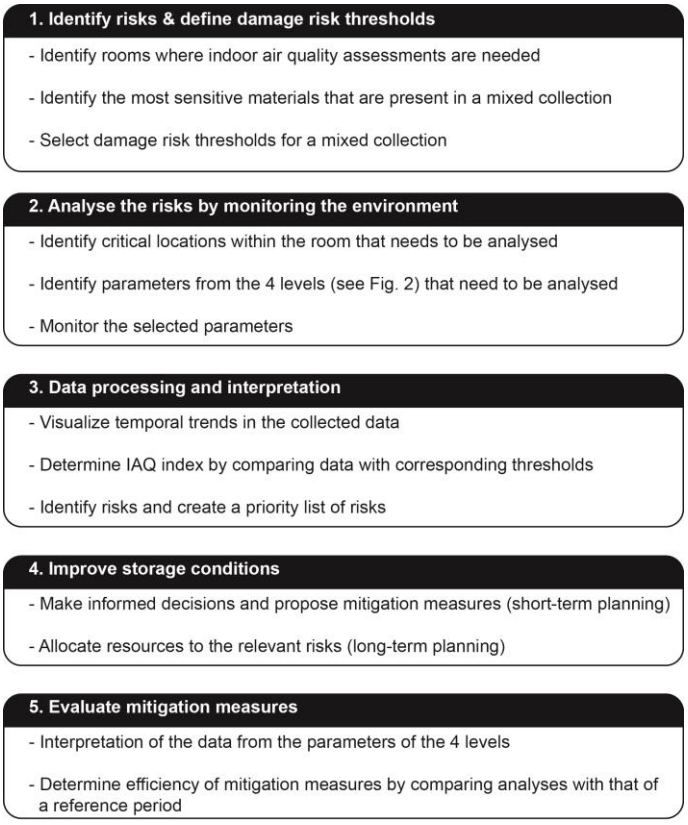

Fig. 3: The workflow combines indoor air quality (IAQ) assessments with performance monitoring.

3. Interdisciplinarity of the project

The project will be realized by a team with complementary expertise: (1) laboratories performing chemical analyses of indoor environments, (2) mathematicians transforming data streams in IAQ indexes, (3) collection caretakers specialized in facility and collection management, and (4) conservation scientists translating the IAQ indexes in realistic mitigation measures.

4. Impact and final results

The final results will be beneficial for museum caretakers in and outside the project, as well as for decision makers to become aware of the problem of air pollution inside museums. The best practices can inspire decision makers to undertake action. Besides reports, workshops and publications, products with a long-term impact will be generated:

- **Monitoring kit:** A ready to use measurements box will be developed with a minimal number of affordable measuring instruments, which can be lend to collection caretakers.;
- **User-friendly software:** The measurements box will be accompanied by a user-friendly software that is able to process the data stream, allowing non-experts to evaluate IAQ;
- **Workflow:** A workflow will be developed for the performance monitoring.

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