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Elements of preventive conservation at the Fondazione Scienza e Tecnica of Florence in the H2020 APACHE project

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ABSTRACT
Preventive conservation is recognized today as a series of fundamental measures which can be taken to contain the elements of degradation that afflict cultural heritage. The European project APACHE (Active & intelligent PAckaging materials and display cases as a tool for preventive conservation of Cultural HEritage) aims to develop innovative and affordable preventive conservation solutions for cultural heritage preserved in museums, collections, archives and libraries, both within the exhibition spaces and storage areas. Indeed, one of the project's goals is the development of novel sensors for microenvironmental monitoring as well as solutions for re-establishing equilibrium in these environments in case of need. Another project goal is the creation of an application to support decision making and interventions by personnel tasked with collection conservation. In all projects, APACHE is addressing a range of conservation parameters including temperature, humidity, and VOCs and pollutants that derive from the environment, packaging and objects themselves. The APACHE partners include the Fondazione Scienza e Tecnica of Florence (FST) with holdings composed primarily of nineteenth-century collections of scientific and technological interest. This paper illustrates the FST's participation in the APACHE project, in particular the case studies they contribute to the research projects. The case studies monitor a variety of objects and packaging with respect to temperature, relative humidity and pollutants.

Key words:
preventive conservation, EU Project APACHE, Fondazione Scienza e Tecnica.

RIASSUNTO
Elementi di conservazione preventiva alla Fondazione Scienza e Tecnica di Firenze nel progetto H2020 APACHE

La conservazione preventiva è oggi riconosciuta come un insieme di fondamentali misure per contenere i meccanismi di degrado che affliggono il patrimonio culturale. Il progetto europeo APACHE (Active & intelligent PAckaging materials and display cases as a tool for preventive conservation of Cultural HEritage) ha come obiettivo quello di mettere a punto soluzioni di conservazione preventiva innovative per i beni culturali conservati in musei, collezioni, archivi e biblioteche, all'interno sia delle aree espositive che di deposito. È programmata infatti la realizzazione di sensori innovativi ed economici per il monitoraggio microambientale e di materiali per riequilibrare questi ambienti in caso di necessità. Un altro obiettivo è la realizzazione di un applicativo per supportare gli interventi di chi si trova a operare per la conservazione delle collezioni. I parametri sopra i quali APACHE lavora sono sia quelli di temperatura e umidità, sia quelli relativi ai VOC e agli inquinanti provenienti dall'ambiente, dai contenitori o dagli oggetti stessi. Fra i partner è presente la Fondazione Scienza e Tecnica di Firenze che conserva collezioni, prevalentemente ottocentesche, di interesse scientifico e tecnologico. Verranno qui illustrate le attività portate avanti dalla FST nell'ambito di APACHE e in particolare i casi di studio selezionati sui quali è in corso una attività di monitoraggio rispetto a temperatura, umidità relativa e inquinanti.

Parole chiave:
conservazione preventiva, progetto europeo APACHE, Fondazione Scienza e Tecnica.

THE APACHE PROJECT

Disadvantageous and unstable environmental conditions (light, humidity, intrinsic/external pollutants) can pose severe threats to movable tangible cultural heritage (CH). In particular, modern/contemporary art is very sensitive to air pollutants owing to its composition rich in new/industrial materials (especially polymers) (Pastorelli et al., 2014). Coping with these issues, Preventive Conservation (PC) looks for optimized dis-

play/storage solutions, so as to minimize degradation during aging, storage or exhibition. While a very small portion of museum objects is on display, the vast majority is often stored under unsuitable climate conditions. Recent active and intelligent packaging materials proposed in food industry are based on short-term solutions that lack the long-term stability required to preserve CH assets. In the APACHE project, active novel packaging materials are combined with sensors and wireless sensor technologies (WST) to provide smart, low-cost easy-to-deploy systems to safely store and exhibit artifacts. The smart and affordable novel materials, based on material science advancements and discrete and continuum modeling, dramatically reduce the costs to monitor and control the climate in storages/exhibitions. These solutions overcome the limitations of currently used Passive Sampling Devices (PSDs) and monitoring systems, which are expensive, cumbersome to calibrate, and lack timely sensing and durability (Grzywacz, 2006).

The research in APACHE focuses on two main objectives.

1) Producing ACTIVE Packaging and display-cases/boxes solutions, based on innovative functional materials that positively affect, and interact with, the packed objects. Examples include active components to compensate temperature and humidity fluctuations, adsorb airborne pollutants and discourage fungal activities. The design of these solutions takes advantage of materials modeling.
2) Realizing INTELLIGENT Packaging and display-cases/boxes tools, i.e. tools that give an additional function to the packaging. Examples comprise environmental sensors that communicate through WST such as Wireless Sensor Networks (WSN) and Radio Frequency Identification Devices (RFID). The sensors, placed in storage boxes/crates/display-cases, will thus act as "intelligent" devices to protect artifacts during storage and display.

Fig. 1. Display case with the botanical models.

APACHE focuses on four classes of art materials, which are frequently found in polymateric and composite collections', and all emit gaseous pollutants as they age (Strlič et al., 2013):

- organic artworks/objects (leather, wood, parchment, textiles);
- plastic and other synthetic artworks/objects;
- modern (i.e. industrially produced) paints and dyes;
- industrially made paper and composite wooden objects (archives, drawings, models, photographs).

The project firstly models the degradation of art materials, determining the impact of volatile organic compounds (VOCs) from both packaging materials and the artifacts. Modeling outputs will be used as a reference values to develop sensors. Second, new tools and solutions are being designed to control environmental conditions of enclosures: these include the aforementioned temperature and relative humidity regulators, novel absorbents and antifungal membranes, and novel VOCs and T/RH sensors. The latter will be electronically integrated into a wireless sensing and networking platform. The third phase involves end users and potential stakeholders in the construction of a decision-making software to allow estimation of the longevity of stored objects and operative choices for their PC. A set of trainings and workshops will be organized on the use of the new solutions, open to industrial sectors, museums, restoration companies, researchers, administrators and technological institutes.

APACHE project started on January 1st 2019, it has a duration of 42 months, received a EU contribution of 6,837,732.75 €. The Consortium includes 26 partners from 12 different countries.

FONDAZIONE SCIENZA E TECNICA

The Fondazione Scienza e Tecnica (FST) was founded in 1987 and its aim is to promote and disseminate scientific and technological knowledge, beginning with the conservation and valorisation of the historic and scientific heritage of the Istituto Tecnico Toscano, a nineteenth-century secondary school in Florence (Gori, 2001).

This rich collection (Soldani & Lippi, 2018) holds more than fifty thousand items, divided between naturalistic collections, scientific instruments, models, machines, appliances, manufactured products, and a contemporary library. The collection is preserved in an 1891 building with its original furniture. This makes it possible to retain the context and the atmosphere in which the collections were acquired. But, from a conservation perspective, this presents challenges.

The Physics Cabinet (Brenni, 2013) collection is open to the public in its original setting, while the natural history collections have been kept, until now, in storage, in an area accessible only to scholars.

THE FST CONTRIBUTIONS TO THE APACHE PROJECT

While art, architecture and archaeological heritage receive significant attention for their conservation needs, the same cannot be said for historical scientific and technological collections. Since they have only recently gained recognition as part of our cultural heritage, there is a lack of attention to the specific concerns and materials of apparatus and natural history specimens.
FST is a partner of the APACHE consortium and a member of its "end user" group along with other museums including the National Museum of Hungary, the Soprintendenza of Abruzzo (MiBACT), National Museum of Slovenia, and the Centre Pompidou. We consider this partnership an opportunity for improving knowledge on scientific and technological heritage conservation and for disseminating better preventive conservation tools and innovative materials in our community of professionals, scientific museums and collections.
In particular, we have contributed multiple case studies to the project's work on micro-environmental measuring. The FST case studies were selected based on their location, constituent materials and container type. In our documentation we addressed the parameters connected with the APACHE research objectives: temperature, relative humidity, volatile organic compounds (VOCs) and pollutants.
Our first case study is the display case containing our collection of plant models (Fig. 1). These models were made for teaching purposes by the Brendel Company of Germany (Fiorini et al., 2005; Fiorini et al., 2008) between the last decades of the nineteenth century and the beginning of the twentieth century. They were created from an array of materials including: wood, glass beads, feathers, cotton fabric with plaster, papier-mâché, vegetable and animal fibers, resins, pigments, starch, and some polymeric materials (Giatti et al., 2004). At the time of their production, these models were renowned across Europe for their accuracy and usefulness in the classroom. The models have recently been restored and moved out of storage to be placed on public display. The display case is made of composite wood and glass. It is not sealed and has no internal climate control.
The second case study is another large display case holding our collection of electrostatic and electrodynamic scientific instruments (Brenni, 2000) (Fig. 2). In the second half of the nineteenth century, various European producers made educational machines and scientific instruments such as those in the Physics Cabinet which were acquired by the Istituto Tecnico Toscano for didactical purposes. The most common materials used for manufacturing them were wood, glass, and lacquered brass, but we can also find small parts made with silk, ebonite (hard rubber), Bakelite, and various metals for which conservation can be more challenging. These instruments, restored in the 1980s, are very well preserved and have been exhibited in the same display case for several decades. The case, made of wood and glass at the end of nineteenth century, is neither climate controlled, nor sealed. In 2007 all of the Physics Cabinet display cases were refurbished and re-painted, including this one.
Our third case study is part of an herbarium known as the "Erbario tecnologico farmaceutico" (Technological and Pharmaceutical Herbarium) (Regione Toscana, 1994) which is part of our botanical collection (Fig. 3). The plant specimens are fixed on paper sheets and collected in cardboard boxes that are in turn stored in a cupboard. The specimens were harvested in the first half of the nineteenth century, but they were set in their current boxes around the middle of the twentieth century. Recently the individual specimens were enveloped in commercially-produced transparent plastic bags to counteract pests. The cupboard holding the boxes is in a storage area open only to the FST personnel and researchers and is without climate control. It is made of wood with glass panes and is without sealing.
Within the context of the EU-funded APACHE project, FST is monitoring, collecting, analysing and re-

Fig. 2. Part of the collection of electrostatic and electrodynamic scientific instruments.

Fig. 3. Cupboard with the "Erbario tecnologico farmaceutico" in its box.

Fig. 4. Air sampling equipments and data logger in the case study n. 1.

porting data for both inside the object packaging and outside (i.e. in the rooms or, for the third case study, in the cupboard) for all of the above case studies (Fig. 4). It is worth mentioning an additional output of the APACHE project in which FST is involved: the development of a Decision Support System. This is a decision-making software tool based upon a modular set of decision trees for guiding institutions in the selection of the most suitable preventive conservation measures. It will automatically collect and process data in real-time and suggest the best preventive conservation actions to take in case of a threatening situation. The software will be developed in two tiers. Tier 1 will be developed for museums that do not have dedicated conservation staff or a connected sensor infrastructure. The aim is to give general preventive conservation information to the curators based solely on the objects' materials and/or agents of deterioration that may affect a collection. Tier 2 has been developed for institutions with dedicated professional conservators and a connected infrastructure of monitoring sensors. The access to sensor data and collection information is limited only to data owners through an authentication system. The tool is based upon an open repository with all preventive conservation techniques developed in APACHE and other international projects, as well as selected from the literature and common practice.

CONCLUSION

The materials, tools and solutions developed within the EU-funded APACHE project cover the preservation of materials and physical structures of collection items that are tangible, movable and indoor. The project target is to improve preventive conservation actions by small and medium museums through affordable and innovative materials and tools. Dissemination is a sizable part of the scheduled actions within the project and it will take place through social media, the project web site, public trainings and scientific publications.
FST, as part of the consortium, is also working to foster attention and appreciation for scientific and technical heritage. Our aim is to improve knowledge and awareness of innovative and affordable practices in the field of preventive conservation within the scientific and technical museum community.
Please take note of the APACHE website and social media (see websites 1, 2, 3, 4)!
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