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SCIENCE, CULTURE, SOCIETY – NEW CONTENTS AND EDUCATIONAL CONTEXTS

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Towards science-based conservation of objects of cultural heritage

The importance of cultural heritage

Cultural heritage is one of central constituents of human life and activity. It is the material and spiritual legacy inherited from previous generations, maintained at present for the benefit of future generations. This is done because it determines our culture and identity developed throughout the ages as a result of inter-human and human-environment interactions. Consequently, the heritage enables us to understand and appreciate the spirit, the thoughts, ideas, priorities, talents and sentiments of previous generations. This is possible because it has always been through art that people have expressed themselves, their daily life, its important events, emotions, feelings, joys and apprehensions, and importantly, religion and beliefs.

Degradation of objects of cultural heritage

Material cultural heritage encompasses both the outdoor and indoor art. Both are unavoidably exposed to the activity of the environment they are placed in or stored. Naturally, as soon as the work of art is produced, chemical reactions with environmental factors begin and the process of aging starts. This brings about degradation of the artworks. Oxygen in the air, light, changes in temperature and humidity, along with other climatic factors and natural causes are responsible for the inevitable degradation of art.

Today, this degradation of artworks through aging has been tremendously accelerated by pollution. Factors such as air pollutants produced by the burning of fossil fuels (sulphur and nitrogen oxides), also soot and dust in addition to microbiological danger (bacteria and fungi) speed up the degradation processes. For instance, the oxides of sulphur may severely wear away stone and metal monuments and sculptures, especially those found outdoors, e.g. resulting from the combination of sulphur oxide with moisture, acid rain when contacted with marble changes its crystalline calcium carbonate to a powdery, chalklike gypsum (calcium sulphate). Sulphides in the air, by contrast, react with pigments such as white lead to form lead sulphide, which results in the graying of white areas in paintings, while azurite blue ($Cu_3(CO_3)_2(OH)_2$) turns brown due to the formation of copper sulphide, etc.

Apart from the detrimental effects of environmental factors on the condition of artworks, their decay is now also accelerated by ever increasing tourism that, besides its intensity, now also includes the acts of vandalism as well as accidental damage.

Given these degradation processes, the objects of cultural heritage to be maintained need conservation. In some cases the degradation cannot be reversed, but art conservators always try to help slow down the process.

Art preservation, restoration and conservation

Although very much alike, the three practices applied to degrading art, that is preservation, restoration and conservation, have different goals (Donelly, Rivas, Nutile, 2010). Most commonly, preservation is seen as a specific chosen approach to the treatment of historic sites, art collections or given artworks/documents of special historical significance. Restoration by contrast, is the practice of restoring art, i.e. bringing it back to the original state or as close as possible. The art restorer normally cleans, repairs and typically reconstructs the work. Quite to the contrary, conservation is the practice of conserving art, i.e. maintaining the works normally by applying processes that stop the decay and prevent its further development. The art conservator examines the work, establishes the causes of decay, establishes methods of preservation and finally applies the necessary treatments with as little restoration as possible. To do the conservation the conservator must fully understand the structure of the artwork, its complexity, the extent of degradation of each part of the work, and make a forecast on further developments.

Given these goals, while typically art restorers are trained in artistic ways, the training of art conservators should be significantly more extensive to include natural sciences in addition to obvious art history and artistic training.

Studying art conservation

Typically and traditionally, art conservators get their education by studying arts and humanities at a university level, be it in art schools or at humanities faculties at universities. Today, however, a growing awareness among art conservators is observed that the traditional art-based conservation is not sufficient and in order to be truly effective, art conservation has to make use of natural sciences and their advanced techniques (Barański, 2008; Łojewski, 2010). Sciences, such as chemistry, physics, biology and materials engineering offer powerful tools that today's conservation cannot do without. Based on in-depth analyses, the tools allow for the identification of and, more importantly for applying counteraction to the detrimental chemical, physical or biological transformations that have occurred and can continue to occur in the objects.

Along with traditionally applied art- and history-based techniques, the sciences involved in art conservation have formed a new fascinating interdisciplinary approach to the historical materials. Among those sciences, chemistry seems to be a key science and as a result it has evolved to give rise to the formation of a new branch termed conservation (preservation) chemistry (Barański, 2008). The application of

chemical techniques allows for, among others, the determination of: (i) chemical composition of the objects, (ii) the origin of the materials used in the objects, and (iii) the technology used to produce the objects, obviously all of them done in the least invasive way. Very importantly, conservation chemistry also studies the mechanisms of aging/degradation processes, establishes the optimal conservation procedures to be applied, and searches for novel schemes of conservation.

Modern analytical techniques for the conservation of objects of cultural heritage – A postgraduate course of study at the Faculty of Chemistry of the Jagiellonian University

Remarkably, as of yet conservation chemistry has not become a regular course of study in the system of higher education in Poland. In this context, to respond to this new science-related challenge in art conservation, in 2005 the Faculty of Chemistry of the Jagiellonian University set up a postgraduate course of study in Modern analytical techniques for the conservation of the objects of cultural heritage (Łojewski, 2016). The course is addressed to art conservators, archeologists, museum curators, librarians, archivists, members of local governments in charge of historic sites, researchers, and everyone interested. Fig. 1 presents a poster advertising the course and announcing the admission for the year 2016/17.

The course combines chemistry and materials science with elements of physics and biology. The curriculum was designed to ensure that the graduates are able:

(i) to scientifically diagnose and cure the objects, i.e. to recognize both their state and the threats imposed by the conditions, study and analyze them,
(ii) to envisage the developments and above all to work out the optimal strategies to do the repair of the objects and ensure their longevity.

It is a one-year program (165 h) that consists of lectures and practical classes. The program is composed of the following three blocks of classes:

1) Principles of chemistry (16 h of lectures and 15 h of practical classes). The aims of the course are:
(i) to refresh the knowledge of chemistry, emphasizing the problems connected with the conservation science (degradation and preservation),
(ii) to actuate the language of chemistry for the description and interpretation of the observations and measurements made,
(iii) to actuate the chemistry thinking that connects the macroscopic world with the world of atoms and molecules,
(iv) to teach the laboratory skills, calculations and elaboration of the experimental results.
2) Modern analytical techniques to be applied in studies of the objects of cultural heritage (36 h of lectures and 58 h of practical classes).

The course includes: spectroscopies (FTIR, Raman, UV-vis), XRF, XRD, ICP-MS, chromatographies (GC, LC, SEC), microscopies (optical and SEM), LIBS, capillary electrophoresis, accelerated aging, mechanical studies, dating, color measurement, hyperspectral imaging and microbiological studies.

3) Natural sciences in conservation science (40 h of lectures).

Fig. 1. Poster advertising the postgraduate course of study in Modern analytical techniques for the conservation of the objects of cultural heritage

The course deals with materials from which the objects of cultural heritage are made, discusses the specific degradation processes, proposes the techniques for their investigations, as well as the protocols to minimize the degradation. The materials studied include: metals, dyes and pigments, paper, textiles, leather/parchment, wood, glass, stone, and ceramic building materials.

As teachers for both lectures and practical classes in our course serve specialists from our Faculty and importantly, from different centers across Poland, among others from Warsaw University, Warsaw University of Technology, Military University of

Technology in Warsaw, Nicolaus Copernicus University in Toruń, Central Laboratory for Conservation of Archival Records in Warsaw, Wrocław University, AGH University of Technology, Pontifical University of John Paul II, National Museum in Kraków, Institute of Forensic Research in Kraków and Institute of Catalysis and Surface Chemistry of the Polish Academy of Sciences in Kraków, Likewise, students of the course come from different cultural centers, museums, libraries and governmental offices from all over Poland and abroad.

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Abstract

Cultural heritage is one of central constituents of human life and activity. It is the material and spiritual legacy inherited from previous generations, maintained at present for the benefit of future generations. This is done because it determines our culture and identity developed throughout the ages as a result of inter-human and human-environment interactions. Exposed to degradation by aging, but now also accelerated by the pollution and ever increasing tourism, the artifacts of cultural heritage to be maintained need conservation. For the traditional conservation to be truly effective now it has to make use of sciences and their advanced analytical techniques. These allow the detrimental chemical and physical transformations that has occurred and can continue to occur in the objects to be identified and more importantly, to be counteracted. In this context, the Faculty of Chemistry of the Jagiellonian University has in its offer a postgraduate course of study in Modern analytical techniques for the conservation of the objects of cultural heritage. Addressed to conservators, archeologists, museum curators, librarians, archivists, members of local governments in charge of historic sites, researchers, and everyone interested, the course is a platform for interdisciplinary art conservation science.

Key words: cultural heritage, aging and degradation, art conservation, education of art conservators, conservation chemistry, postgraduate course of study

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