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RECENT STUDIES IN CONSERVATION SCIENCE AT THE BRITISH MUSEUM

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The British Museum holds the national collections of antiquities, ethnology, coins and medals and prints and drawings. The collections are diverse, containing artefacts made by man from paleolithic flint tools to twentieth century plastic credit cards. Some of the objects are famous: the Parthenon sculptures, the Rosetta stone, Egyptian mummies and coffins, and the Sutton Hoo finds can all be seen in the Museum galleries. The number of objects held is an estimated 6-7 million.

The Department of Conservation is responsible for the conservation, that is the repair and stabilisation, of the collection. The Conservation Research scientists are responsible for establishing mechanisms of deterioration, identifying methods and materials for conservation, and determining strategies for stabilisation. In this work samples are taken for analysis from objects, but because each object is essentially unique the samples taken are normally very small. The analytical techniques used in the Museum have been selected to cope with the size of sample available, or to allow non destructive analysis where possible. The main techniques used are FT-IR, uv-visible spectrometry, powder x-ray diffraction, x-ray fluorescence, SEM-EDXA, atomic absorption and neutron activation. For some investigations other techniques are more appropriate, and companies, other museums or university departments carry out this work on behalf of the museum. X-ray photoelectron spectroscopy has been used in a study of tarnishing of silver; ion chromatography has been used to study soluble salts and unusual alteration products on objects; and thermal analytical techniques have been utilised in a study of conservation techniques for sun-dried clay tablets inscribed with cuneiform, the earliest form of writing.

Recent research on the effect of indoor pollutants on the collection; on the conservation of cuneiform tablets; on the deterioration of black dyed New Zealand flax; and analysis of the Rosetta stone will be presented to illustrate the use of analysis in studying the deterioration and conservation of the British Museum collection.

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MATERIALS CHARACTERIZATION AND THE COMPUTER MODELING OF WORKS OF ART

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The computer modeling of complex, multi-material, composite structures such as oil paintings and photographs requires the proper mechanical and physical properties. These values will be different for dynamic analyses such as shock and vibration and for environmental effects such as changes in temperature and relative humidity (RH). The physical properties most relevant to the behavior of cultural properties are the changes in dimension and mechanical properties, such as strength and stiffness. These physical properties will also modified by chemical changes due to aging or to conservation treatment procedures. The effects of relative humidity are diffusion controlled and are thus long termed and quite time dependent. To develop fully the property alterations from RH effects, the dimensional changes of the individual components of an artwork must be measured over the largest possible environmental range and with consideration for the anisotropic behavior of many materials. The time dependent nature of physical properties can be eliminated by considering "equilibrium" states with their accompanying physical properties.

Once the appropriate material properties of an object's components have been determined, the behavior of the object can be modeled by finite element analysis (FEA). This technique can be used to determine the effects of dynamic behavior, such as shock and vibration, and the effects of environment, such as changes in temperature or relative humidity. Comparison of the computer models and the actual behavior of objects can then be made. Examples of oil paintings and photographs show the useful application of FEA techniques to understanding their behavior.

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DEGRADATION AND FAILURE IN THE LAB: STUDIES OF THE AGING PROCESSES OF ARCHIVAL MATERIALS

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It is critical to understand the aging processes of materials in museums and archives in order to determine appropriate storage and display environments, and to evaluate the effects of treatments. Most reactions and processes that take place on the museum time scale are too slow to study directly, so other approaches must be used. One can study naturally aged materials, but the information gained is limited because the original properties of the materials and the aging environment (the conditions of the "experiment") usually are not known or controllable. An alternative is the accelerated aging of new materials. Accelerated aging conditions may include elevated temperatures or relative humidities, or exposure to intense light or high concentrations of pollutants. Unfortunately, it is difficult to demonstrate that the resulting changes are equivalent to "natural" aging and thus relevant to objects in the museum. To demonstrate the equivalence of two sets of aging conditions, it is necessary to show that the same reactions and physical processes take place under both sets of conditions, and that the relative rates of the reactions are the same for both conditions. To be equivalent to natural aging, accelerated aging must speed up all reactions by the same factor without introducing new ones.

The degradation processes of cellulose were examined by analyzing the soluble degradation products. This analysis allows the determination of the relative rate of each reaction represented by a degradation product. For paper samples artificially aged under different conditions, the mixture of reaction products varied somewhat with relative humidity but only minimally with temperature up to 90 °C. It was predicted that accelerated aging at elevated temperatures would correlate with natural aging at a similar relative humidity. Changes in physical properties such as strength and stiffness also were followed as a function of aging time and condition in order to predict the changes resulting from natural aging. Naturally aged paper samples (and other forms of cellulose, such as linen thread) exhibit the predicted changes, both in types and amounts of degradation products and in physical changes. Such results demonstrate that for cellulose it is indeed possible to conduct accelerated aging tests that are relevant to natural aging.

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