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GREENART

HERITAGE, SCIENCE AND TECHNOLOGY

Heritage sciences are also facing new ecological challenges. Knowledge transfer, preservation of cultural objects, technological equipment, energy consumption. What are the options within the scientific community? Here are some avenues for reflection.

Heritage sciences constitute an interdisciplinary research field for the scientific study of cultural and natural heritage. Drawing from diverse disciplines of humanities, sciences, digital technology, and engineering, "heritage sciences" is a generic term that encompasses all forms of scientific research on human creations, and the combined works of nature and humans, which hold value for individuals. They aim to enhance the understanding, maintenance, sustainable use, and management of both tangible and intangible heritage. The heritage sciences sector has rapidly evolved over recent years. The number of scientific publications produced each year has significantly increased over the last twenty years, with over a third resulting from international collaborations. Heritage scientists predominantly work in heritage, academic, or research institutions, and their work ranges from fundamental research to more applied studies with the ambition to improve the understanding of cultural heritage and develop new ways to ensure its preservation, appreciation, and transmission, while aligning with the eco-responsibility perspective since December 2019 (the launch date of the European Green Deal). Like everyone else, they consume energy and resources, generate pollution, and produce waste. But what is the environmental impact of their work and how can they act to become eco-responsible?

Open access

Open science is a broad topic covering various issues. In July 2018, the French Ministry of Higher Education, Research, and Innovation published the National Plan for "open access to scientific research results, without barriers, delay, or payment". This principle of openness is gradually being adopted by all institutions. It allows the author of a scientific paper to publish it in open access, so that the entire text is freely accessible to any reader. The APCs ("Article Processing Charges" or publication fees) are financially covered by the author or, more often, by their affiliated institution. The economic model is thus that of the "author-payer". The establishment of open-access text repositories has indeed caused the number of research studies on the internet to skyrocket. Internet users are rarely aware, but their wanderings in the virtual world have a real energy cost. According to Alex Wissner-Gross, a physicist at Harvard University, two Google searches would consume as much carbon as a hot cup of tea and generate 14 grams of carbon emissions, almost the footprint of an electric kettle (15 g).

Invasive, non-invasive, fixed or portable

The artworks that have reached us are precious and must be studied with the utmost caution. This is why the use of chemical methods requiring samples is becoming

— *Antonio Mirabile*

InsightART robotic X-ray scanner

Courtesy InsightART

increasingly rare: removing material, even in very small quantities, is no longer acceptable on heritage objects. Moreover, the sample is not always representative of the complete work, as it is often localised on the edges or in already damaged areas, around gaps. Hence, numerous new non-invasive analysis methods have been developed over the past twenty years. But it is primarily the new portable instruments designed for in situ analysis that offer the most advantages for research on artistic productions. Fixed analysis instrumentation requires the relocation of the artwork; it is the museum that is going to the lab! Beyond the carbon footprint associated with the manufacturing of a crate used only once with all the plastic cushioning systems inside and an air or other transport, heritage objects are subjected, during their transport, to conditions that promote various types of deterioration and damage. The most common dangers include handling effects, shocks, vibrations, and variations in relative humidity and temperature. It should not be forgotten that some deteriorations occur gradually and are not necessarily detectable immediately.

Instrumentation and obsolescence

The term “obsolescence”, stemming from the Latin *obsolescere* meaning to lose value, was used by the Romans to denote an object that wouldn’t be useful for long. Obsolescence is typically defined as a set of mechanisms encouraging consumers to frequently renew their purchasing act. Planned obsolescence, characterised by manufacturers’ intent to shorten product lifespan, is one of the most controversial forms of obsolescence due to the perceived manipulation of consumers to meet companies’ growing sales objectives. Regardless of its form, obsolescence is problematic from a sustainable development perspective. It leads to accelerated acquisition and disposal cycles of goods, whose primary consequence is a skyrocketing growth of waste. The obsolescence phenomenon is particularly evident in the electrical and electronic sector, where users tend to frequently change devices to keep up with rapid innovations. Each year, 20 to 50 million tons of electrical and electronic equipment waste is generated. It’s essential to know that in all sectors and among all scientific instrumentation manufacturers, factories only provide spare parts for about ten years following the last marketing.

However, it’s worth noting that these cutting-edge instruments like mass spectrometers or scanning electron microscopes demand a lot of effort to acquire and are often very costly (hundreds of thousands or even several million euros). Grant applications allowing the acquisition of these instruments are often lengthy, thus, support personnel put a lot of effort into keeping them operational as long as possible. Smaller common instruments like pH meters or balances with shorter lifespans are recycled with small electronic equipment. But just like a well-maintained car, scientific instruments can be useful for about ten years. In some cases, the instrument simply isn’t performant enough for research needs anymore.

In rapidly evolving scientific fields, equipment transitions from a development phase to a routine operation stage. The obsolescence rate of knowledge is high, and the evolution of instrumentation towards rapid commercial exploitation is notable. It then becomes essential to think about organising research laboratories in a reactive, flexible, and networked manner.

Scientific imaging

The last category of common analysis methods concerns imaging applied to works. This can be used either to preserve a record of the work’s state at a given moment or within an investigative framework. When talking about recording, photography comes to mind. However, other two-dimensional (2D) full-field imaging techniques besides photography exist. Staying within a domain close to visible radiation, UV photographs allow imaging of restored areas, while infrared ones provide a different distinction between closely coloured pigments. Infrared reflectography enables visualisation of underlying drawings made with carbon. Moving further in frequency, X-rays allow the object’s transmission radiography, accounting for its density differences. These imaging techniques can be modified to render the three-dimensional (3D) structure of the object, like with X-ray tomography. It’s also worth noting that several presented techniques can also be used to image objects, with the final image realisation in a “point by point” mode. The complexity of heritage materials is such that simultaneous recourse to various aforementioned techniques is often necessary to correlate results and extract sought-after information. Likewise, the development of multispectral cameras is encouraged to analyse works simultaneously across a large portion of the electromagnetic spectrum (especially UV, visible, and infrared). But, what will remain of these digitally born images in twenty years? What fraction of this work will be transmitted in the future? Probably quite little. As recently shown by a joint report from the Academy of Sciences and Technologies, the spontaneous aging of supports leads to constant migrations for digital information conservation (copying from an old to a new support). The operation is costly due to necessary handling and equipment; storing information on hard disks running day and night entails a real environmental impact (electrical consumption and air conditioning).

Energy consumption

The energy crisis, currently impacting the world and having strong effects on all of society (individuals, companies, research, administration…), does not spare SOLEIL, which had to renew its electricity supply contract for 2023 in 2022. SOLEIL, a particle accelerator (electrons) produces synchrotron radiation, an extremely bright light allowing the exploration of inert or living matter. In consultation with its supervisory bodies CEA (Atomic Energy Commission) and CNRS (National Center for Scientific Research), it had to take the very difficult decision to cease operating the accelerators and the 29 light lines during the so-called Run 1 period, from 18 January to 27 February 2023. This choice also aligns with the need to participate in the national effort to reduce electricity consumption during the winter period, which could prove critical for electricity supply.

Scientific research and eco-responsibility

Scientific research has always been subject to strategic orientations, being influenced by policies and subsidies from various government levels and societal evolution. For several years, certain scientific circles have been advocating for research to contribute more to establishing a genuinely sustainable society. However, many researchers work on topics that, they believe, have no connection with eco-responsibility themes, even though this concerns us all. Through their knowledge, scientists have a privileged position to implement sustainable and effective solutions. They have an exceptional ability to innovate within their research work. There’s no doubt they will be capable of integrating the challenges. The shift towards a viable society thus necessitates a renewal of how we view scientific research, a more globalising vision, which includes long-term, interconnected, and transdisciplinary solutions-focused approaches.

Courtesy National Galleries of Scotland

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