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Heritage Science – Perspective, Provenance, Preservation

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Abstract

Often the perspective of heritage science can seem opaque, with the perception of science being only for "scientists". The fairly recent move to using the term "heritage science" is better known in Europe, but there is some confusion as to what this term encompasses. Heritage science refers to any of the multidisciplinary fields that contribute to the discovery, security, and preservation of a diverse range of cultural heritage materials. Many heritage collection items are complex multi-composites with convoluted preservation needs and degradation pathways. One of the areas that seems to be less well understood and appreciated is the capacity for heritage science to add new layers of knowledge to collection items, as well as the capacity for re-interpretation through this new information. Further areas of heritage science that support humanities include confirming provenance, the ability to link and reconnect separated collections, and the utilization of new technology to provide levels of security, an area of support greatly needed in the current environment for extensive trafficking of heritage.

Introduction

Heritage science as a field is often not fully understood or communicated, and it is up to our community to ensure this barrier to shared knowledge is reduced and removed. Adding scientific knowledge to the characterization and assessment of collection items – at-scale or for unique special collection items – is a critical component for stronger connections with curators of collections and humanities scholars, highlighting an important need for more integration between science, social and economic data. With trafficking being an important area for protecting cultural heritage, there have been many invasive attempts to add security markers to collection items, especially relevant as we try globally to deal with centuries of trafficking of heritage materials. The ironic aspect of these invasive techniques is that there are some relatively simple techniques that can capture non-visible information. These simpler and less invasive techniques are far less intrusive than inked stamps and markings added by institutions, acts that sadly often make it straightforward for the community dealing in smuggling and theft of heritage materials to erase these provenance marks. The sections below will outline how science transforms information and data into knowledge, how new technologies can add levels of security, and inform preservation through predictive testing and better understanding of degradation mechanisms.

Challenges - Reducing Barriers to Integration

Many heritage scientists have become increasingly concerned about the lack of appreciation and recognition, and hence transfer of knowledge to the greater heritage, humanities and preservation community about how heritage science can enhance the knowledge of collections. Most often this issue relates to creating better interaction with curators and researchers, utilizing non-invasive techniques, and building layers of additional depths through connected research with scholars and humanists. Every successful research project the author and other colleagues have worked on that has been successful, has been effective because of the multidisciplinary group that has been brought together – scientists (from diverse fields of science), curators, individual scholars, information technology (IT) professionals conservators, and curators.

One area to explore to increase integration of heritage science is through creating a stronger and more informed and connected network of professionals in the library, archive, museum, art gallery, academic and preservation arenas. This would be more inclusive and expand the overlapping areas of colleagues who have specific expertise, who enhance that through working together, and by sharing this information and data, all involved augment their expertise to create new knowledge for heritage collections. Not only is creating the network important, but sustaining those connections is one of the ongoing challenges. Personal relationships can be developed, but often disappear when colleagues move on and don't transfer those connections to other staff and colleagues. Additionally, a further challenge within some of our larger institutions is assuring ongoing access to the information. As a field we need to improve mechanisms that ensure the data to be shared remains easily accessible, understandable, and opens the door to new collaborations, questions and methods of visualizing heritage science data, while adding value to collections.

To begin solving the problem we as heritage scientists need to acknowledge that barriers to access and interpretation of heritage science data exist and must be reduced and potentially removed. The approach that seems to work best appears somewhat simplistic – rather than try to change the world, starting the process through enhancing existing one-on-one personal connections can begin the narrative and conversation. Through reaching out and asking our non-science colleagues what their collection research questions are, and how could heritage scientists can then work together with them to answer those questions, makes the interaction about the collection and the question, not the scientific tools. One barrier in the past has been that every time there is a new instrument, there can be a tendency to want to use that new tool, rather than discussing collaboratively what information is needed to answer the question, and using possibly techniques that have been around for years. The microscope is a good example – it is one of the best tools to answer a multitude of questions, and often disregarded in favor of some other more sophisticated instruments. This links to another barrier that provides obfuscation, that annoying tendency for the use of acronyms that are only understood by people in the field – in this case scientists – using shorthand rather than explaining material characteristics and scientific techniques in an easily digestible way, and ensuing the approach to solving a heritage collection problem

includes all partners [1]. One example that brought this home was finding out that a colleague we had worked with for multiple years was struggling with a provenance question, but hadn't thought to reach out, not realizing that this was something with which we could rather quickly assist.

Through creating project teams that include all preservation professionals from the outcome, there is a much greater possibility that the final results will be accessible and reach more divers audiences. That interactive discovery aspect allows the co-creation of knowledge. By increasing engagement and awareness of what heritage science data could add, as well as building those layers of information within the collaboration, colleagues in all areas began to see that this knowledge could inform all heritage professionals in various institutions. Further, we learned that through this process of engagement, we start to assist in possibly changing the current interpretation through layered scientific data, a development having significant impact in relation to under-represented and some under-explored marginalized collections.

Utilizing characterized scientific reference samples that replicated those materials in rare and fragile collections, was another method for demonstrating the power of what a heritage science technique could add while showing the non-impact and non-invasiveness of the techniques. The Center for Heritage Analytical Reference Materials (CHARM) was created to be able to "experiment" and correlate scientific techniques on non-collection items to see what information could be gained, and to assure the technique was truly non-invasive [2] [3]. Sharing with colleagues what data various scientific techniques could capture using CHARM materials was useful in assuaging concerns about the impact of science on collections. Visual non-invasive imaging techniques such as multispectral imaging (MSI) was often used at the start of a collaboration to reveal hidden and redacted information and were a simple tool to begin new conversations and avenues of shared research interests. International collaborations where the language translation was outside our expertise was also a powerful way of ensuring co-partnerships, building cooperation, and active sharing of knowledge for deepening understanding of collections by adding scientific data.

Another less discussed barrier to integration of science and humanities is existing funding models. Interdisciplinary research is more broadly recognized, but it is still a challenge to find funding slated for "science" that will benefit cultural heritage and the humanities. In Europe the major funding frameworks require inter-country collaboration as a base requirement, with the existing EU's Horizon Europe key funding program for research and innovation having a budget of €95.5 billion [4]. The framework also supports and requires projects to help achieve the United Nation's Sustainable Development Goals [5]. In the United States, funding is largely private rather than public, and segregated by discipline. Looking for more sustainable funding models and frameworks that could start to support more integrated inter-disciplinary collaborative research would be a strong move forward in reducing barriers.

Results

Methods for recognizing and reducing barriers to integration of heritage science have been outlined above. To solve these issues, the methodology has been to use a variety of approaches to engage and better integrate science techniques, since it often was dependent on the backgrounds of the specific colleagues we were working with and the particular research required. Utilizing existing personal connections has seemed to be the best way to expand the network, both within internal institutions, between institutions, and internationally. For curators and researchers who were not familiar with what heritage science techniques could do, and the type of information gained, often the first step was sharing previous examples of what type of knowledge could be gained through different scientific techniques. Ensuring that colleagues understood that these technologies used would not harm the collection item in any way was the first critical step. When a number of colleagues had engaged with scientists who did not explain their methods, they felt disengaged from the process of discovery, and not included in the outcome of the research. Comments shared included the feeling of being disenfranchised when techniques were explained in lofty terms using impenetrable acronyms, and some noted it felt more like an exam than a collaboration.

The following illustrate a range of examples and approaches that expand the integration of heritage science for changing collection interpretations, adding new and fresh perspectives, and building new information leading to useful provenance data. These approaches were extremely successful and begin to demonstrate the breadth and depth of the types of knowledge that can be gained and shared from integrating heritage science.

Ongoing conversations with a colleague from the United Kingdom (UK) during a previous loan to the Library of Congress (LC) led to an incredible exploration of two rare parchment manuscripts, a Magna Carta and Carta de Foresta, Edward 1st, ca.1300, from the collection of Sandwich, UK a number of years later. Undertaken during the pandemic, with only one full day of access due to security, Preservation Research and Testing Division (PRTD) staff at LC developed a rigorous new approach to optimizing time through pre-planning and full engagement from curatorial, conservation and management colleagues. The non-invasive analytical approach began with baseline spectral imaging (MSI) to map the spectral response of ink, stains and other materials across the parchment, and based upon that information, a range of complementary "point source" spectroscopic techniques were undertaken. CHARM reference samples were used to confirm and identify various components, as well as a unique inclusion of 3D scanning of the manuscript and capturing the volatiles profile of the manuscripts to help determine the level of degradation.

Figure 1. *Upper: LC staff and team colleagues; Lower, Carta de Forest Parchment – Illustrating Text Loss and Staining*

A very successful international collaboration was developed with colleagues at University College Cork, Ireland (UCC) *Inks& Skins* starting from initial conversations around what the humanities questions were, and how heritage science techniques could add to the unknown history of medieval Gaelic manuscripts [6] [7]. The research project began with the utilization of MSI to map differences in inks and pigments across a manuscript page assisting with better understanding of scribal practices, as well as capturing and revealing data from beneath stained and degraded text. Since none of our team in the USA could read Gaelic, the close connection that developed from shared expertise led to all parties gaining knowledge.

An early success from building the relationship and sharing examples, was expanded access to medieval manuscripts. The original project was to be based on a 14th century manuscript – as we shared was MSI could reveal and capture, the project expanded to include rare manuscripts dating back to 7th century Ireland. An example, the Cathach (A.D. 560-600) is the oldest extant Irish manuscript of a psalter - a manuscript volume containing the Book of Psalms and other devotional content. The Cathach may be the earliest example of a very specific form of Irish writing, and is written in Latin. After seeing examples of what MSI could reveal, this rare manuscript was made available to us to carefully capture MSI data cubes, images that are still adding new information as we expand to additional complementary techniques such as Fiber Optic Reflectance Spectroscopy (FTIR) that enables the identification of colorants and pigments.

Figure 2. *Dr. Fenella France & Prof. Ó Macháin carrying out FORS analysis of the Cathach at the Royal Irish Academy (RIA) Library*

Another outcome from this collaboration was the description from a humanities colleague of MSI as the "*next level of digitization*" with the recognition that with expanding access to this imaging data for other humanities scholars, would improve scholarship. Our discussions led us to a better understanding of how humanities scholars wanted images and data to be visualized. Another important aspect was understanding how imaging data could add to shared knowledge of scribal practice and parchment makers techniques, through processing the data to expose creation techniques [8].

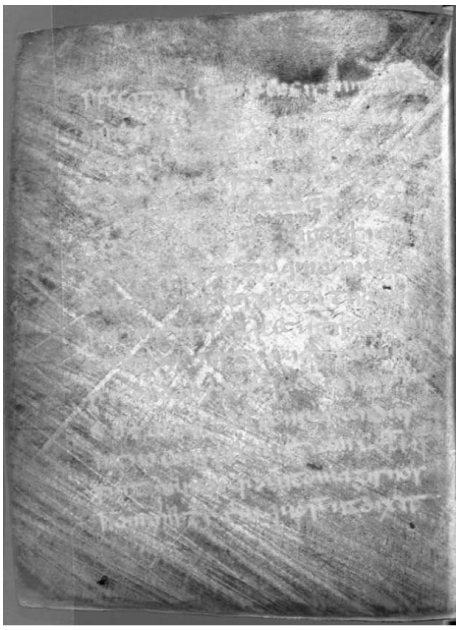

Figure 3*. Stowe Missal, MSDii3, 31v (late 8th Century – MSI Revealed Parchment Scrape Markings*

There are times when information comes to light about collections that require examination. When these are rare and fragile collection items, and evidence has been removed, MSI and other spectroscopies are non-invasive techniques that can aid the examination. Das Narrenschiff was a historic and invaluable medieval book that vanished from a monastery in Switzerland

during World War II, and eventually resurfaced in New York City in the 1940s. After being preserved at the Library of Congress in Washington D.C., having been bought in good faith, it was revealed through heritage science imaging and spectroscopy techniques to be the book that had been taken, and in December 2022 the priceless artifact was returned to its original home in Fribourg, Switzerland [9]. MSI revealed the original stamp that proved ownership and illustrated the ability for heritage science techniques to non-invasively provide security information for rare collection items, as well as being useful in anti-trafficking initiatives. The MSI both revealed what had been tried to be removed, as well as capturing non-visible information (from the ultraviolet and infrared regions) that cannot be removed since it is not easily visible to the naked eye.

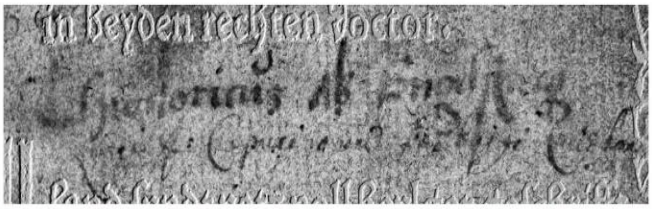

Figure 4. *Das Narrenschiff: Principal Component Analysis Image of Page aii recto Illustrating a non-visible inscription.*

An example of how heritage science can impact interpretation of collection items is illustrated with the Rosenwald manuscript 13, *Betrachtungen des Leidens Christi und Gebete für Klosterfrauen* (*Contemplations of the Passion of Christ and Prayers for Nuns*). The small hand-sized prayer book contained an image on parchment, The Holy Face, known more commonly as the veil of Veronica. Curators had assumed the darkened image was due to deterioration, and while the nimbus around the face was indeed tarnished silver, the base coloration of the face of Christ, was intentionally black [10]. This has since led to a new exploration of related collection items, and completely changed the curatorial interpretation of this rare manuscript.

Figure 5. *Detail of page 58v, Betrachtungen des Leidens Christi und Gebete für Klosterfrauen (Contemplations of the Passion of Christ and prayers for nuns), c. 1500. Rosenwald 13, Lessing J. Rosenwald Collection, Rare Book and Special Collections Division, LC*

An additional ongoing initiative that expands through most research projects, is engaging project partners from different disciplines in how to best visualize and share heritage science data with colleagues, as well as with new and diverse audiences. Sharing of prototypes with humanities, social science and science colleagues is assisting in developing a more robust and adaptable platform for data visualization.

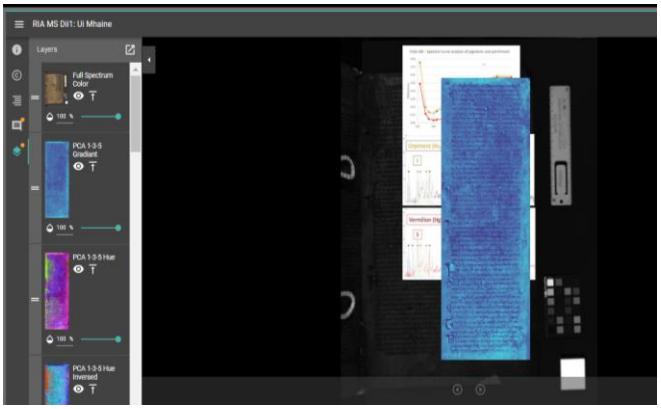

Figure 6. *International Image Interoperability Framework (IIIF) Mirador Shared Heritage Data Initiative*

Conclusions

The implications from the discussion and examples given above demonstrate the importance of the integration of heritage science – knowledge and techniques – into the broader community of libraries, archives, museums, art galleries, and academic, through the range of types of information that can be added to collections. Building strong collaborative research projects to coordinate the multidisciplinary nature of heritage science is important, maintaining and sustaining those connections is the truly critical aspect. Assuring that terminology and information is shared in an inclusive manner regardless of discipline, will assist with the experience of incorporating heritage science into exhibitions, preservation, and public-facing information. Demonstrating the capacity to add levels of security to collection care through non-invasive methods is also critically important in the current environment of global unrest and instability. Ensuring heritage science is transparent, comprehensive, and participatory will benefit all professionals in the cultural heritage arena, and potentially attract new heritage specialists.

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Dr. France, Chief of the Preservation Research and Testing Division at the Library of Congress, researches non-invasive techniques and integration and access between scientific and scholarly data. An international specialist on environmental deterioration to cultural objects, her focus is connecting mechanical, chemical and optical properties from the impact of environment and treatments. She maintains collaborations with colleagues from academic, cultural, forensic and federal institutions through her service on a number of international bodies. In February 2016 Dr. France was appointed as a CLIR Distinguished Presidential Fellow, and a Board Member in 2020.