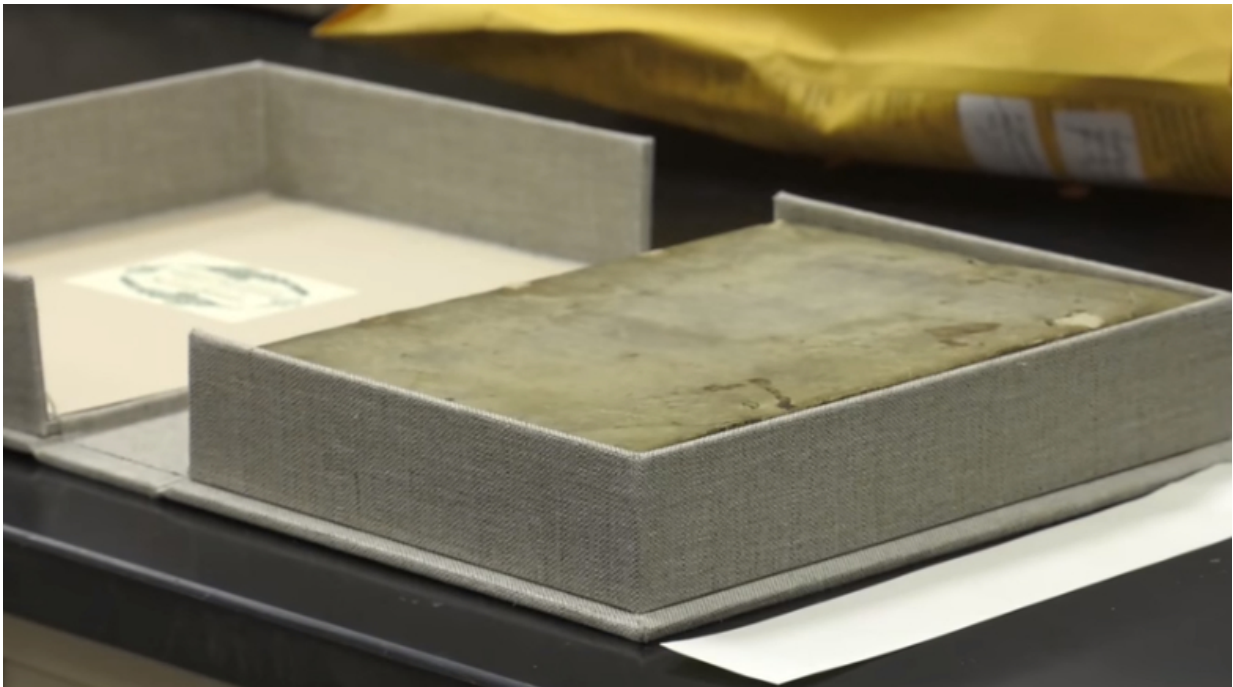


# Fused imaging reveals sixth-century writing hidden inside bookbinding

July 18 2017, by Amanda Morris

---



After being hidden for centuries, the secrets within medieval manuscripts might soon come to light.

By fusing two imaging techniques—visible hyperspectral imaging and x-ray fluorescence—an interdisciplinary team of Northwestern University researchers has developed a new, non-destructive technology that gives

access to medieval texts hidden inside of ancient bookbindings.

Between the 15th and 18th centuries, bookbinders recycled the bindings from medieval parchments into new binding materials for printed [books](#). While scholars have long been aware that books from this time period often contain hidden fragments of earlier manuscripts, they never had the means to read them.

"For generations, scholars have thought this information was inaccessible, so they thought, 'Why bother?'" said Marc Walton, senior scientist at the Northwestern University-Art Institute of Chicago Center for Scientific Studies (NU-ACCESS). "But now computational imaging and signal processing advances open up a whole new way to read these texts."

Partially supported by the Andrew Mellon Foundation, the research was published online in the journal *Analytica Chimica Arts*. Northwestern Engineering's Walton co-authored the study with electrical engineering and computer science professors Aggelos Katsaggelos and Oliver Cossairt. Emeline Pouyet, a postdoctoral fellow in NU-ACCESS, served as the paper's first author. Richard Kieckhefer, professor of religion and history in Northwestern's Weinberg College of Arts and Sciences, and Arthur Woll, senior research associate at the Cornell High Energy Synchrotron Source, also contributed to the study.

The book responsible for sparking the study is a copy of Greek poet Hesiod's *Works and Days* from 1537. Purchased by Northwestern in 1870, the copy is the only remaining imprint retaining its original slotted parchment binding. Although it was this binding that originally caught the attention of Northwestern librarians, it was the suggestion of writing beneath the parchment on the book board which incited new questions.

When NU-ACCESS researchers studied the binding, they noticed that

the bookbinder tried to remove the writing on the book board, likely through washing or scraping. The book board, however, retained two ghostly columns of writing surrounded by marginal comments, which were still visible through the parchment on book's front and back covers.

"The ink beneath degraded the parchment, so you could start to see the writing," Pouyet said. "That is where the analytical study began."

Walton and Pouyet originally used a visible light hyperspectral imaging technique to view the writing, but it yielded poor results due to the parchment's irregular degradation. The technique did indeed make the writing a bit clearer but not clear enough for historian Kieckhefer to read. Next, the pair tried x-ray fluorescence imaging using a portable instrument. The technique provided the first information about the ink composition; however, the text was still unreadable due to poor spatial resolution.

In search of a more powerful imaging source, Walton and Pouyet sent the book to the Cornell High Energy Synchrotron Source (CHESS) in Ithaca, New York, where the bright x-ray source and fast detection system allowed for a full imaging of the main text and marginalia comments in the entire bookbinding. When the researchers sent the more clearly imaged writing to Kieckhefer, he immediately recognized it as sixth-century Roman Law code, with interpretive notes referring to the Canon Law written in the margins.

Walton and Pouyet hypothesize that the parchment originally might have been used in a university setting where Roman Law was studied as a basis for understanding Canon Law, which was a common practice in the Middle Ages. The legal writing was then possibly covered and recycled because it was outdated as society had already struck down the Roman laws to implement church code.

"When you have the right tool, analysis is a lot easier," Walton said. "But the problem is that you can't always bring priceless books to an often out-of-reach synchrotron beamline. We wanted to be able to use our lab-based instruments to do this sort of work."

The pair then contacted Northwestern computer science professors Katsaggelos and Cossairt to help explore new ways to image the book.

"We had to develop new methods of doing the analysis that we wouldn't otherwise have had," Walton said. "There's nothing that exists off-the-shelf that we can use to simply image this book and read the hidden writing."

"There is a vast number of wavelengths in the electromagnetic spectrum, and each wavelength has its advantages and disadvantages," said Katsaggelos, the Joseph Cummings Professor of Electrical Engineering and Computer Science. "Some of them can penetrate deeper into the specimen, some of them have better resolution, and so on."

Using a machine-learning algorithm developed by his team, Katsaggelos discovered that not one imaging technique but a fusion of two would yield the best results. His team combined visible hyperspectral imaging, which includes wavelengths within the visible light spectrum to provide high spatial resolution, with x-ray fluorescence imaging, which provides high intensity resolution. The algorithm informed the researchers of the relative contribution of each modality to produce the best image.

"By combining the two modalities, we had the advantages of each," Katsaggelos said. "We were able to read successfully what was inside the cover of the book."

Katsaggelos' data fusion image was so clear that it rivaled an image of the main text produced by the powerful x-ray beams at CHESS.

Although this mystery of the text hidden in the bookbinding of Hesiod's *Works and Days* has now been solved, Walton and Pouyet believe their work has just begun.

"We've developed the techniques now where we can go into a museum collection and look at many more of these recycled manuscripts and reveal the writing hidden inside of them," Walton said. "This is really the start of a much larger initiative."

**More information:** E. Pouyet et al. Revealing the biography of a hidden medieval manuscript using synchrotron and conventional imaging techniques, *Analytica Chimica Acta* (2017). [DOI: 10.1016/j.aca.2017.06.016](https://doi.org/10.1016/j.aca.2017.06.016)

Provided by Northwestern University

Citation: Fused imaging reveals sixth-century writing hidden inside bookbinding (2017, July 18) retrieved 20 March 2024 from <https://phys.org/news/2017-07-fused-imaging-reveals-sixth-century-hidden.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.
---