SCRATCHING THE SURFACE —

New imaging tool confirms female scribe etched her name in medieval manuscript

Meet Selene, a new photometric stereo recording prototype. Think of it as 2.5D imaging.

JENNIFER OUELLETTE - 2/21/2023, 7:40 PM

Enlarge / Bodleian MS. Selden Supra 30 open at pp. 18-19.

Jessica Hodgson, a graduate student at the University of Leicester, was poring over a medieval manuscript in the Bodleian Libraries' collection at the University of Oxford when she spotted a faint etched inscription on one of the pages. It seemed to spell out the name "Eadburg," but the etching was too faint for full confirmation. So Hodgson turned to John Barrett, technical leader for a recent project at the Bodleian called ARCHiOx (Analyzing and Recording Cultural Heritage in Oxford), for help.

Thanks to the project's prototype photometric stereo recording and 3D scanning systems, Barrett confirmed Hodgson's discovery. The analysis also

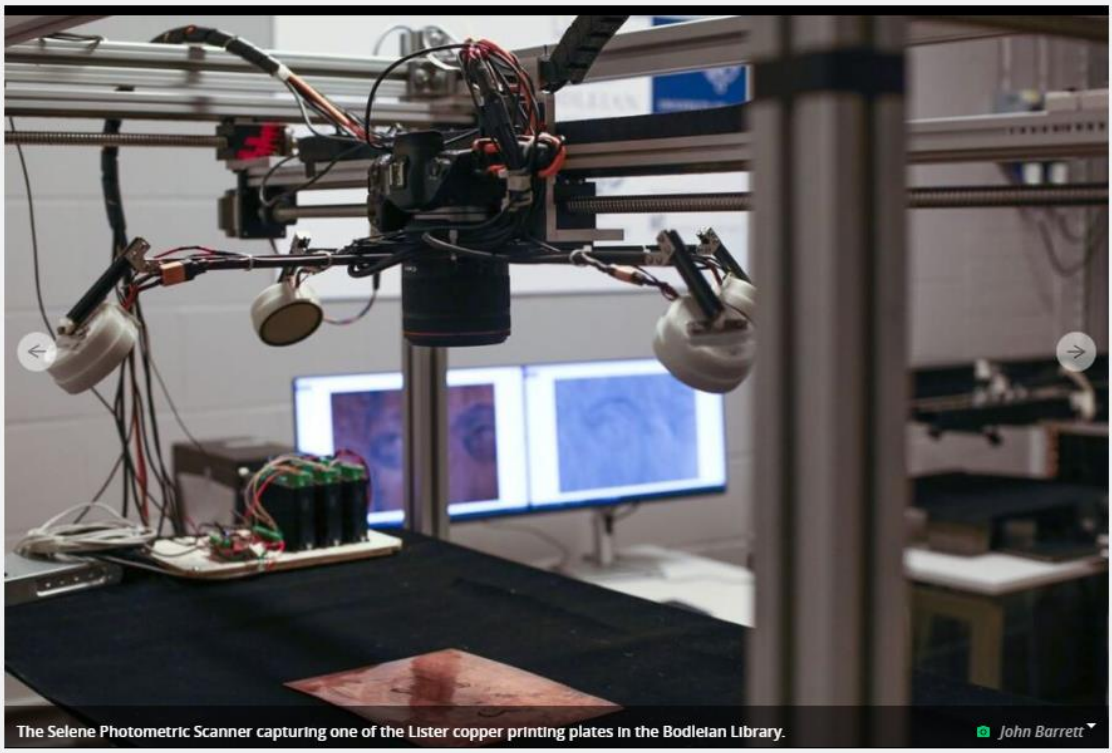
revealed multiple other etchings of the name "Eadburg" (in both full and abbreviated forms), along with several etched doodles in the margins. Who was Eadburg? Hodgson believes she was a highly educated woman of high status—possibly a female scribe or an abbess—who lived sometime in the early medieval period (between 700 and 750 CE). This latest discovery bolsters a 1935 discovery of the letters "EADB" and "+E+" in the lower margin of another page in the same manuscript, both believed to be abbreviated forms of "Eadburh/Eadburg."

The ARCHiOx Project

The ARCHiOx Project is a partnership between the Bodleian Libraries and the Factum Foundation, set up by Adam Lowe, an artist who trained at Oxford in the 1990s. In 2001, Lowe moved to Madrid to set up what he described to Ars as "a multidisciplinary workshop that's really a playground for artists, where we build bridges between new technologies and traditional skills." By 2009, there was so much interest from various historical projects regarding the group's technologies that Lowe established the Factum Foundation for digital technology and preservation. Today it serves as a research hub for high-resolution, three-dimensional recording of the surfaces of objects housed in museums and institutions around the world—including tombs, paintings, and books and manuscripts like those housed at the Bodleian.

Various kinds of non-destructive X-ray imaging are frequently used by archaeologists and conservationists, among other applications. That includes multi-spectral imaging, which takes visible images in blue, green, and red and combines them with an infrared image and an X-ray image of an object. This can reveal minute hints of pigment, as well as hidden drawings or writings underneath various layers of paint or ink.

For instance, researchers have previously used the technique to reveal hidden text on four Dead Sea Scroll fragments previously believed to be blank. Swiss scientists used multispectral imaging to reconstruct photographic plates created by French physicist Gabriel Lippmann, who pioneered color photography and snagged the 1908 Nobel Prize in Physics for his efforts. And last year, scientists used the method to discover the first known Greek remnants of the astronomer Hipparchus' lost star catalog, hidden beneath Christian texts on medieval parchment.



New imaging techniques

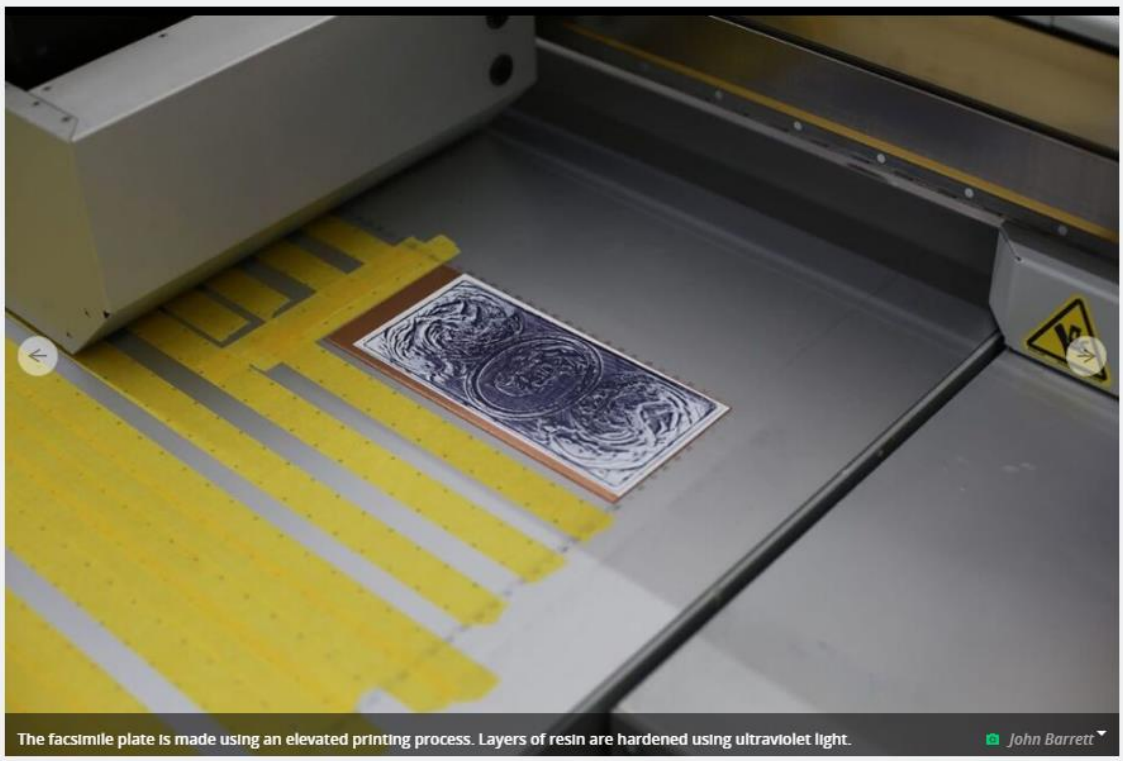
Lowe knew of these methods, but he was surprised to learn that nobody was working on recording the surface of objects. "Traditionally, the digitization of books has [focused on] the extraction of the text, which can then be accessed online," said Lowe. While he emphasizes that this is a very important activity, he thinks it has been done at the expense of the kind of work Barrett is doing at the Bodleian, looking at what he calls the "materiality" of those manuscripts: their surface qualities, bookbinding, typography, and the like. So the Factum Foundation started working first with 3D scanning systems and then developed its own photometric stereo scanner, dubbed Selene, which the Bodleian is using for the first time.

The concept is similar to photogrammetry capture systems, such as those that feature a dome with 40 lights to illuminate a target object from multiple perspectives to create 3D data. The problem is that this results in far too much data if one wants to capture a larger original object. Selene is a much more efficient way to record 3D data—10 to 20 times more efficient than methods like photogrammetry, per Lowe. The 3D data is stored in 2D images. Lowe

and Barrett consider this high-resolution, low-relief capture system as 2.5D imaging.

Selene uses a fairly standard high-resolution digital camera in a fixed position on a big frame, which takes just four source images, each meticulously lit from a different direction with four custom flash units. The system captures a series of image tiles at a resolution of 1,040 pixels per inch, with the number of tiles determined by the size of the original. "Capturing data is all about the relationship between information and noise," Lowe told Ars. "The quality of the data we're capturing with four [images] is not significantly less than with 40. In many ways, it's significantly better because there's less noise in the data."

The resulting shaded renders make it possible to examine the surface texture of an original object from any angle, while removing any visible tone and color, enabling close analysis of textural details that might otherwise be very difficult to see or record using traditional photographic techniques. Selene can record surface details down to a mere 18-25 microns or less. Combining that data with complementary data collected by the Lucida 3D imaging system makes it even easier to measure height and depth more accurately. "We're capturing differences in height of about a fifth of the width of a human hair," Barrett told Ars. "So we're starting to see the materiality of the substrate. Whether it's parchment or paper, we can see all of these invisible markings—scratches people have left behind."



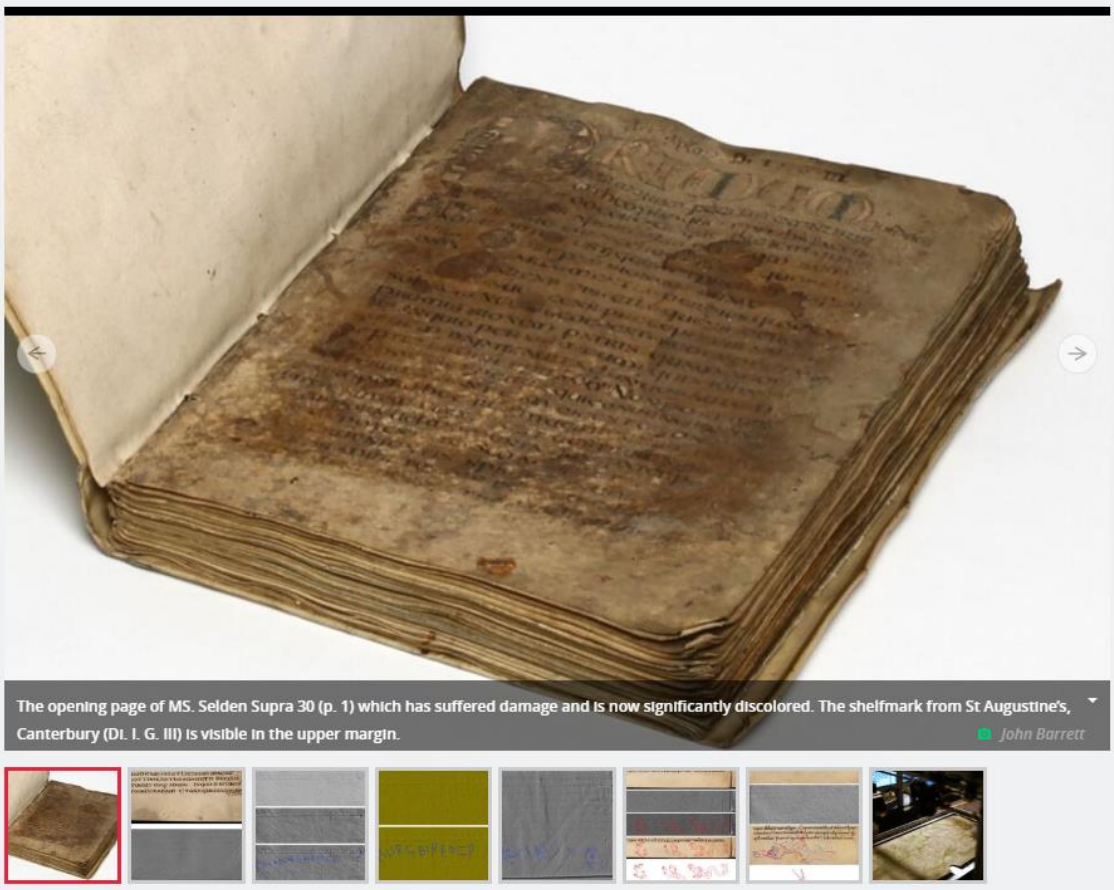
Applying ARCHiOx to copper plates

The first Bodleian artifacts Barrett chose to record for the ARCHiOx project was a collection of 18th century copper printing plates, which are notoriously difficult to capture using traditional photographic techniques. There are hundreds housed in the Bodleian, many badly corroded after 300 years. Because of that corrosion, the plates reflect little light, and reproduced images lack tonal variation and detail. Barrett's chosen plates included portraits of the antiquarian Anthony Wood and a 17th century archbishop named William Laud, as well as portraits made from drawings attributed to the poet William Blake.

Selene and Lucida were able to reveal the original details, and Barrett adapted a geographic information system (GIS) to create a topographic map of the surface details with such high resolution that when viewed from the side, one can clearly see the peaks and troughs on the surface of the engraved copper plate. Other plates had shallow engravings on the back as well, usually practice etches by the artist, which can barely be seen at all. The back of one such plate (featuring one Cardinal Masara) just looked like a series of

horizontal lines. The 3D recording Barrett made revealed previously unseen musical notes. Those practice etchings depict a musical score, complete with lyrics likely inspired by Psalm 9.

The ARCHiOx team was also able to create 3D facsimiles in resin (backed by a copper sheet) of a few of these copper printing plates, including the Wood portrait. In Lowe's workshop, the resin facsimiles were inked and run through a facsimile of Goya's printing press to create fresh prints for the first time in 300 years. While there were some differences in quality between the original prints and the 21st-century reproductions, Lowe thinks this might be caused by limitations of the 3D printing technology rather than the 3D data generated by Selene. As 3D printing continues to improve, so will the quality of future modern prints created with the facsimiles of 18th-century copper plates.



The possibilities with ARCHiOx are endless

One of the Bodleian's most prized manuscripts is the Gough Map, a late medieval map of Great Britain of unknown authorship. Spectral imaging studies concluded in 2017 that the Gough is not a single map, but consists of

three distinct layers: the oldest (late 14th century) depicting all of Britain, the second (early 15th century) showing the south of England and Wales, and the third (late 15th century) showing southeast and south-central England. The map also has some 2,000 pinholes grouped together to create outlines in the shape of pictorial town signs— likely created while tracing the Gough Map onto another map. Using the imaging techniques of ARCHiOx, Barrett and Lowe were able to image those pinholes with very high resolution, even creating a facsimile of the original Gough map, which is rarely taken out of storage due to its fragility.

Per Barrett, the ARCHiOx Project is just beginning to figure out all the different ways the Selene and Lucida imaging technologies might be used, describing them as a kind of "Swiss Army knife." That's why he was thrilled when Hodgson approached him about recording the medieval manuscript where she'd spotted signs of an etched inscription. Dubbed MS. Selden Supra 30, the text is a copy of the New Testament Acts of the Apostles, believed to have belonged to a woman or group of women based on a prayer copied onto what was once a blank page.

ARCHiOx first produced a high-resolution shaded render of the surface of the inscription. Additional processing created an even more enhanced series of renders, and subsequent recording showed Eadburg's name spelled out, in full, five times on five different pages of the manuscript, along with abbreviated forms. There were also several etched doodles in the margins, mostly human figures that appear to have been traced by drawing a line around the reader's thumb or finger.

According to Hodgson and Barrett, there were nine known women named Eadburg living in the region between the 7th and 10th centuries, based on evidence gleaned from other historical records. One of them was the abbess of a female religious community in Kent from around 733 to 761 CE, which is consistent with the dating of MS Selden Supra 30. That makes the abbess a likely candidate for the author of the inscription and marginal doodles. "I think we need to carefully and systemically go through our early medieval collections now to try and find more of these, because they tell us about people's interactions with the manuscripts," said Barrett.