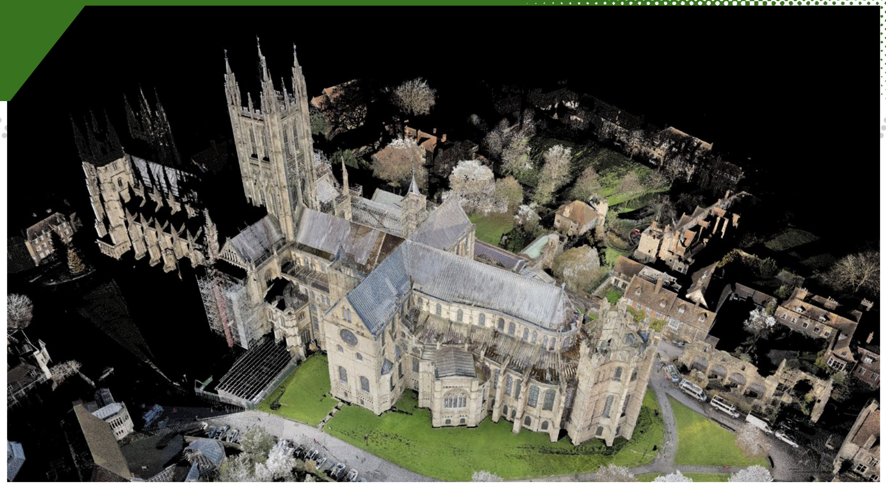
Figure 7: South flank of the Presbytery and Trinity Chapel of Canterbury Cathedral.

Capturing Canterbury Cathedral

BY BIRTE FICHTER

Art historians have long grappled with the challenge of describing, measuring, and representing the great monuments of medieval architecture. Though hundreds of these buildings have stood for as many years, few records of their construction exist, and what drawings have been made in the modern era are often compromised by the inevitable simplification that comes from an inability to precisely measure the totality of the building. Thanks to extraordinary advances in technology over the last decade or so in the realm of laser surveying, however, today's art historians are able, practically for the first time, to accurately assess the dimensions, in all of their complexity and irregularity, of these magnificent constructions (**Figure 1**).

Over the past decade, Professor Tallon, Associate Professor of Art at Vassar College, has used Leica Geosystems laser-scanning technology both to see and to represent great Gothic buildings more accurately than ever before possible.[1] His studies of the cathedrals of Paris, Bourges, Chartres, Sens—to name only a few—have fundamentally changed the way each building is understood.[2] A new investigation, this time of an English cathedral, Canterbury, was undertaken in December of 2014, using one of Leica's latest generation of scanning hardware, the P20 (**Figure 2**).[3] Because



Andrew Tallon

Figure 1: Birdseye view of the Canterbury Cathedral point cloud acquired in 2014.

the scanner uses phase-based technology with advanced error correction, a far greater number of points could be collected in a given amount of time with respect to the previous generation of time-of-flight scanners—and with the same degree of accuracy. In this case Tallon, with the able assistance of Canterbury Cathedral Head Electrician Steve Buchan, had only two and half days on site (**Figure 3**); they collected over *five billion* data points in just under one hundred stations (and with a high-resolution spherical panoramic photograph for each).

But the increase in rapidity of work was due only in part to the higher speed of the scanner. It was also thanks to a workflow made possible by close integration between the latest generation of scanners and Leica's Cyclone software. Whereas in the past it would have been necessary to set up a network of targets—and to acquire them in each case with the scanner, to avoid surprises at the time of registration, a lengthy process—at Canterbury targeting was necessary only in the spaces with insufficient scan overlap with other stations, such as beneath the roof. As long as sufficient station-to-station overlap among scans was assured, the great majority of scans could be registered in Cyclone using Visual Alignment; Cyclone's sophisticated cloud-to-cloud algorithms then were used to complete the process (**Figure 4**). Given the speed increase without compromise of accuracy, one could reasonably speak here of a scanning revolution!

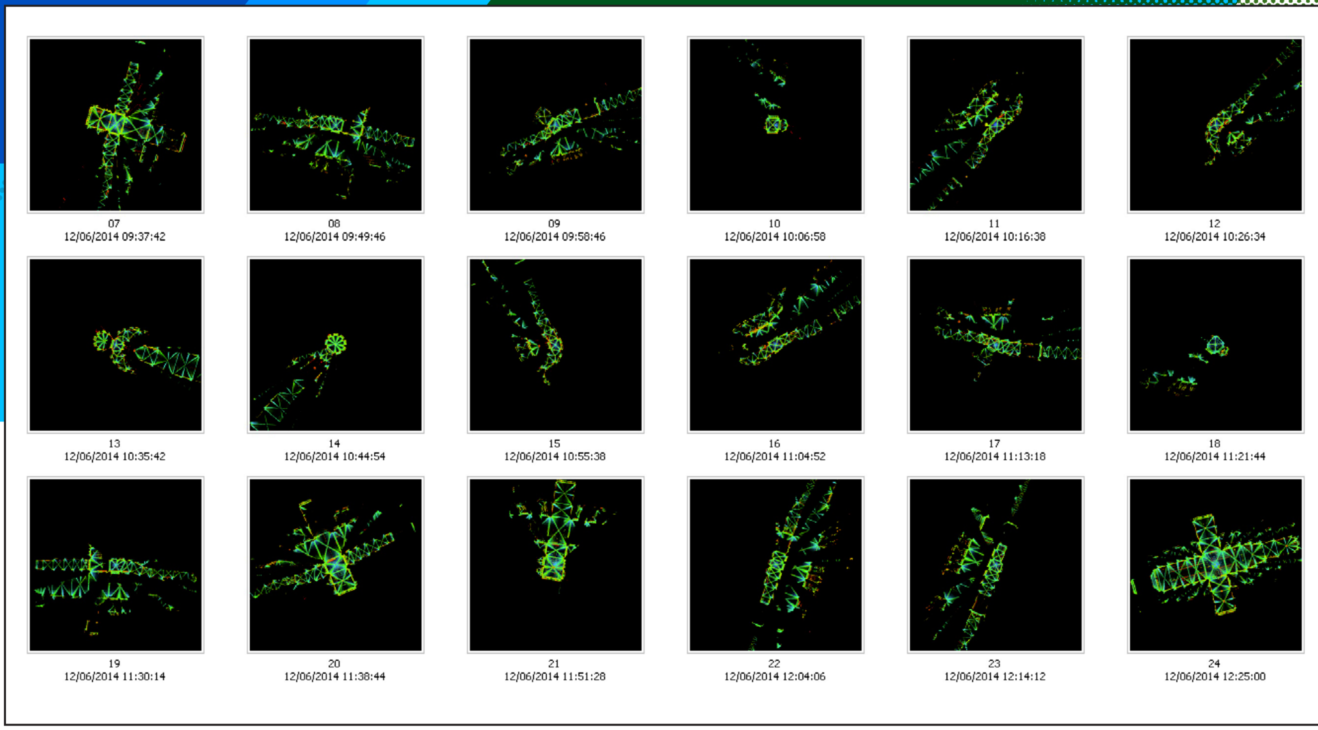
The density of the scan has an additional benefit in terms of representation: when the data points are sufficiently close they more effectively create the illusion of surfaces, and when photo-mapped with perfectly coincident spherical images, as was done with the Canterbury data, the building is better able to "speak" to the non-specialist, unaccustomed to reading the conventional intensity-based color scheme of laser cloud data (**Figure 5**).

Recent advances in laser scan deployment technology—in particular Leica's TruView Global software, now fully cross-platform and thus available for the first time to all—have made it easier than ever to share data with interested parties, from the architects who care for the buildings and who can take measurements as necessary without having to erect scaffolding, to students of architecture, to the general public, who might wish to become better acquainted with an important

Andrew Tallon

Andrew Tallon

(Left) **Figure 2:** Leica Geosystems P20 HDS laser scanner in action at Canterbury Cathedral.
(Right) **Figure 3:** Andrew Tallon (near) and Steve Buchan (far) at work on the transept roof at Canterbury Cathedral.

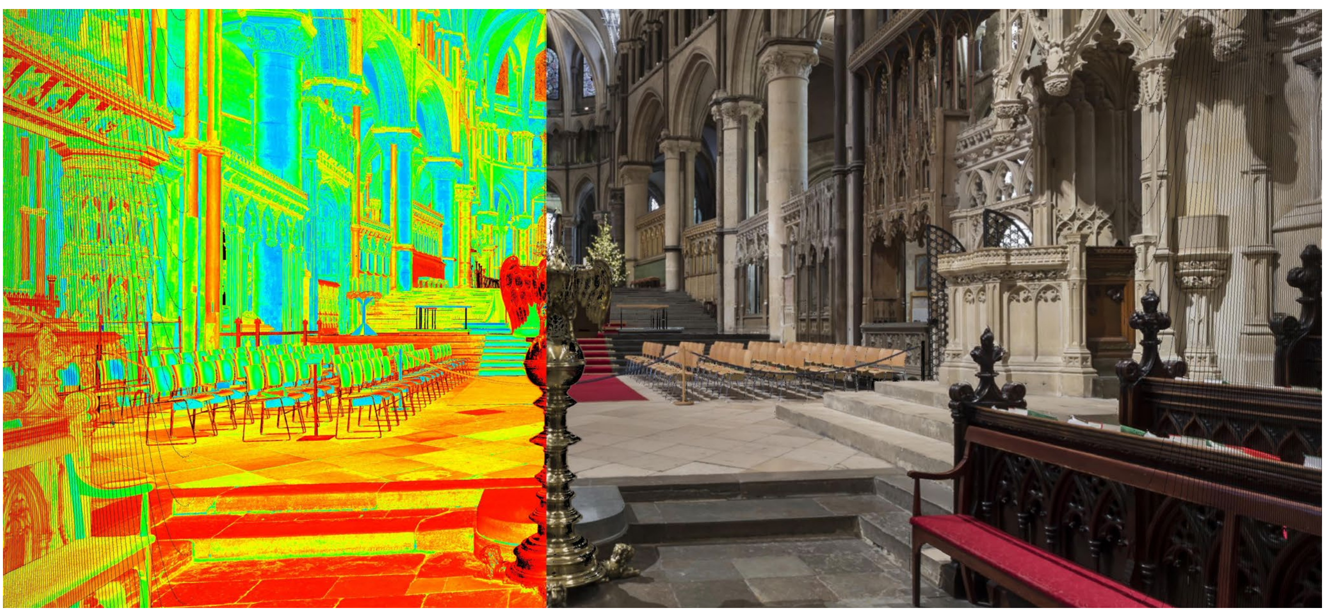


Andrew Tallon

Figure 4: Leica Geosystems Cyclone software, Visual Registration thumbnails.

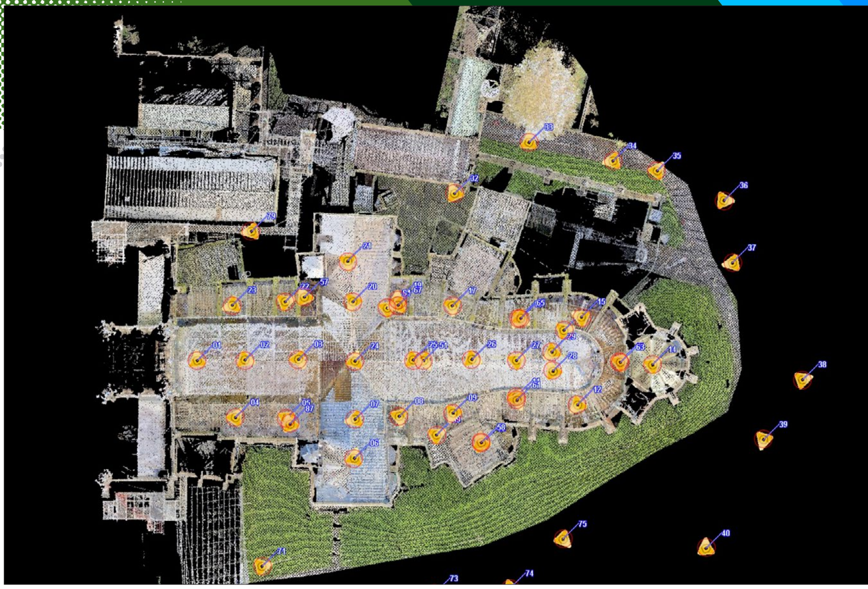
historic building (**Figure 6**).[4] Another technology of representation recently released by Leica, JetStream, allows users to break free from the station-based navigation system proposed by TruView to move through the entirety of a point cloud, served from a single point on the web—an impressive and welcome advance in terms of virtualization.[5]

Why Canterbury? The site of a famous shrine to Thomas Becket, the Cathedral of Canterbury is a witness to the implantation of a new architectural style, "French construction," on the shores of England (**Figure 7**). A new church had been begun in the ashes of a great fire in 1070 by Archbishop Lanfranc. The choir of this Romanesque building, rebuilt and extended by Archbishop Anselm, was once again damaged by fire in 1174. The subsequent reconstruction can be followed in unusual detail because of a singular document in the history of western architecture, a year-by-year construction narrative written by a Canterbury monk called Gervase.



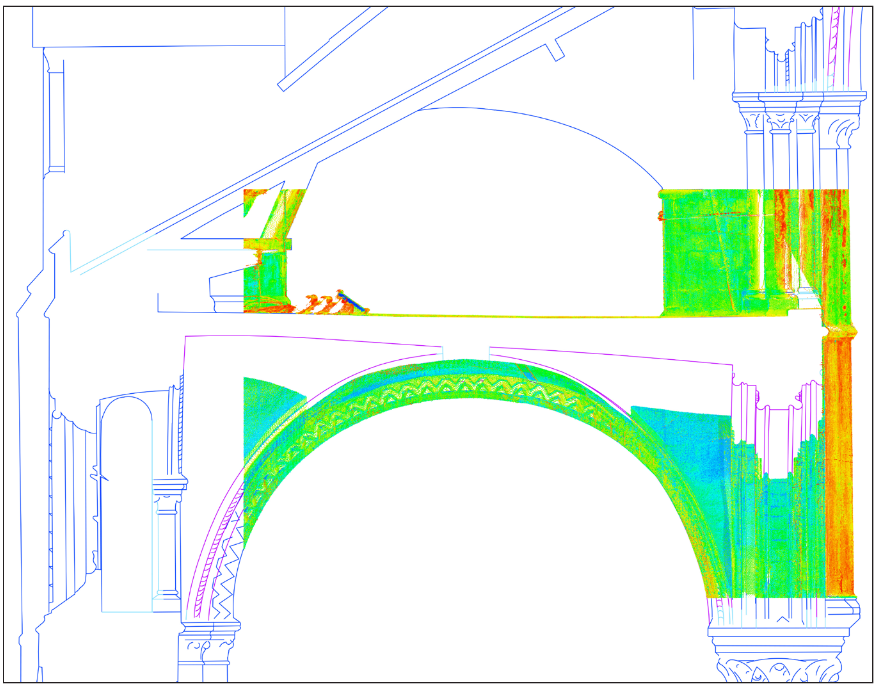
David Langley

Figure 5: Canterbury Cathedral, choir, photo-mapped points (right) juxtaposed with intensity coloring.



Andrew Tallon

(Above) **Figure 6:** Canterbury Cathedral TruView Global node map.



Birte Fichter

Figure 8: Partial section through the north side of the choir of Canterbury Cathedral. Blue lines are drawn directly from the scan section plane; pink lines represent the vaults, which are those to the west of the section plane; light blue lines are extrapolated.

The new laser data make it possible to document, in visual and structural terms, a building whose architectural elements were in the process of being actively reconsidered as construction proceeded: the design, in other words, was not set in stone by the first builder William of Sens and slavishly followed by his successor William the Englishman, but was rather re-evaluated on the basis of feedback supplied by the building itself. The building, in concert with the text of Gervase, thus supplies an extraordinary window into the thought processes of two great twelfth century architects.

To properly take the pulse of this process it was necessary to create a series of comparable section drawings through the portions of the building that could best represent the change (**Figure 8**), undertaken by the author using AutoCAD and Leica Geosystems's CloudWorx plugin. This involved a process of abstraction and recombination: compressing a complex three-dimensional form into two dimensions is not as simple, alas, as connecting the dots through a single slice of data. With the completion of these new drawings—the first accurate sectional views of the building—it will be possible to tell the story of Canterbury anew. The second phase of the Capturing Canterbury Project will involve the creation of the first accurate ground plan of the cathedral, an essential tool for historians and for the building staff alike.

Endnotes

1 For an example of the ways in which laser scanning technology have been used to analyze buildings, see this online National Geographic report on Professor Tallon's analysis of Washington National Cathedral: http://news.nationalgeographic.com/2015/06/150622-andrew-tallon-notre-dame-cathedral-laser-scan-art-history-medieval-gothic/

2 See gothicstructure.org for more information.

3 For more information see http://www.leica-geosystems.com/en/Leica-ScanStation-P40-P30_106396.htm

4 Please see http://truviewglobal.leica-geosystems.com/location/sitemap/562e997511fc01ad14cdb1a8 The author is grateful to David Langley, Applications Engineer at Leica Geosystems USA, for preparing the TruView and for his expert advice.

5 For a video example of JetStream in action at Canterbury, please see http://scansw.leica-geosystems.com/public/canterbury/

Birte Fichter is student at Vassar College from San Francisco. She is majoring in Art History, and has worked as Associate Professor Andrew Tallon's Research Assistant for the past several months. This is her first publication.