

Lucida: The 3D Laser Scanner for Conservation

Factum Arte is a multidisciplinary workshop based in Madrid, Spain dedicated to digital mediation and the production of projects that redefine the relationship between two and three dimensions while addressing the complex dynamic that exists between originality and authenticity. Founded by the artists Adam Lowe

and Manuel Franquelo, it is focused on the development of new technologies applied to both contemporary art and heritage conservation accompanied by the highest levels of digital and physical craftsmanship.

Factum Arte's team has been involved in 3D scanning since it was formed in 2001. The first project was

to demonstrate that 3D scanning the surface of the polychrome relief carvings tomb of Seti I had an important role to play in the conservation of the Valley of the Kings. The interest in 'surface capture', both long range and close range, for screen viewing and for physical re-materialisation remains a core concern.

If data can be rematerialised with the exact characteristics of the original it is clear evidence of the quality of the data. To make a facsimile (an exact replica of a work of art) the digital information needs to record many aspects of an object—both visible and invisible. Facsimiles are becoming increasingly important for study, dissemination and to redefine the ways we approach the protection of vulnerable sites (many of which were never intended to be visited). In the years following the initial replica of 16 square meters of the tomb of Seti I there has been an imperative to promote the use and development of 3D laser scanning technologies. This has been applied by Factum Arte to the production of facsimiles of the Dama de Elche, Goya's plates for *Los Caprichos*, the reconstruction of the eastern end of Ashurnasirpal II's Throne Room, Veronese's vast painting of the Wedding at Cana, Leonardo's Last Supper and many other commissions.



Facsimile of the Tomb of Tutankhamun made by Factum Arte.

BY CARLOS BAYOD



Lucida 3D scanner.

The Facsimile of Tutankhamun, an initiative instigated in 1988 by the Society of Friends of the Royal Tombs of Egypt, opened to the public in May 2014. The work, carried out by Factum Arte with the support of the Factum Foundation for Digital Technology in Conservation and installed at the entrance to the Valley of the Kings, gives the public the chance to visit the site without damaging the original. It has also provided the opportunity to focus on visitor experience. The chamber and sarcophagus were recorded at resolutions between 100 and 400 microns using the [Seti3D laser scanner](#) (that uses a Reversa two camera—one laser scanning head) in combination with other 3D and photographic recording systems (mainly the [NUB3D Triple structured light scanner](#)). The digital data, scanned in eight weeks, was used to physically recreate the relief and

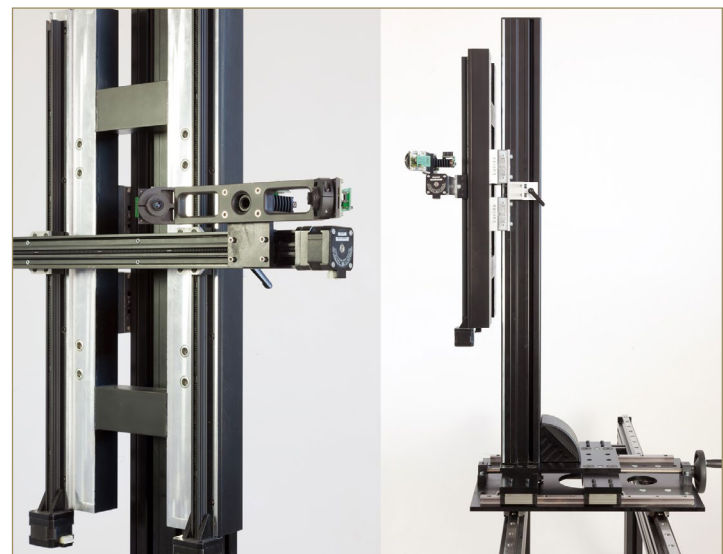
colour of the walls with extremely close resemblance to the original. The result, the highest-resolution facsimile of an Egyptian tomb realized to date, is the initial phase of a major initiative to document and preserve the Theban Necropolis and to promote sustainable tourism in Egypt.

It is projects like these that provoked the creation of a bespoke 3D scanning system especially conceived for the surface recording of works of art. The result is the [Lucida scanner](#): a robust, low cost, portable 3D laser scanner for recording the surface of paintings and relief objects. It uses

its own software and has been designed for practical use on a limited budget while achieving the highest resolution 3D recording of large-scale objects. Designed and developed by Manuel Franquelo and fabricated by Factum Arte's workshops, the Lucida scanner demonstrates what can be achieved when a group of people with specific needs and experiences work together to solve problems that have emerged from practical application and experience.

How do you scan a black glossy surface? How do you scan a black glossy surface that is next to a white glossy surface, or a tooled gold surface? Paintings have specific qualities that require focused solutions. During the design, the 'noise to information ratio' was of the greatest importance. We analysed noise that belongs to the recording system and noise that is a part of the surface that is being recorded.

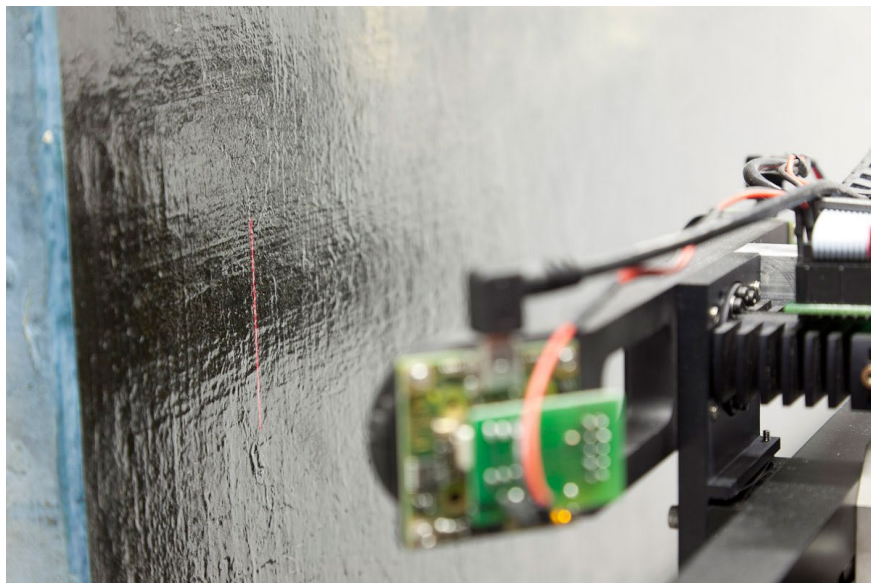
For the 3D recording technology to be meaningful for cultural applications it is essential that the correspondence



The scanning head is mounted on a system of linear guides.

between the surface and the recording of that surface is as close as possible. Lucida has overcome the problem of contrast and reflection through innovative algorithms designed to reduce noise without altering the characteristics of the surface that is being recorded. The goal is the acquisition of a reliable, high-resolution and dimensionally accurate map of the texture that can be studied on screen or re-materialised in the physical domain. Our concern is not just with shape, but with both shape and surface– and the complexity of the surface texture. This intimate understanding of surface is leading to new insights about how an artwork has changed, how it has been looked after, how it has been valued and what has been done to it.

The first prototype of the Lucida was used in the Museo del Prado to digitize

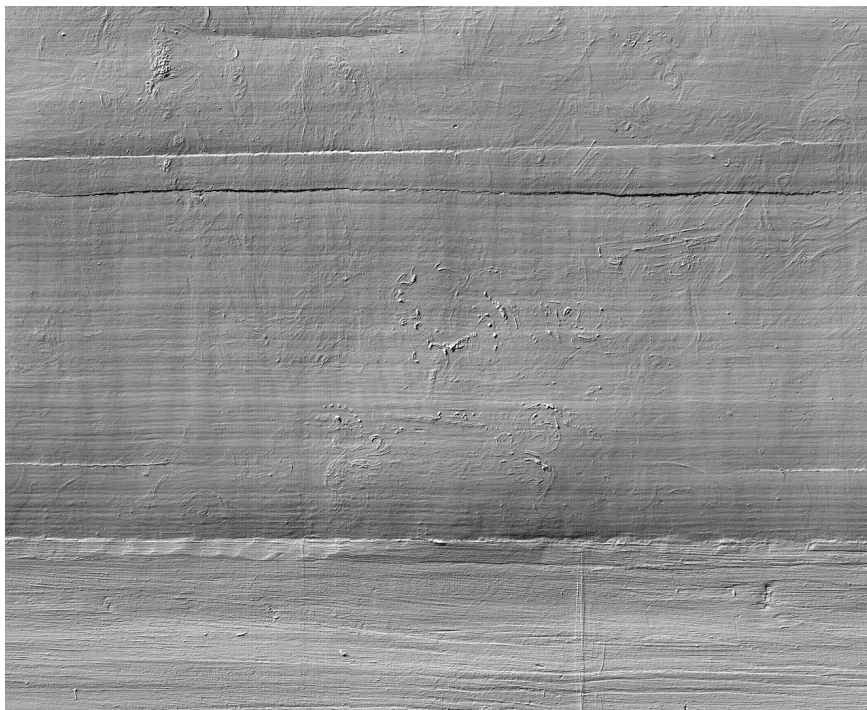


Lucida 3D scanner recording the surface of a canvas.

the surface of a painting that was about to undergo a major restoration. This panel is one of a series painted

by Rubens as preparatory sketches for the tapestry cycle *The Triumph of the Eucharist*. Lucida was used to record the relief of the front of the panel at a resolution of 100 microns. The color was recorded with a [Clauss panoramic photography system](#).

The 3D information that was obtained is now of great value because the shape, size and texture of the painting changed significantly during the restoration process. It is unusual that size changes dramatically but in this case an addition of several centimeters on each side of the painting was removed. The restoration was to stabilise the paint and wooden panel before it was exhibited in front of the tapestry that was based on the design. The recording was done in conjunction with the curatorial and conservation teams at the Museo del Prado. The data will now become an important part of the history of the painting and was supplied to the museum both as a digital archive and as a physically routed plaster panel. In line with Factum



Render of the 3D data of a painting scanned with Lucida (detail).

Foundation's commitment to conservation the copyright on this data and on all future applications of the data belongs to the owner of the artwork.

Other 3D scanning systems process the captured data as point clouds or triangulated mesh as it is being recorded. This is an irreversible abstraction that results in a permanent loss of information. The Lucida scanner stores the data as raw tonal video. It will be possible to re-process this 'condensed' data in the future at a higher-resolution and with improved software. This is a unique feature that reflects a deep understanding of the needs of the art conservation community.

Lucida also generates 3D information as grayscale depth-map files, making it possible to inspect the data as an image. This permits the user to access and process the data with image processing software rather than specialized 3D software, which tends to be expensive and requires regular updates. The visualization of the 3D data as a shaded render also permits its combination with other layers of information such as color, infra-red, x-ray, ultra-violet and historical photographs. A lot of work is now being focused on the production and presentation of multilayered archives that are starting to have a major impact on the forensic study of works of art.

Factum Arte and the Factum Foundation are working to promote the systematic use of non-contact high-resolution 3D scanning of works of art as an important part of every restoration process. Each small change in the surface of a painting produced by any type of intervention leaves an irreversible trace on its surface. It is our collective responsibility to ensure

that future generations have a record of the dynamic nature of the past and the changes that happen over time. With this in mind Factum Arte and the Factum Foundation opened 'Lucida Lab Milano' within the Open Care complex in Milan in 2014. A Lucida scanner is now permanently in London and other locations are under consideration. We are currently finalising permission with the Ministry of Antiquities to open a fully equipped training centre in Luxor where Egyptian operators will be trained to use the Lucida scanner and start the task of recording the whole of the tomb of Seti I (which has been closed to the public since the 1980's).

High-resolution 3D data used in conjunction with accepted technologies will transform the way we monitor and protect our cultural heritage. Lucida 3D laser scanner will not only enable museums and institutions to obtain a permanent record of the surface of paintings and low relief objects at a specific moment in time, but it will also make it possible to accurately monitor the condition of artworks sent out on loan, document the surface in anticipation of any intervention or restoration process, establish a protocol for measuring change and ultimately to make facsimiles of objects that can no longer withstand the visitor numbers that continue to increase exponentially. Sustainable cultural tourism is the goal and the faithful documentation of works of art is essential to understand their importance in the present and their impact on the future. ■

Carlos Bayod Lucini is architect and Head of 3D laser scanning at Factum Arte.

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