# The Oxford Handbook *of* THE VALLEY OF THE KINGS

- Provides an overview and contextualizes the archaeological advances in the Valley of the Kings
- Written by an international team of leading experts
- Up-to-date, incorporating cutting-edge research on this critical World Heritage site

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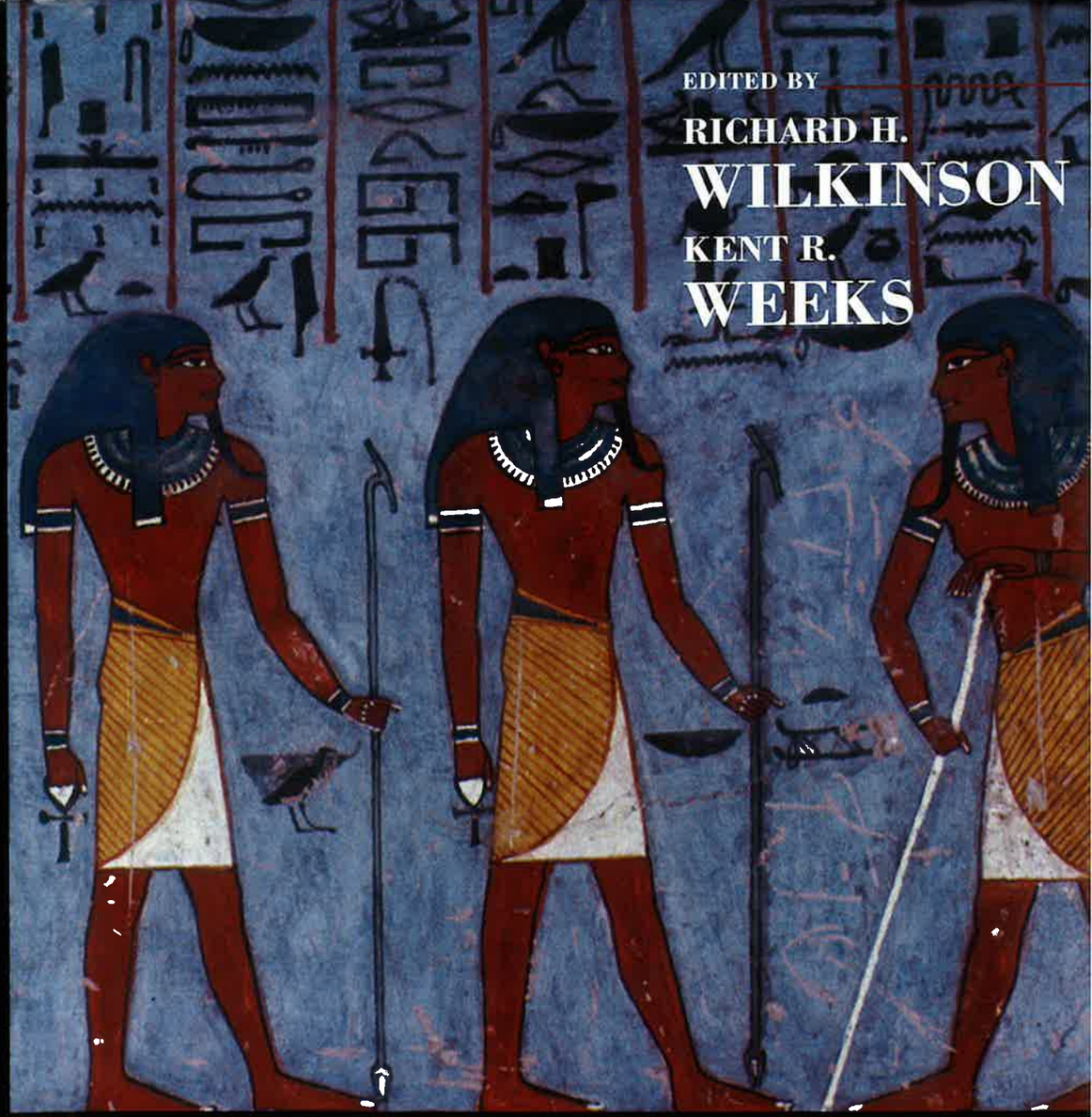

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CHAPTER 35

# TOMB RECORDING

## *Epigraphy, Photography, Digital Imaging, and 3D Surveys*

ADAM LOWE

> The authorities face agonizing decisions. Do they admit visitors to royal graves and witness the near-certain deterioration and perhaps disappearance of unique wall paintings from sheer people pressure? Or do they close everything to save it for future generations?... The dilemma pits the preservation of the priceless and finite archive that is ancient Egypt against the pressing economic needs of a developing country—altruism for future generations against short-term advantages.
>
> (Fagan 2004, 252)

## The Role of Recording and Reconstruction and the Development of Sustainable Tourism

In the eighteenth century Joachim Winckelmann proposed that sites and artifacts should be conserved and preserved, not restored, renovated, or reconstructed. At the time Winckelmann and others were excavating Rome and shaping our image of ruins and antiquity—an image that embraced Greek, Etruscan, Roman, and Egyptian influences. The comment was aimed at the imaginative and active approach of many of his contemporaries, especially Piranesi, who was restoring, renovating, and reconstructing, treating the remains he found as a sourcebook for ideas and information. Piranesi was an artist. Winckelmann was an academic who represents the philological approach that was in tune with the twentieth century, and his views reflect those of most heritage



professionals today. This approach was enshrined in the 1964 Venice Charter and other charters issued by ICOMOS, UNESCO and heritage professionals. However, as new technologies become available to record and study objects with forensic accuracy, it is clear that the decision-making processes of heritage managers and the practical tasks of conserving and preserving the past are neither simple nor an exact science.

However discreet the attempts to conserve might be, they alter the appearance of the original and often have unforeseen consequences that can be irreversible. They impose changes in color, tone, texture, and sheen, they condition the look and character of the sites and how we perceive them. They raise both moral and aesthetic issues. In the Valley of the Kings the glass panels installed in some tombs introduce a museum language that has nothing to do with the function or character of the tomb. The lighting, text panels, smell of human sweat, guards, tour groups, and a ban on photography all play their part in imposing an aesthetic dimension on the act of preservation.

When Winckelmann was writing in the middle of the eighteenth century, tourism was limited to a few wealthy and acquisitive individuals. The problem facing the heritage managers of today is how to ensure that our cultural heritage is preserved for the next generation in a meaningful way. Whatever practical and political arguments are put forward, an essential part of every approach is documentation: we have a duty to record what we have inherited. Twenty years ago it was not possible to digitize, store, and then rematerialize an object that, side by side with the original and at a normal viewing distance, looked identical. Now this is possible. It requires time, understanding, technology, and a different mindset. It demands new intellectual and professional frameworks. It also requires the development of hardware and software designed in conjunction with the people who are working to preserve and conserve. It involves collaborations among disciplines that struggle to share a common language.

Since the tomb of Tutankhamun was discovered, tourism has been the biggest threat to its survival. Yet Egypt's economy is dependent on tourism. Andrea Byrnes has described the problems clearly in her essay "Replication of the Tomb of Tutankhamun: Conservation and Sustainable Tourism in the Valley of the Kings" (Byrnes, 2013). She observes that Flinders Petrie and others were aware of the problem and that Howard Carter commented on the impact on the fabric of the tomb caused by the humidity and dust brought in by the visitors. She sites Michael Jones's chapter in Wilkinson's *Egyptology Today* and provides figures: "In 2005, for example, Egypt earned 6.4 billion US dollars in tourist revenue, providing work for around 12 percent of the nation's workforce." According to Kent Weeks and Nigel Hetherington's *The Valley of the Kings: A Site Management Handbook* (2013), during the height of the 2004 season the Valley of the Kings received 7,000 visitors per day and more than 1.8 million visitors in total for that year. The site management plan operates on the assumption that visitor numbers in the Valley of the Kings will have reached 15,000–20,000 per day by 2014. The tombs were built to last, but they were not built to receive visitors.

At the entrance to the tomb of Tutankhamun is a yellow sign that reads "EXTRA TICKET FOR TUTANKH AMON TOMB 100L.E." The celebrity of the tomb adds to its

value and attracts visitors. While political unrest in recent years has led to a temporary downturn, the growth of tourism and the continued public interest in Egyptology will undoubtedly lead to the return of the visitors once public confidence in political stability returns. In the twenty-first century the Valley of the Kings has to play a dual role. On the one hand it is a repository of paintings and written texts that reveal essential insights into who we are. On the other it is essential for the economy of Egypt in general and Luxor in particular.

Tutankhamun's tomb is a tourist magnet. Schools around the world fill receptive and imaginative minds with the great stories of the boy king, pharaonic culture, adventure and archaeology, Howard Carter and curses, gold, and symbolism. Hollywood and computer games turn this interest into entertainment. The treasures from the tomb were moved to the Cairo Museum following the discovery, where they are seen by many more people than if they had remained in Luxor. Touring exhibitions of selected objects attract wider audiences and remain popular. In London, the 1972 exhibition *Treasures of Tutankhamun* attracted 1,650,000 visitors. Now, in addition to exhibitions of original objects, several identical commercial touring exhibitions based on tourist-quality copies and dramatized documentaries are successfully touring the world. All of these generate interest and result in increased tourism.

Some of the measures carried out by the Supreme Council of Antiquities to protect the tombs have had a positive effect, but all involve restricting access and keeping people moving through the tombs. Banning guided tours inside the tombs has made a significant difference and prevents large concentrations of people in one area. The restriction of each visitor to only three tombs per visit, the closure of the tomb of Seti I, and the imposition of severe limitations on visits to the tomb of Nefertari and the use of a rotation system (similar to that used to protect the Etruscan tombs in Tarquinia) all help. But ultimately, as with the caves at Lascaux and Altamira, the only solution for long-term preservation is to radically reduce visitor numbers. The question is: Can this be done in a way that keeps attracting the visitors and enhances our understanding of the importance of the site and the knowledge it contains? The use of new recording technologies is central to any answer. The role of facsimiles still needs to be defined and demonstrated. Since 1988 the Society of Friends of the Royal Tombs of Egypt, under the direction of Erik Hornung and Theodor Abt, has been championing this approach. The Supreme Council of Antiquities initiated a research project in the tomb of Seti I in 2001, and the recording work in the tomb of Tutankhamun started in 2009. In 2012 the facsimiles of the burial chamber, the sarcophagus, and the re-creation of the missing fragment from the tomb of Tutankhamun were given to the people of Egypt by the Society of Friends of the Royal Tombs of Egypt, the Factum Foundation, and Factum Arte (see Figure 35.1). The work has taken almost four years to complete and has involved a large group of individuals, each with different skills, working together as a team. Permission has been granted by the ministries of tourism and antiquities to install the facsimile on a site next to Howard Carter's house at the entrance to the Valley of the Kings. The aim is to encourage the conservation



FIGURE 35.1 The final installation of the facsimile of the burial chamber of Tutankhamun, during its temporary installation at the Conrad Hotel as part of the EU Task Force, November 2012.

[Photo by I. della Valle, courtesy of Factum Arte.]

community and the general public to visit both the original tomb (while it remains open) and the facsimile and contribute to the debate about the problems of preserving and safeguarding fragile sites.

The work that was carried out by Factum Arte over the past decade in the tombs of Tutankhamun and Seti I is a start—it reflects a coherent approach to the development and use of digital technology to record the surfaces and structure of the tombs in astonishing detail. These data are essential for objective study and to monitor the decay that is taking place. The fact that the data are of sufficient quality to reproduce physically in three dimensions is evidence of their correspondence to the original. This work has involved the development of new technologies to record, inspect, archive, and reveal the complex histories of these two tombs. It has involved the development of a complete working practice to rematerialize the data that can be communicated and taught. It is an approach that is rapidly gaining acceptance and has led to the creation of the Factum Foundation for Digital Technology in Conservation. The foundation funded most of the work in Egypt and has two main aims: to provide the technology and human skills to satisfactorily record the condition of the tombs and to convert public interest into a force that understands the difficulties of preserving the past and makes a positive contribution to its preservation.

## Technical Considerations Based on Non-Contact-Surface Observations

The craftsmen who made these tombs had a highly developed understanding of materials. It is probable that they attached symbolic significance to the materials they used, the order in which they were applied, the way they were mixed, and their final appearance. They certainly understood the physical properties of the materials they worked with. They prepared the plaster layers and the application of the paint so the walls could breathe. They understood how to draw long black lines with even edges, they understood how to make and prepare both natural pigments and those that required human artifice in their production. It is equally probable that they knew that when the tomb was sealed the natural environmental stability would ensure their work lasted, guaranteeing immortality for the pharaoh. The enemy of preservation is dynamic change: changes in temperature, humidity, and the levels of dust; chemical changes; and other diverse environmental fluctuations about which we are not yet aware.

The tomb was hacked out of the bedrock. Tool marks are visible underneath the plaster layers and brick holes. There is a visible raised line to the left of center of the north wall, as if the burial chamber was cut from both sides. The walls are coated with several layers of thinly applied plaster to smooth the irregularities in the bedrock before application of the priming coat and painted decoration. There is a skim of greyish coarse plaster and then a coat of a creamy brown plaster wash. On the north wall there are many air bubbles that appear to be in this "wash" layer. On the lower part of the west wall there appear to be two layers of plaster, while on the south wall there seem to be three, although it generally looks as if the plaster was applied quickly and reapplied where necessary. On the west and north walls there are tool marks in the plaster, as if it was applied by trowel, but there are also areas where it has been smoothed by hand, and traces of fingers can be observed. Over the plaster there is a coat of white priming paint in many places, but it is neither uniform nor consistent, and on the south and east walls the golden ochre paint was applied onto the plaster without the priming layer.

There are many dark brown spots that are the subject of ongoing research by the Getty Conservation Institute. These microorganisms cover most of the painted area of the tomb, appearing in places on the ceiling but not on the sarcophagus. Based on the evidence of Harry Burton's photographs[1], they haven't changed since Carter opened the tomb, suggesting that the walls were not fully dry when the tomb was sealed. Damp walls and the decaying offerings in the tomb provided the conditions that the micro-bacteria needed to grow. They "grew" in interesting ways on the painted areas and seem to prefer the light red under drawing and the areas in or around cracks. They also seem to be attracted to fibers within the paint or plaster. The photograph by Harry Burton of the "missing fragment" shows that there was no micro-bacterial growth on this area of the decoration. This section of the south wall could breathe and would have dried faster than the painted areas in contact with the bedrock.



On the north, west, and east walls some areas of missing plaster were repainted at the time of the original painting and as a result are now covered with brown spots. Others areas of loss have been filled since the opening of the tomb, and the restorer has covered his work with splashes of brown paint in imitation of the micro-bacteria. Based on observational information, it seems likely that the binder of the paint is primarily gelatin, while the binder in the black lines is more glossy and brittle, suggesting a natural resin; gum arabic was (and still is) readily available in and around Luxor.

A close study reveals that the baboons on the west wall were painted in the following order: 1. plaster, 2. white priming coat, 3. yellow paint, 4. red under drawing, 5. red face, 6. blue, 7. white hair, 8. black lines. The baboons are painted with a variety of tones of blue, which appears to suggest a mixed color varying in tone and hue. The leopard on the north wall was painted in a slightly different way: 1. plaster, 2. white priming coat, 3. yellow paint, 4. white paint, 5. red under drawing, 6. pale yellow skin, 7. red dots, 8. black outlines. There are many drips and splashes of yellow and red paint, suggesting haste or a lack of care.

## Problems Inherent in Remedial and Aesthetic Restorations

Even from a distance it is clear that the surface of the painted walls is heavily cracked, and there is significant paint loss (see Figure 35.2). The surface reveals that the paint layer is in a friable and fragile state. The surface decay suggests that what is going on under the surface may be more serious. Observation of the dust deposits reveals that in places the plaster is detaching from the wall. From the high-resolution photographs it is possible to see shadows behind some of the holes in the paint and plaster—it is clear that large sections of plaster are only held in place by the skim layer of plaster and the consolidant that has been applied. The scale and location of some of the refills and repainting (the largest is an area of about 1 square meter) confirm this and reveal the fragile condition of the paint surface.

On the west wall near the handrail there is clear evidence that human touch has smoothed and eroded the surface and that all areas within reach are significantly more degraded than the rest of the tomb. On the area around the figure of Tutankhamun, lying on his funeral sledge, one can see the cracked and flaking nature of the paint, with the slightly glossier black lines lifting from the background golden ochre. Even from the position by the handrail one can make out an irregular surface sheen, as if the large areas of the wall have at some point been given a wash of consolidant. The high resolution photographs make it possible to study the surface in great detail and then test these observations against the actual wall. From close up the fragile state of the paint surface is instantly clear. Hundreds of injection marks reveal that significant work has been done in an attempt to bind the paint layer and plaster to the bedrock; white residues and drip

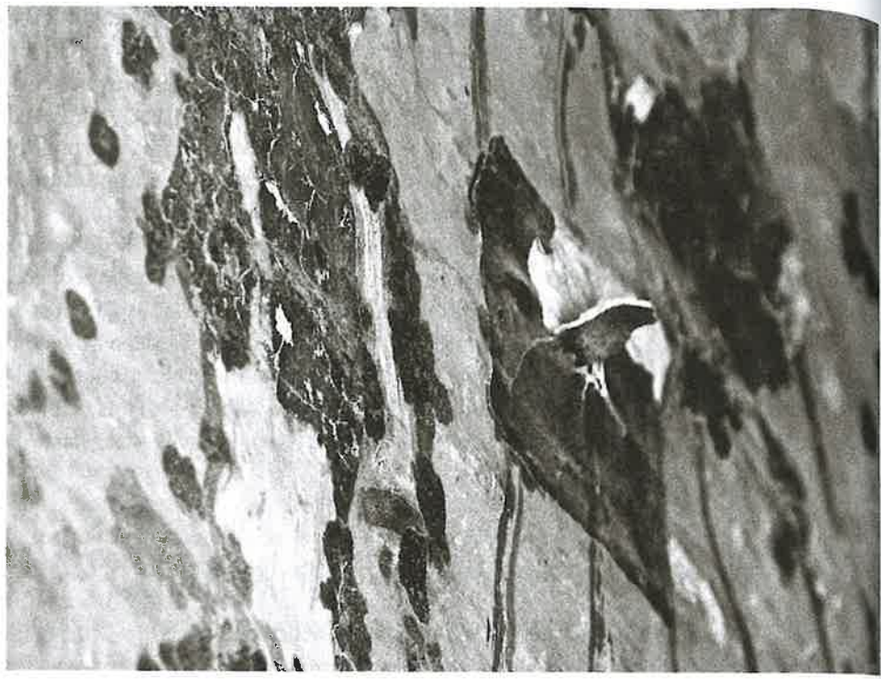

FIGURE 35.2 The surface of the East Wall in the burial chamber of Tutankhamun, showing flaking paint and a sheen from surface painted Paraloid.

[Photo by G. Dupond, courtesy of Factum Arte.]

marks from local surface applications of Paraloid can be found in many places. To fully understand what is happening, the conservators from the Getty Conservation Institute will need to see if the application of Paraloid is the problem or the solution. If it has limited the ability of the paint surface to breathe it will cause a buildup of moisture, and this will encourage the growth of salt crystals, which are capable of pushing the paint off the wall. This mix of a fragile surface and dynamic change caused by fluctuations in temperature and humidity will eventually result in collapse. There has been significant paint loss since the tomb was opened. If the means of consolidation are now a cause for concern, the treatment will need to be reversed.

## Reversibility—A Term in Need of Clarification

Reversibility is a central principle of conservation practice. The term refers to the ability to remove any addition or change that is made. Since the 1970s Paraloid, a product



originally designed to make printing ink more flexible, has been used extensively in the tombs. Now many conservators have serious reservations about its use and reversibility over time. When used to consolidate the painted surfaces in the tomb of Tutankhamun or Seti I, Paraloid cannot be removed without significant paint loss. The application of this acrylic resin also changes the color and tone of the paint; this is an irreversible change. Paraloid injected under the surface of the paint to stick the paint and plaster layer to the bedrock is also irreversible and changes the way the surface moves and breathes.

In the 1999 ARCE condition report on the tomb of Seti I, Dr. Bojana Mojsov comments: "[D]uring recent 'restoration' efforts plaster and several pigments have been added on top of uncleaned surfaces with varying results. This is particularly disturbing since it was done just recently and now only adds to the relatively numerous problems of the reliefs. All of this layer of *pentimento* ought to be removed and the surfaces cleaned before we can see what is left of the original decorations underneath or make any decisions about future restoration."

At the time that the ARCE report was being prepared a new "test" restoration was being carried out in Seti's tomb (room F). This test has resulted in a significant change in tone and color to a section of about 50 by 50 centimeters. Fifteen years after it was done, this test clearly demonstrates the problems inherent in using Paraloid, but it also reveals the way restorations change the appearance of the image. The white area on the left of the restoration has been over-painted with a white that both is a different "color" and has a different character than the original white. The unrestored area to the left of the restoration reveals a matte white (almost certainly huntite) painted over a greyish underpainting that could be either the plaster base or an intentional undercoat. The restored area appears to be a recently applied acrylic or gouache under a layer of Paraloid—the surface consolidation has slightly yellowed and the paint it covers is now flaking off the wall. All of this demonstrates the inherent difficulties of keeping things stable if the environment is dynamic and confirms the importance of high-resolution documentation.

## Reasons for Optimism

Despite all the reasons for concern, the twenty-first century is providing us with new high-resolution recording technologies that can digitize the tombs with sufficient accuracy to monitor the speed of decay. With the correct political support and infrastructure, the documentation could be carried out by Egyptian teams, providing employment in Luxor and the surrounding area—in theory it could also be self-financing. The fact that it is possible to record the tombs in color and three dimensions with forensic accuracy should become a central part any preservation policy. New technologies and software applications are resulting in innovative ways to study, analyze, and elaborate information. The developments in technology are moving fast, but a divide between technicians who understand the equipment and managers who understand the

technical possibilities interferes with their application. The practical solution at present is to take advantage of the successful mechanisms that are in place and already applying technology—the Theban Mapping Project is one example.

In 2001 the Theban Mapping Project began work with Quantapoint to use their laser measuring system to produce accurate 3D plans and models. The Theban Mapping Project website was launched in August 2002, and its impact was immediate—by the end if its first month it had 150,000 unique visitors, clearly demonstrating a need and a receptive audience.

While the Quantapoint system can produce an accurate survey of the shape of a tomb, it cannot map the details of the surface texture or color. This requires different equipment and a different set of skills. The work that Factum Arte carried out in the tombs of Seti I and Tutankhamun recorded the surface of the walls with 100 million measured points per square meter. Color was recorded at a resolution of 800 dpi at a scale of 1:1. These data could be aligned and added to the Theban Mapping Project website. This would allow the virtual visitor to study the structure and layout of the tomb, zoom into any area and see the decoration in color, select any section and magnify it in order to inspect details, shift between color and 3D data, and connect to archives of historical photographs and other source material. The availability of this quantity of information in a virtual form does not reduce the desire to visit Egypt. On the contrary, it encourages it. It nurtures an intimacy with the site and facilitates new ways of study. But equally important, it allows us to know what damage we are doing—to monitor the speed of decay and to make informed decisions about how to safeguard the Theban necropolis and assist in the long-term preservation of the site.

## The Practical Application of Digital Technology in Non-Contact Conservation

Outlined below are the stages involved in the non-contact recording (dematerialization) and the construction of a facsimile (rematerialization).

The digitalization of the surface of a work of art is a relatively new field: if carried out at sufficient resolution, it can be used to both study and monitor the surface of any object. It can also be used to rematerialize the object in diverse forms, ranging from multimedia presentations to the construction of exact facsimiles. The validity of this type of recording is dependent on the quality of the data gathered. Since their invention in the 1920s, photographically based 3D recording systems have focused on capturing the shape of an object. It is only recently that the technology has been able to record surface data. Recording the relief and texture of a surface is now possible and is leading to new insights into why the surface looks the way it does.



### Dematerializing 1: The Lucida Laser Scanner—Designed to Record the Tombs

Lucida is a 3D laser scanner designed by artist and engineer Manuel Franquelo, custom built by Factum Arte, and funded by Factum Foundation. This system, the result of more than ten years of investigation into the high-resolution recording of the surface of paintings and relief objects, uses two cameras and one laser. A thin strip of red light is projected onto the surface of the object. As the line moves over the surface, it is recorded by the two cameras, positioned on either side of the laser. The distortions of the line produced by the relief of the surface are recorded as a tonal depth map, which is then converted into 3D information. The scanner moves parallel to the surface plane of the object, controlled by linear guides. Lucida uses a system of double exposure to extract the optimum data from both dark and glossy surfaces. The relationship between noise and information is critical; for any recording technology to be meaningful for cultural applications, it is essential that there be a close correspondence between the surface and the recording of the surface.

The Lucida scanner stores the data as raw black-and-white video. This is a radical innovation that significantly distances Lucida from other scanning systems, which use software algorithms to convert the photographic data into a three-dimensional mesh—this transformation is an irreversible abstraction of the data that results in a loss of information. Lucida condenses the raw (unprocessed) information, thus removing many of the obstacles that could limit future generations from accessing and reprocessing it.

Lucida uses the raw files to generate 3D and rendered simulations of the surface relief. These can be exported into triangulated meshes (.stl), point clouds, or a variety of different renderings. It is by virtue of the renderings that the recorded data can be accessed without specialized (and usually expensive) 3D software: it can easily be opened with standard image viewers. Moreover, it can be incorporated into accurately aligned, multilayered files that can also include additional types of recording, such as infra-red, X-ray, and color information. Multilayered files are proving very helpful for researchers and conservators alike and facilitate an accurate, objective, and meaningful method for analyzing the artwork.

The Lucida scanner is easy to use and transport. Due to its size, lightness, and physical configuration, it allows the user to work in conditions that are normally incompatible with computer-based technologies. It can be powered by electricity or battery. The battery can be recharged with solar energy by using a simple solar panel. In all the equipment that has been developed for use in Egypt, the aim has been to reduce cost, reduce complexity, and produce robust systems that can be used in the dusty, harsh conditions that exist in the tombs of the Theban necropolis.

### Dematerializing 2: White Light Recording

There are several white light scanning systems that could be used in the tombs of the Theban necropolis. Each has advantages and disadvantages. The system chosen and

FIGURE 35.3 The SIDIO white light scanning system recording the surface of the sarcophagus of Tutankhamun.

[Photo by G. Dupond, courtesy of Factum Arte.]

used by Factum Arte in 2009 was the NUB3D SIDIO (see Figure 35.3). While it is heavier than many comparable systems and only has one camera, the data it records have a close correspondence to the surface being recorded. The SIDIO system employs a conjunction of optical technology, 3D topometry, and digital image processing to extract 3D coordinates from the surface of the object, a technique known as triangulation. Three-dimensional information is acquired by analyzing the deformation caused when parallel lines are projected onto the surface of an object and recorded by the camera. With these images, SIDIO integrated software calculates a coordinated XYZ point cloud relating to the surface and shape of the object. The SIDIO records the surface from many individually positioned shots that are then aligned. It requires a skilled and experienced operator to achieve good results.

## Dematerializing 3: A Panoramic Photographic System

After working with a parallel photographic recording system for many years, Factum Arte switched to panoramic recording when the technology became available to produce high-resolution images quickly and accurately. At the end of 2010 we started working with German company CLAUSS. They have been developing panoramic photographic equipment since 1993 and launched their pan-and-tilt head in 2003.



The automated equipment consists of a motorized, panoramic head and a computer (to control the head), as well as the recording device (camera) and the archiving software to download and name the resulting photographs. The lighting, distance, speed of recording, and resolution all depend on factors specific to each recording task. When recording the image many photographs are automatically taken in sequence and then stitched together at subpixel accuracy. The aim is to record a high-resolution image that is in focus and has a resolution of at least 600 dpi at a scale of 1:1. The camera used to record the tomb of Tutankhamun was a Canon EOS7DII DSLR with various lenses depending on distance. The use of a UV-filtered, high-speed flash is recommended, but in conservation recording there is resistance to the use of flash. In the tomb a low-level cold light source was used. Depth of focus can be a problem, but this can be overcome by combining a mix of focus stacking and panoramic recording. The different planes of photographs are stitched together using focus-stacking software technology. The merging process consists of multiplying control points between photographs on the same plane and photographs on different planes, until a stitching result of subpixel accuracy is achieved. The result is a gigapixel image with uniform sharpness.

When carrying out photographic recording for conservation purposes, all the normal color and greyscale references are used. However, Factum Arte have found it essential to develop their own color reference system for use when printing the data. The main difficulty of recording the color is to understand the extreme complexity of the painted surface. The paintings were executed as broad areas of paint with a limited palette, but a combination of centuries of aging and modern interference has resulted in an inconsistent and intricate surface.

## Rematerializing

At a time when many people are just starting to understand the role virtual models can play in studying and presenting cultural heritage, the technology is making it possible to go one stage further and return the data into a physical form. What has been carried out in the tomb of Tutankhamun is a two-way process—from the real world to the digital archive and then from the digital files back into the physical world without significant change or loss of detail.

This has been possible for some time, but the costs have been prohibitive. Now, due to a highly focused and motivated team at Factum Arte, the protocol has been put in place to vastly reduce the costs and break down all stages of the work into tasks that can be taught to a local workforce in Luxor. The details of this work are not the subject of this text, but it is important to outline the many stages that are involved.

The most time-consuming and expensive part of the rematerialization process is routing the 3D data at high resolution. To rout a 1-by-1-square-meter panel in 3D at a resolution of 250 microns takes approximately 400 hours. Once routed, the sections need to be

cast and joined together. A skeleton has to be made to hold the panels in place and allow the entire surface of the tomb to be assembled with a floor and a ceiling.

Printing onto a relief surface presents its own difficulties, and after experimenting with various transfer systems Factum Arte developed its own elastic membrane that can be printed as a flat sheet. The membrane is a layered mixture of three materials: a thin, flexible inkjet ground, an acrylic gesso, and an elastic acrylic support. It is built in seven layers rolled onto a slightly textured silicon mold. The printing of the facsimile was done using a purpose-built flatbed inkjet printer. For many years this printer has been at the center of Factum Arte's approach to the production of facsimiles, as it allows the image to be built up in layers, each printed in perfect registration. This approach means that both the color and the tone can be controlled and locally altered to ensure a perfect match.

The printed flexible skins are positioned using a slow-cure contact adhesive. Sight and touch are both essential to ensure the exact relationship between the surface and the color. Working with a raking light, the skin is positioned and repositioned until all details in the printing correspond to the underlying surface. Once positioned correctly the skin and the relief are put into a vacuum chamber, and pressure is applied evenly until the adhesive has cured. Due to the gossamer-like character of the skin when it is fixed to the surface, it takes on the character of the wall of the tomb.

The burial chamber is assembled from interlocking panels that are bolted together from the outside. It has been designed for ease of transport and assembly. Once the tomb is assembled the final joins are filled and retouched.

The proposed lighting for the facsimile in its eventual location should match the lights used in the Valley of the Kings. The acoustics, smell, and temperature can also be controlled to increase the similarities between the original and the facsimile. Special effects can be used to control humidity and temperature, and projections onto the surface can inform the visitor of the problems in the tomb and the impact of these dynamic conditions.

## The Biography of Objects—The Object as Subject

The biography of any cultural artifact reveals various levels of human intervention at different times in its life. Many of these interventions have been made to preserve the object, but others reflect changing attitudes toward our relationship with the past. Some actions that have disastrous consequences are well intentioned, while others are not. The tombs in the Valley of the Kings contain examples of mindless vandalism as well as acts of love, care, and possession that have had equally ruinous and unpredictable consequences. The tomb of Seti I contains numerous examples of both; graffiti from the nineteenth and twentieth centuries cover the walls, and sections have been removed



and are now in museums and collections around the world (the largest two sections are in the Musée du Louvre and the Museo Archeologico in Florence—interestingly, these two fragments now look very different from the original tomb and from each other). Belzoni cast large sections of the tomb in wax and vegetable fiber to make the "first" facsimile, which introduced the wonders of pharaonic culture to London in the 1820s. The travel agents used to sell plaster-casting kits to their tourists so they could take their own "handmade" souvenirs home; both had grave consequences for the tomb. Evidence of erosion of the surfaces and accidental damage can be found everywhere.

Values and opinions change from generation to generation. Winckelmann's statement that we must conserve and preserve is obviously correct, but we now have tools that he never had. Perhaps we can engage once again with the act of reconstructing and rethinking our relationship to the past in a way that makes it more accessible. Culture has wrongly been connected to leisure. This has led to many of today's problems. The tombs are not being preserved to give future generations something to do when they are on holiday; they are being protected to safeguard the important knowledge they contain. It is essential that this is done without impositions on the original. The aim is not to turn an original into a reproduction of itself by altering its appearance, but to allow the next generation to inherit the past in full knowledge of the complexity this involves.

If the facsimile, in its site next to Carter's house, can capture the public imagination in a similar way to the discovery of the tomb, then Tutankhamun can secure his immortality—at least for a while longer. With the right approach, new technologies are making it possible to have both an altruistic approach that preserves the site for future generations and the commercial benefits of tourism that the people of Egypt need right now.

## Postscript

This text was written in 2012 after the facsimile of the burial chamber had been presented to the Egyptian people by Baroness Ashton on behalf of the European Union. Between January and April 2014 and Egyptian team under the direction of the Egyptian architect Tarek Waly and a team from Factum Arte worked to install the facsimile in an underground space next to Howard Carter's house at the entrance to the Valley of the Kings. This initiative has met with extensive press coverage and almost universal praise. The same team is now awaiting the final permission to restore Stoppelaere house and create a training centre devoted to high-resolution recording in 3D and colour. As local operators are trained they will begin the epic task of recording all the decorated surfaces in the tomb of Seti I. A transfer of equipment and knowledge on this scale is redefining how we think about the long-term protection of heritage sites in an age of mass tourism.

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## Note

1. Photographs by Harry Burton in *Tutankhamun: Anatomy of an Excavation*, Oxford: Griffith Institute, University of Oxford, 2006. <http://www.griffith.ox.ac.uk/gri/carter/gallery/>

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