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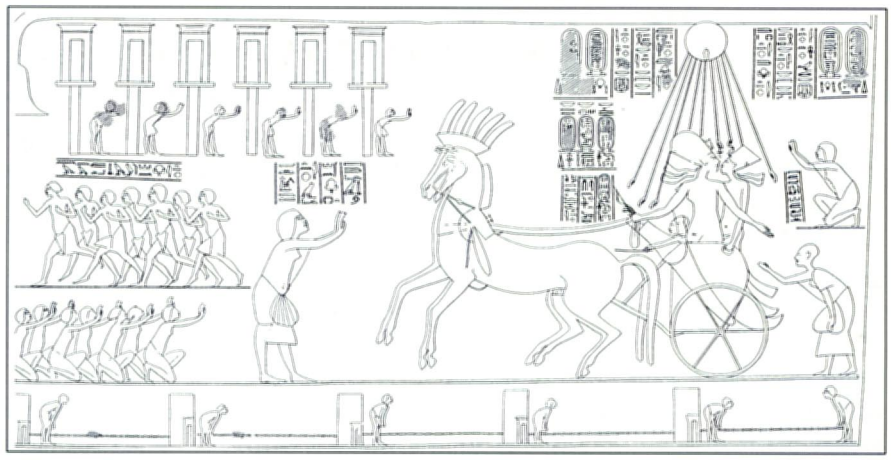

Amarna, southern tombs, tomb 9 of Mahu. *Scene showing Mahu and his sentries greeting Akhenaten, Nefertiti and Meretaten, as copied by Norman de Garis Davies* (Rock Tombs of el-Amarna, IV, *1906, pl.XXII). Compare the recent EES photograph by Gwil Owen on p.23.*

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Cover: *Amarna, courtiers' tombs. The interior of tomb 16 in the southern group. See pp.21-24. Photograph: Gwil Owen for the Egypt Exploration Society*

'Digital epigraphy' at Giza

With the increasing need for documentation of the mastaba tombs of the Old Kingdom, an expedition to the Giza pyramids from the Museum of Fine Arts, Boston, is turning to computers for help with Egyptological epigraphy. **Peter Der Manuelian** reports on using the latest technology to study the past.

Egypt's ancient cultural heritage is, despite the many efforts to conserve it, in urgent need of long-term protection, and scholars are not the only ones worrying that many monuments taken for granted by the current generation may not survive for the next. At the start of this millennium, the time has come to take advantage of new technologies and to re-evaluate some of Egyptology's traditional documentation methods. Excavation, conservation, restoration, documentation and publication continue to be prime objectives of archaeological fieldwork in Egypt. The remarks below focus on epigraphy - one of those prime objectives that could benefit from a digital approach.

The Harvard University - Museum of Fine Arts, Boston, excavations in the vast mastaba cemeteries of the Giza Necropolis, conducted by George Reisner between 1905 and 1942, continue to enhance our study of necropolis development and social organisation during the Old Kingdom. In addition to the funerary architecture and excavated artefacts, the tomb wall relief scenes and inscriptions provide a primary source for all aspects of ancient Egyptian culture. Creating reliable facsimile drawings and photographs of these scenes is thus one critical component of the documentation process.

Most of the wall reliefs and inscriptions from the Old Kingdom mastaba tombs surrounding the Great Pyramid of Khufu were never drawn by Reisner's original expedition. But the Museum Expedition's photographic documentation of the site is impressive.

Colour scan of the Giza slab stela of Wepemnefret (G 1201), ready for digital tracing

Between 1902 and 1942 Reisner produced some 60,000 large-format glass-plate expedition negatives at Giza and 22 other sites along the Nile. Our efforts to rescue and digitise these irreplaceable glass negatives would be a story unto itself (see further, p.11) Almost sixty years after Reisner's death, many of these images serve as the photographic base documentation for our experiments in digital technology. It would be a wasted opportunity today to trace directly texts and scenes on a damaged wall when such suitable early-expedition photographs exist, showing twice as much surface back in 1905 as is preserved in 2000.

The best examples of Egyptological epigraphy have always combined the expertise of several specialists - photographers, epigraphers/artists and Egyptologists. Probably the two most commonly used epigraphic methods are direct 1:1 tracing at the tomb or temple wall (using affixed tracing paper or film), and the tracing of enlarged photographs. A new computer-aided technique called digital epigraphy attempts to combine the high quality and accuracy of traditional methods while accelerating the process to allow for the documentation of more monuments in less time.

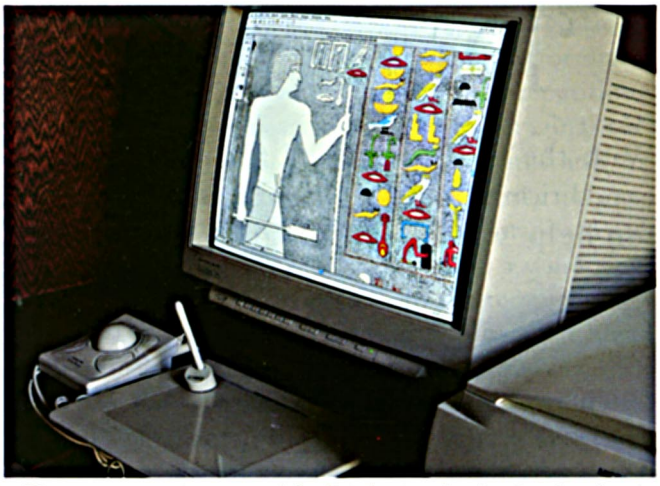
In preparing the epigraphic portion of additional volumes of the Museum's

General view looking south down 'Street 2100' towards the pyramid of Khafre. (Photo: Peter Der Manuelian 99.10.35)

North wall of chapel of Kanefer, mastaba tomb G 2150. (Photo: Peter Der Manuelian 99.9.31)

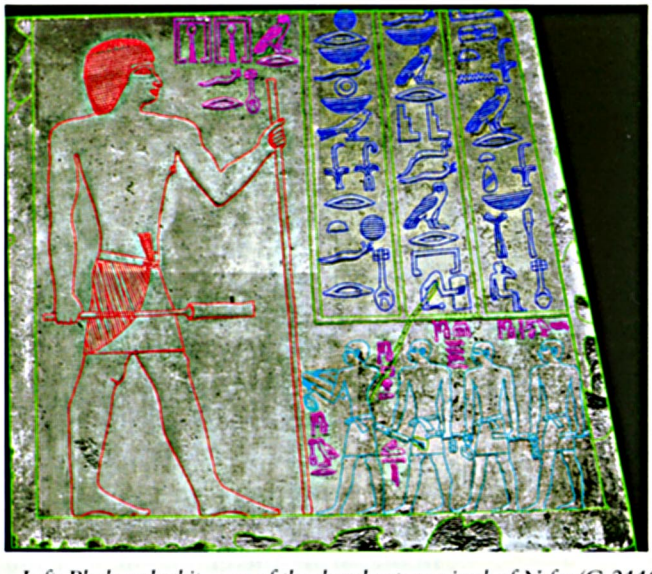
Giza Mastabas series, our work now depends on the computer as a vital part of the drawing process. Digital epigraphy consists of two steps: 1) preparation of digital or digitised (scanned) photographs of the ancient wall as the base or template for 'on-screen tracing', and 2) use of computer drawing programs to trace the digital photographic image on screen. Computer-drawn lines may be broadly divided into two types: 'bit-mapped' lines (unconnected black squares called pixels) which are too coarse and jagged for facsimile work, and 'vector' lines (mathematically calculated lines and curves between specific points) which are very well suited for Egyptological facsimiles.

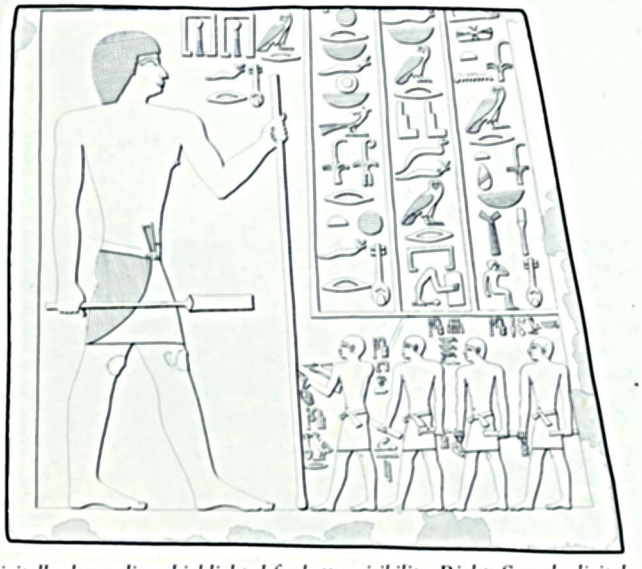
For the documentation of the Giza mastabas, the original Museum Expedition (Reisner) negatives are first scanned at high resolution; the higher the resolution and larger the file size, the greater magnification of details will be available on the computer screen. Next, the scanned image file is imported into the drawing programme. With the scanned photograph in place on the computer screen, a digitising tablet and cordless pen serve to emulate the traditional pen-and-ink tracing process. Since black drawing lines are often difficult to see against the underlying photographic image, we often temporarily colour all lines on the drawing red, yellow, or other bright hues for maximum contrast. Similarly, we can render any portion of the photograph or drawing temporarily invisible at any time, for purposes of comparison or collation. Anyone who has struggled to peer through partially opaque plastic film tracing papers to see the carved wall surface underneath will appreciate these features immensely.



The computer equipment used for digital epigraphy showing the colour-highlighted black and white scan of the entrance jamb of Nefer (G 2110)

The resulting computer-drawn lines and curves are infinitely adjustable; rather than 'trace', the epigrapher/artist actually uses the computer to manipulate the curve between two anchor points until it 'matches' the contour of the ancient carved line. Thus the swoop of a carved eyebrow, shape of a bird's wing, or curve of a cartouche can be controlled meticulously and improved endlessly. When all the lines have been drawn, proofs are printed on a standard laserprinter, and are then collated and annotated at the original monument, just as with traditional epigraphy. The corrections are added later to the drawing on the computer, and the collation process is then repeated as many times as necessary. Upon completion, the drawing file can be





Left: Black and white scan of the chapel entrance jamb of Nefer (G 2110) with digitally drawn lines highlighted for better visibility. Right: Sample digital epigraphy computer drawing of the same scene. No ink was used. (Drawing: Peter Der Manuelian)

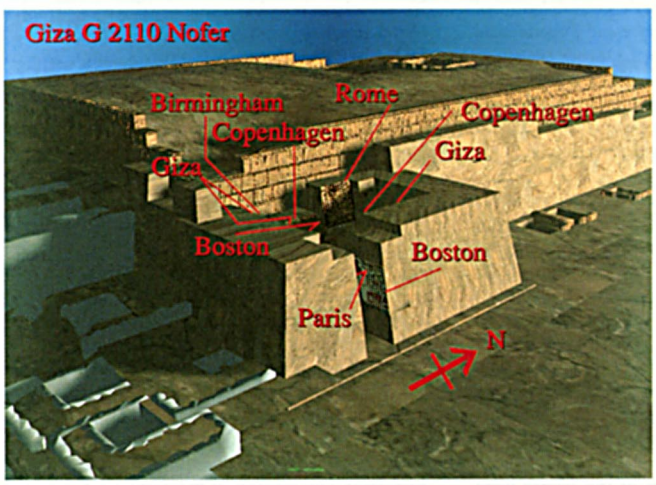
imported directly into a page layout or book design programme for publication. It can also be enlarged, reduced or 'repurposed' for a number of uses (print, on-line distribution, etc.), all without additional labour or costs. Details from a number of drawings may be arranged and compared easily; the digital drawing becomes a unique research tool.

Most of the advantages of using a word processor versus a simple typewriter can be applied to using digital epigraphy instead of traditional ink-based epigraphy. Correcting errors and making fine-tuned adjustments are simplified and gone are the worries of scratching away ink with a scalpel blade. Unexpected changes midway through a project, such as alterations in drawing scale and line weight, no longer pose insurmountable challenges. Individual drawings that form part of an entire wall can be combined, separated, rotated, or resized for different publication needs. Indeed, for Egyptian monuments whose wall reliefs are inaccessible or are spread throughout the world, and whose photographs were taken at a wide variety of scales, scaleable digital photographic montages and on-screen drawing might provide the only practical recording solution.

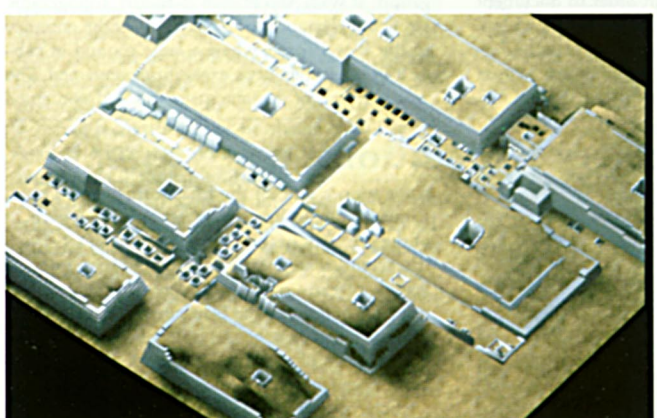
Left: Colour scan of scene from the tomb of Tepemankh at Saqqara, ready for digital tracing. Right: Digital drawing of the same scene with the photograph removed

New ways to describe and represent archaeological data become available once one takes advantage of digital epigraphy. Many of these have yet to find their way into traditional (paper-based, black-and-white) academic avenues of publication, but technology is changing some of these avenues as well. Digital epigraphy may be used to restore the colours of ancient wall decoration and prepare eventual 3D reconstruction of ancient Egyptian monuments. From here, perspective renderings, animated walk-throughs, virtual reality motion and rotating panoramic viewing are all tools that can help us better simulate and understand Egyptian environments. The Giza Mastabas Project recently completed an in-depth series of panoramic photography at Giza in QuickTime Virtual Reality (QTVR) for posting on the Internet. These are just a few of the tools that are becoming scholarly research aids and could lead to new discoveries.

It remains to be seen whether digital epigraphy will eventually liberate Egyptologists from the office or drawing studio altogether. If future generations of portable computers provide sufficient screen quality, and resistance to the elements, epigraphers might eventually be able to draw digitally in the field, at the tomb or temple wall or in a museum storeroom overseas, bringing almost the entire epigraphic process to the monument. There will probably always be a place for traditional tracing methods, but scholars should continue to explore any and all responsible systems that could help to record the ancient monuments before their complete deterioration. For purposes of documentation - at all levels and in the broadest sense of the word - we are finding that digital epigraphy has tremendous potential.



CAD rendering of the Giza mastaba of Nefer (G 2110), showing locations of chapel wall reliefs



CAD rendering of the major mastabas of Giza nucleus cemetery 2100

❑ Peter Der Manuelian is New Media Coordinator and Research Fellow in Egyptian Art at the Museum of Fine Arts, Boston. He is co-director of the Giza Mastabas Project and co-editor with William Kelly Simpson of the Giza Mastabas Series. For more on digital epigraphy and Egyptological publishing, see *The Journal of the American Research Center in Egypt* 35 (1998), pp. 97–113, and http://www.manueliandesign.com