

Application Sheet

HIGHLIGHTS :

- > **Touchless scanning of priceless historical artifact**
- > **Photogrammetry survey achieved accuracy of better than 0.001"**
- > **Photogrammetry indexing targets allowed individual scans to be quickly and accurately aligned**
- > **Using photogrammetry index targets to align scans reduced number of required scans by 50%**
- > **OptoTop HE system could be configured to smaller field view to capture finest detail of engravings**

“Combining Aicon DPA Pro Photogrammetry system and Breuckmann OptoTOP HE allowed all the intricate detail of this priceless historical artifact to be efficiently captured ”

ACCUREX USES AICON PHOTOGRAMMETRY AND BREUCKMANN SCANNER TO SCAN THE SPHINX OF HATSHEPSUT

Background

Hatshepsut was the principal queen of her half-



Sphinx of Hatshepsut

brother, Pharaoh Thutmose II (r. 1492-1479 B.C.). After he died at a young age, she became regent for Thutmose III (r. 1479-1425 B.C.), her stepson and nephew. She adopted the title of Pharaoh, making her the young prince's senior co-ruler. Sculptures of Hatshepsut soon depicted the queen in male regalia.

After Hatshepsut died, for



Djoser-djeseru

reasons lost to history, Thutmose III ordered the dismantling of all male

representations of her.

Thousands of the statues' fragments, discovered in two pits near Hatshepsut's

funerary temple, have been painstakingly reassembled by scholars of the Metropolitan Museum of Art.

The Colossal Sphinx of Hatshepsut which

was recently scanned by Accurex Measurement is most likely one of a pair of protective works that were placed symmetrically on the lower terrace of Hatshepsut's mortuary temple, Djoser-djeseru ("Holy of Holies"), in the western Theban site of Deir el-Bahri.

The Sphinx's body is a recumbent lion and its head is that of Hatshepsut adorned with the male royal headdress and false ceremonial beard. It has a bull's tail that is indicative of ancient Egyptian royalty's powerful procreative ability.

Scanning the Sphinx

The Sphinx was scanned using a Breuckmann Op-

toTOP HE scanner. In order to assist with the alignment of the individual scans, reflective photogrammetry dot targets were placed at a number of locations on the Sphinx. To guard against damage to the 3,500 year old sculpture, all targets were placed on easy release tape that had been tested to ensure that it would not damage the granite surface. A number of dot targets with a circular bar code were also applied. These are used by the software to process the photogrammetry survey automatically. The Sphinx was then photographed



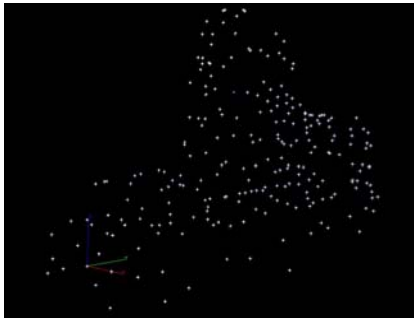
Scanning the sphinx

from a number of angles using a very high quality digital camera. These photographs are the basic observations of the photogrammetry survey. When they are loaded into the Aicon 3D Studio, the software automatically locates all targets on each photograph, and by means of a least squares adjustment, calculates the position of each target to an accuracy

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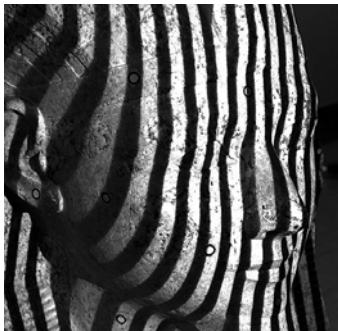
ACCUREX USES AICON DPA PRO PHOTOGRAMMETRY AND BREUCKMANN OPTOTOP HE TO SCAN THE SPHINX OF HATSHEPSUT CONTINUED

of better than 0.001". The positions of the targets without codes are then



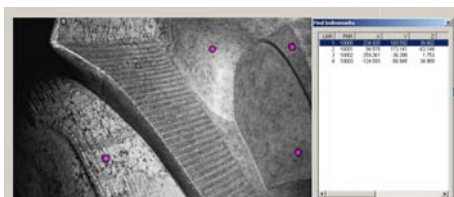
Photogrammetric reference targets

exported from Aicon 3D Studio and imported into the Breuckmann OptoCAT software, which is used to



Scanner projects fringe pattern

run the OptoTOP HE scanner. The positions of these reflective index marks are recognized by the software and used to automatically



Automatic recognition of photogrammetry targets

align each of the scans.

For a project such as this which contains many hundreds of scans, automatic alignment of the scans is a very useful capability. The graphical representation of the scans on the screen shows in which areas data is missing, and these gaps can be closed by

taking additional scans. The technique of automatic alignment cuts down on the number of scans that would be needed if a method such as using the geometry of adjacent scans were used for alignment purposes. Using the geometry of adjacent scans to align them would require approximately 50% more scans.

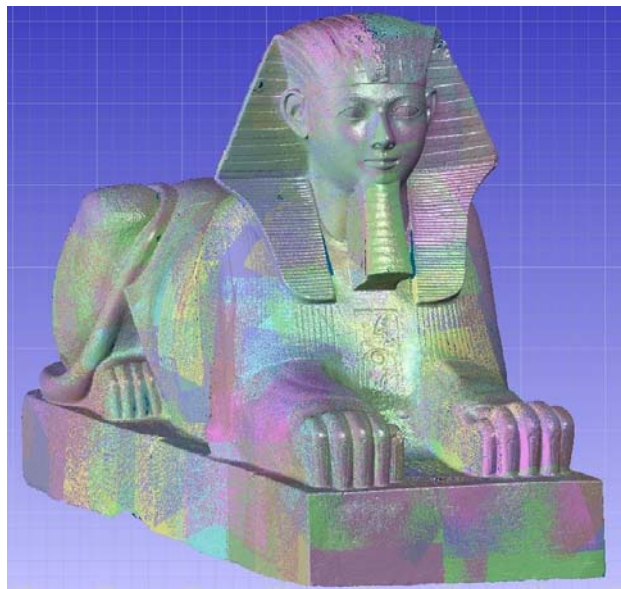
The basic scan of the Sphinx was conducted using the Breuckmann scanner set to a large (700mm) field of view.

A unique capability of the Breuckmann OptoTOP HE scanner is that it can be easily and quickly reconfigured to a smaller field of view by switching the carbon fiber base bar between the

camera and projector. This was especially useful for this application because certain areas on the Sphinx, such as those between the forelegs contain intricate hieroglyphics. For these areas a scanner configuration with a field of view of 200mm was used.

ered in STL format, which can be used for analysis, archiving, or creating replicas

Hatshepsut has been in the news. Her remains were long considered lost, but in June 2007 a mummy from Tomb KV60, known as the



Final model showing individual overlapping scans

Since each scan captures the same number of points but over a smaller area, much higher resolutions can be achieved

Results

Over two hundred scans were required for complete coverage of the Sphinx. The completed model contained much detail that are difficult to see with the naked eye. The final result was deliv-

"Strong One" was publicly identified as her remains by means of a DNA comparison with the mummy of Ahmose Nefertari, Hatshepsut's grandmother.