



How we build reality



Case Study

Stonehenge in High Definition



Company Overview

Z+F is one of world leading manufacturers of phase based laser scanners.

Our strengths lie in our powerful 3D laser scanning hardware and software innovations which are considered to be the best on the market, the continual nature of these innovations and the support that we show to our customers who are loyal and longstanding owing to the service we provide.

In cooperation with the [Greennatch Group](#)



Z+F IMAGER® 5010

Introduction

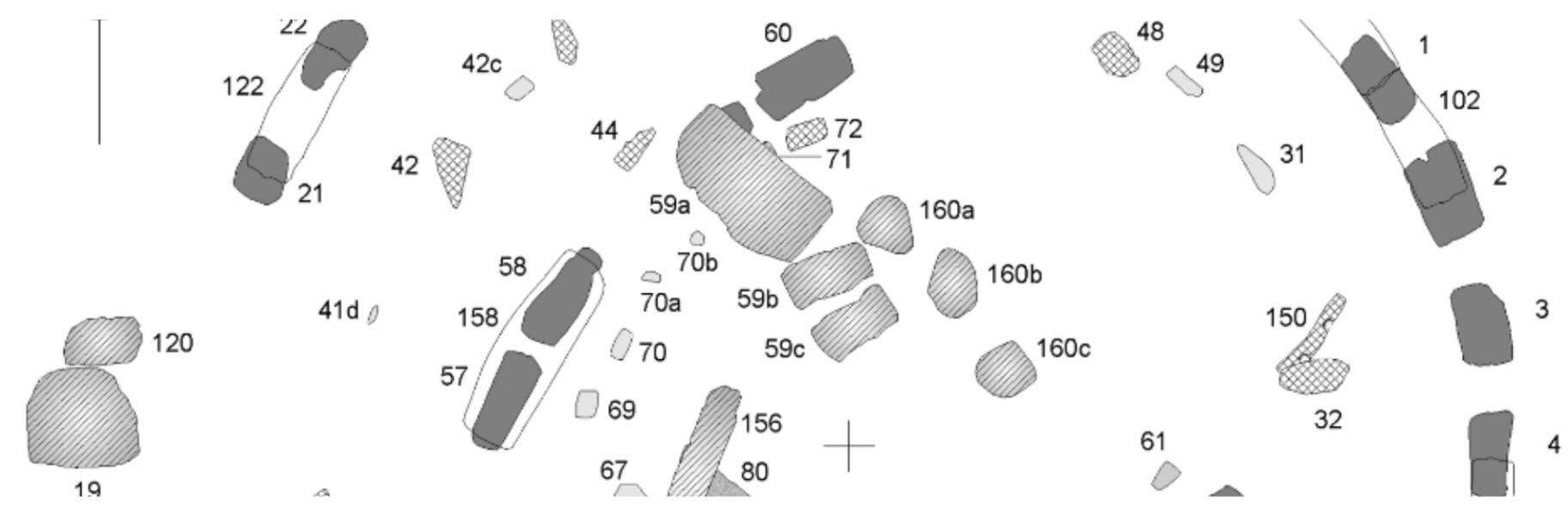
Stonehenge is probably the most important prehistoric monument in the whole of Britain and has attracted visitors from earliest times. It stands as a timeless monument to the people who built it. Stonehenge is composed of earthworks surrounding a circular setting of large standing stones.

English Heritage awarded a prestigious contract to Greenhatch Group based in Derby to create a detailed 3D laser scanning survey of the stones, both standing and fallen, and landscape immediately surrounding it within the area known as 'The Triangle'.

This was to use a combination of modern 3D laser scanning and digital imaging technology in order to capture, in high resolution, the subtleties of both, the topography and the visible surfaces of the stones themselves.

The resultant data will be used alongside existing data sets created during the landscape research project to aid further investigation and presentation of the WHS (World Heritage Site). It will also inform analysis of the stone surfaces themselves, and any carvings upon them, whilst providing the basis for both structural monitoring and presentational displays on the monument.

A combination of modern 3D laser scanning and digital imaging technology have been used by English Heritage to survey all the stones that make up Stonehenge to produce the most accurate digital model ever for the world famous prehistoric monument.



Floorplan of the site, revealing the stones both standing and fallen



Objectives

The objective is to carry out a detailed 3D laser scan survey of the following:

The Triangle

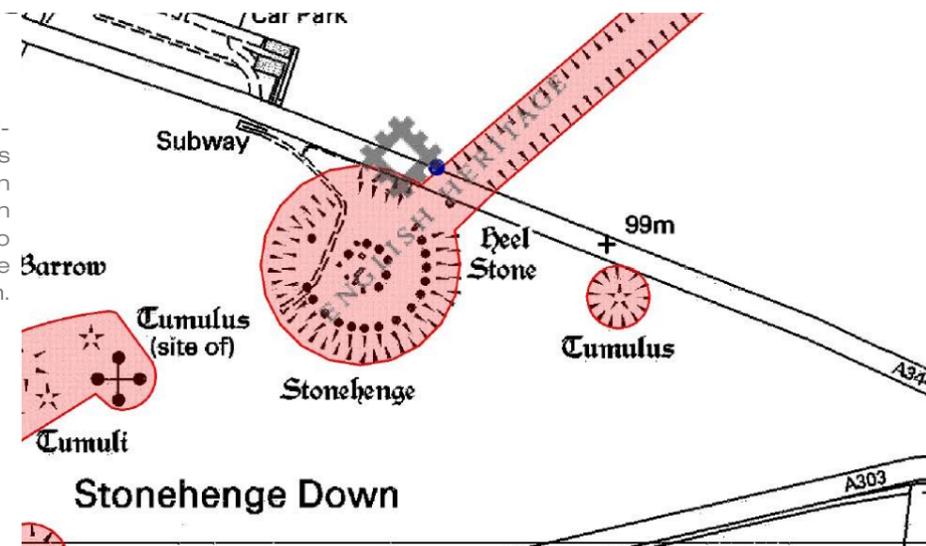
Topographic landscape within 'The Triangle' - using terrestrial laser scanners and appropriate data processing techniques to accurately capture a ground surface model at a point-spacing (resolution) of at least 10cm.

The Stone Circle

The stone circle and landscape immediately surrounding it - using Z+F 3D laser scanners and appropriate data processing techniques to accurately capture a surface model at a point-spacing of at least 2cm for the landscape and up to 1mm for the surfaces of the stones themselves.

The Stones

The standing and fallen stones, including Station, Heel and Slaughter stones - using the close-range high-resolution IMAGER® 5010 from Z+F, combined with appropriate data processing techniques, to accurately capture all visible faces of the stones at a point-spacing of at least 0.5mm.



Stonehenge Site
© Greenhatch Group

Despite the vast amount of archaeological activity and academic study into Stonehenge and its landscape over the centuries, relatively little is known about the lichen-covered surfaces of the sarsens and blue-stones that make up the stone circle. The study served a number of purposes:

It provides very precise base-line data to monitor the physical condition of the monument which is subjected to daily weathering.

Digital data of this unprecedented level of detail on every single stone, their exact location in relation to each other and the precise way they are lodged in the soil, will also be a valuable resource to anyone who is tasked with producing reconstruction models, drawings and computer generated images of the monument for public understanding and interpretation.

Understanding of the known Neolithic "dagger" and Bronze Age carvings as well as modern graffiti carvings might also be enhanced, and new ones might be discovered.

"The surfaces of the stones of Stonehenge hold fascinating clues to the past. They are like manuscripts, a whole palimpsest of the ideas, efforts and idiosyncrasies that marked the lives of people over millennia."

Dave Batchelor
English Heritage's
Stonehenge Archaeologist



*A member of the Greenhatch Group
using the Z+F IMAGER® 5010*

Methodology

Instruments and Software

To provide data to English Heritage's high specification required the use of phased based scanners from Z+F. This allowed Greenhatch to capture data of the following:

- Survey of stone circle structures and landscape immediately surrounding it using a Z+F IMAGER® 5010 Laser Scanner & Z+F M-Cam in conjunction with a Total Station and Precise Control Field Targets with a resultant point-spacing of at least 2cm for the landscape and up to 1mm for the surfaces of the stones themselves.

- Survey of the individual faces of standing and fallen stones, including Station, Heel and Slaughter stones using a high-resolution Z+F IMAGER® 5010 laser scanner with enabled horizontal compensator in conjunction with a Total Station and Z+F Precise Control Field Targets with appropriate data processing techniques to accurately capture all visible faces of the stones at a point-spacing of at least 0.5mm.

- Archaeological report on the assessment of any features which may have become visible or evident after data post processing, possibly warranting further investigation.

Why was laser scanning chosen

The use of the very latest technology, in conjunction with approved registration techniques, will provide exceptionally high quality data sets. For instance, the picture on page 8 and 9 is a perfect example of a selection of stones in colourised meshed model.

In addition to this, the collected high resolution 3D point cloud data collected, provides a snap shot in time of the site's current condition and also an accurate archival reference for future comparison.

Finally, the actual data quality collected is 50 % higher than the resolution currently able to be presented, allowing much higher levels of study and presentation in the future.

The Z+F IMAGER® 5010 was used as it gave the team the ability to multi capture specific scene selections, thus reducing file sizes.

Problems Encountered

The Greenhatch team carried out a full breakdown of the methodology of the site working, before they undertook the survey work. This enabled a smooth and efficient working practice on site and eliminated many problems the team may have encountered. This allowed the site work being completed within the allocated timeframe. The main problems the Greenhatch Group encountered were with the office processing of the data. The huge size of the data sets meant the process took longer than anticipated.

In addition to this, when passing the data on to the archaeologist in the team they could only view 10% of the data due to computer capabilities. This has led to English Heritage requesting the data in various decimation levels to allow different levels of users to access the data.

Finally, the original project brief was to model each complete stone face at 0.5 mm, but after discussions with English Heritage over the file size of the data, it was agreed to only model certain panels on significant stone faces, together with a full archive set of XYZ files for each stone face. This data can then be fully modelled at a later date with the advancement of computer technologies.

"For the scanning work at 0.5mm we used the 5010 and this was our first experience with this equipment but its ease of use and efficiency meant no interruptions in our site workflow."

Stuart Chadwick
Greenhatch Group,
Project Manager



Example of Stonehenge Stone Circle, meshed model

Deliverables

The data for all three areas was registered together onto the site control co-ordinates. This was then exported in *.txt format to be used in the latest 3D modelling software. The site point cloud data was converted to a 3D mesh and the editing undertaken.

Following on from this, the Greenhatch Group was able to create a complete mesh of the triangle area, the bank and ditch and then each stone individually. The picture shows the complete meshed model of the Stonehenge site created.

With some of the larger stones consisting of nearly 40 million points, the final mesh data needed to be decimated to a lower level to enable manipulation and modelling of the data. Using the 1mm stone mesh data,

areas of significant interest were highlighted by the project archaeologist and set panels were then modelled using the 0.5mm data.

Once the models had been completed the data was exported in *.obj format (standard 3D object file format) at various decimation levels due to the size of the final files.

Finally, the data collected at 0.5mm was exported in *.xyz format and issued for archiving. This data was unable to be modelled with current computer and software capabilities. But now archived, it can be used in the future with development of technology.

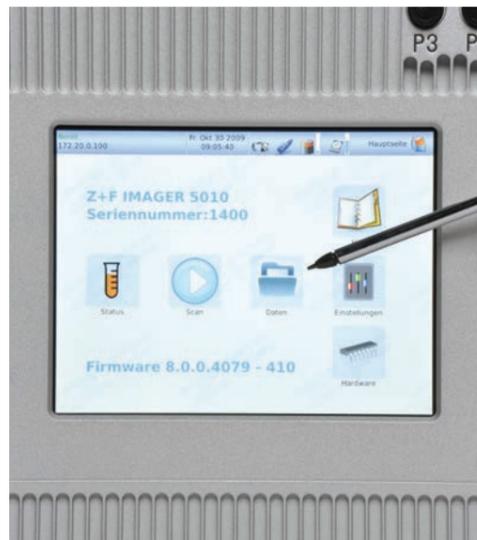
All the scan data in *.xyz and *.obj format was issued together with the Archaeological Report produced using the data which was undertaken by Archaeo-Environment Ltd.





Also a Z-F IMAGER® 5006 was used to scan Stonehenge.

Pictures



The Z-F IMAGER® 5010 and a detailed view of its display..



The Z-F IMAGER® 5010 in the middle of the idyllic scenery of the Stonehenge area.



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