



How we build reality



Case Study *Bagan-Myanmar*



Company Overview

Z+F is one of the world's leading manufacturers in the field of non-contact, terrestrial laser measurement technology. From years of research, development and numerous successful engineering projects, Z+F is the forerunner in this field with a wealth of knowledge, experience and success.

When it comes to implementing future developments, Z+F has always encouraged innovative thinking and open-minds. Our loyal and long-standing customers appreciate our continual innovations, support and services we provide.

In cooperation with the [Zamani Project](#)





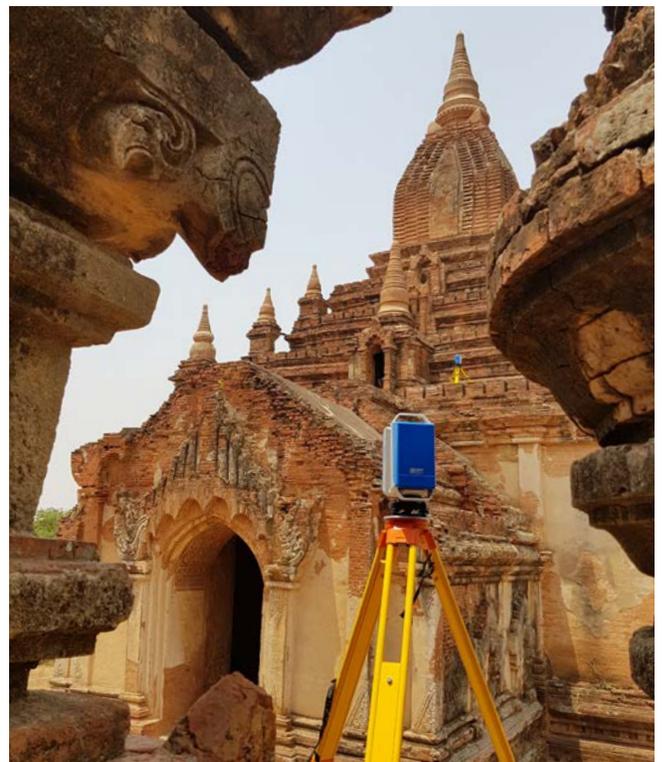
Cooperation

Zamani Project

The *Zamani Project* is an initiative of the University of Cape Town. The team members are experts in digital High Density Documentation (HDD) projects. Also known as the “African Cultural Heritage and Landscapes Project”, the non-profit initiative started in 2004 under the leadership of Prof. Heinz R  ther with the objective to document cultural heritage sites all over the African continent with laser scanning, photogrammetry, conventional survey techniques, panorama and casual photography, videos and remote sensing.

For each site, 3D models are created, from which highly accurate plans and maps are derived, as well as a GIS, incorporating various data from different sources. Within fifteen years the project completed the documentation of about 60 sites in fifteen African countries.

The project was carried out with the permission and support of the Myanmar Ministry of Religious Affairs and Culture.



Parallel use of several scanners through the Multi-scanner-workflow of the Z+F MAGER® 5016



Bagan, Myanmar, Z+F IMAGER® 5016

Introduction

The Buddhist heritage site of Bagan, Myanmar, has been described as the densest concentration of religious monuments worldwide. The more than 2800 Buddhist temples and pagodas, erected between the 9th and 13th century, are located within a 100 km² area. Over the centuries, the site has been threatened by slow natural weathering due to temperature variations, wind and rain, as well as catastrophic events, such as earthquakes.



Aerial view of Sula-mani-hu-hu-hpaya-monument

On 24 August 2016 an earthquake of magnitude 6.8 on the Richter magnitude scale struck Bagan and seriously damaged over 100 heritage monuments. The largest monument documented by the team was the Sula-mani-hu-hpaya temple. This temple was damaged during the most recent

earthquake where it lost its 15-metre tall tower, which broke through the roof of the structure and caused significant damage to the monument and to the frescoes inside the temple.

A total of 11 monuments was documented during three field campaigns to Bagan by the Zamani project in 2017 and 2018. The authorities in Bagan are currently in the process of applying for UNESCO world heritage site status.

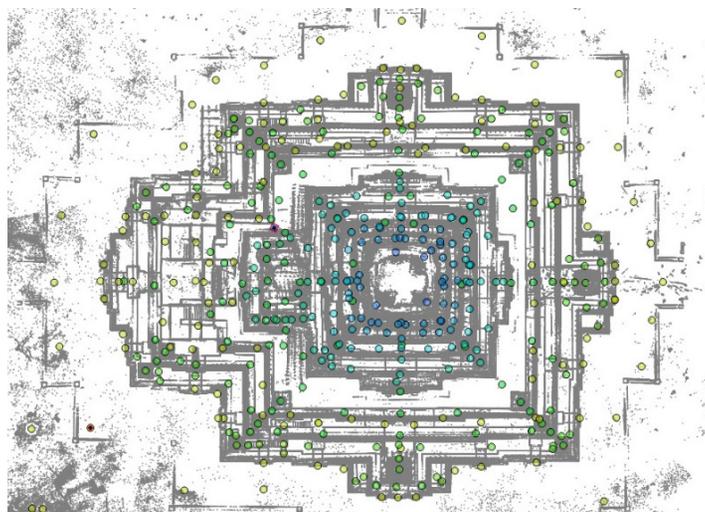


3D model of the Kyauk-ku-umin temple



Data capture

In cultural heritage projects it is important to scan as much of the entire surface as possible and to avoid any gaps in the data, caused by obstructions. Hence, these projects usually consist of a larger amount of scans than usual. In Bagan, bamboo scaffolding made this situation even more complex. Especially with very symmetric buildings, consisting of multiple levels and terraces, it is often difficult to keep track of all scan positions and to make sure none are left out. In heritage projects the use of targets is



Top view of the Sula-mani-hu-hpaya monument with scan positions

generally difficult, as mounting targets on or near the often fragile surfaces is undesirable or impossible. For the

alignment of the scans during this project, the real-time capable registration system of the Z+F instruments proved to be of great help. The solution consists of a combination of hardware sensors, i.e. IMU, GNSS, compass and barometer, which estimates the current position and orientation of the scanner, outdoors, as well as indoors. As the processing happens on a tablet in parallel to the scanning, it was possible to check the registration and to ensure a complete coverage of the monument, without the need for more time on site.

During each fieldtrip, two scanners of the the Z+F IMAGER® 5016 and/ or 5010 series were used in parallel. The integrated HDR camera provided perfect results even in difficult scenes containing very bright and dark areas. Because of the parallax-free camera, the image projection was pixel-accurate, even in close-up scans. In dark environments, the Z+F Smartlight allowed the team to record the inside of the monuments in colour, although no artificial light sources were present. As the light is emitted by the scanner, there are no additional shadows visible in the scene, allowing a homogenous illumination. The scans were later combined with photogrammetrically processed terrestrial and drone-based images to complete top-view areas other surface areas, which were not “visible“ to the scanners thus creating a complete 3D model of the Sula-mani-hu-hpaya temple and City Gate in Old Bagan.



Multi-scanner-workflow with the Z+F IMAGER® 5016 during scanning the old city gate of Bagan

Multi-scanner-workflow

When registering scans together, there needs to be overlap to the previous scans. If the scan containing the overlap was done with another scanner, the data from the other scanner are not on the tablet and thus the registration cannot be continued.

To avoid this conflict when working simultaneously with multiple scanners, theoretically each scan team should thus be assigned its own segment of the scene, e.g. one scanner per level. Practically, however, scanners are used wherever they are needed in a project and once a team is finished it will assist the other ones.

Up to now, users had to run separate projects for each scanning device and carefully plan the scan positions to guarantee a successful registration of each subproject and their combination at a later stage off-site.

Z+F LaserControl® Scout supports the near-real-time synchronisation of multiple simultaneous scanning operations via a single tablet. There are two main workflows available:

Single-Tablet Mode

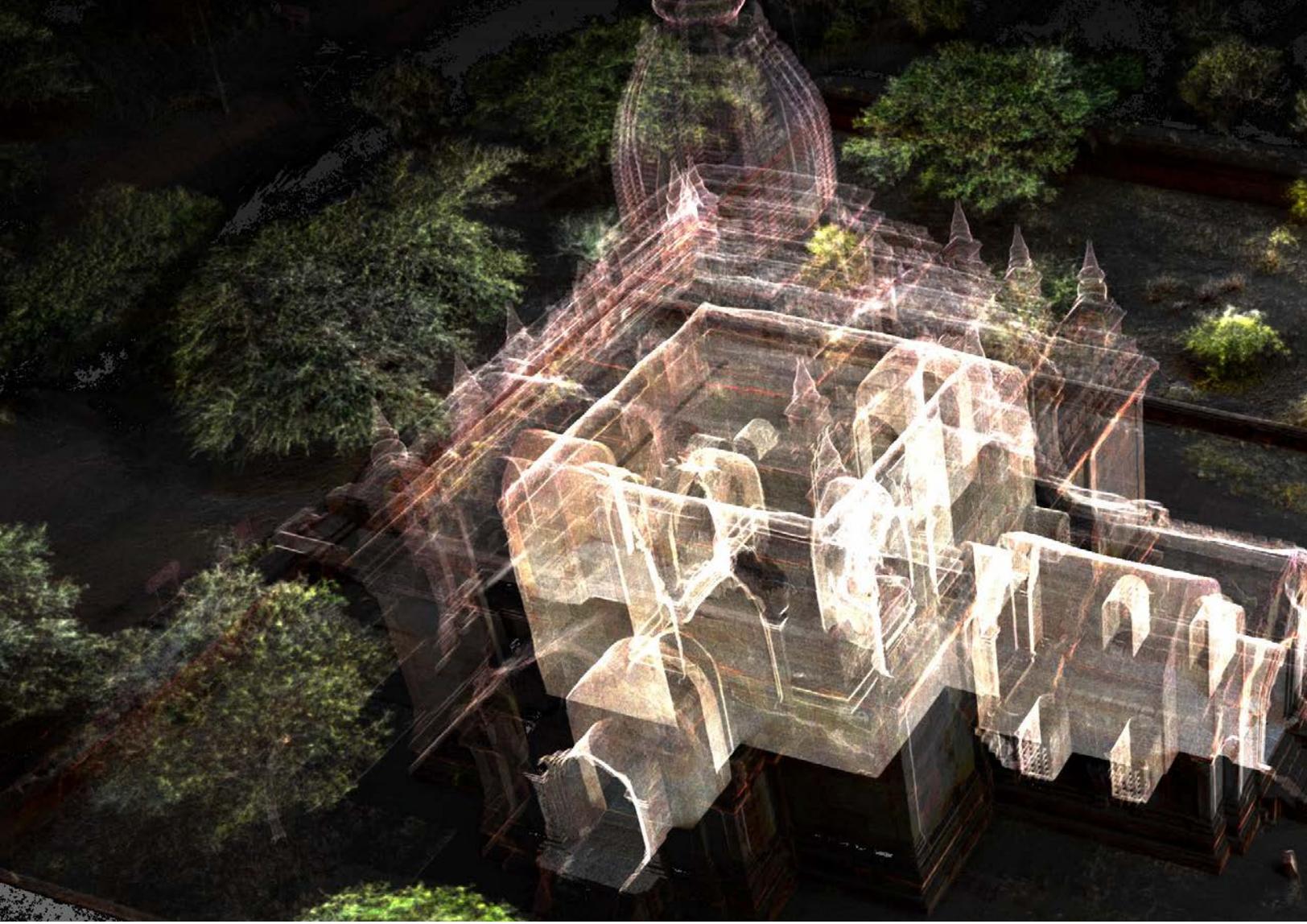
A field coordinator can link his/her tablet to multiple or field operators can link their scanners and thus continuously track the status of the entire project.



Multi-Tablet Mode

Alternatively, each team can work with their own tablet and merge the data, whenever in Wifi range of the other team's scanner.





Results

For the spatial documentation of Bagan, Myanmar, results were generated in 2D as well as 3D format.

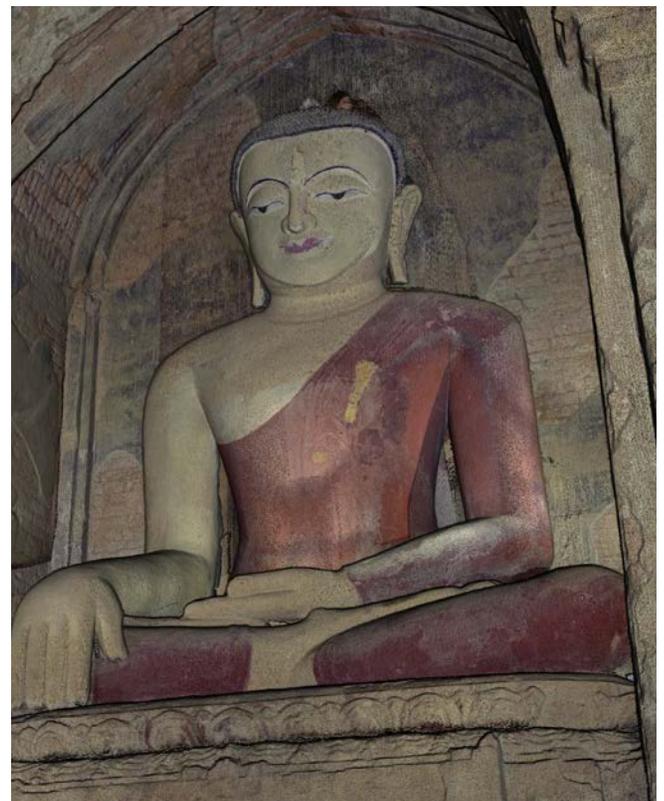
From the collected 3D data, meshed and textured 3D models are generated. These models form the basis for detailed ground plans, sections and elevations as well as virtual tours. The results serve to document and contribute to the preservation of this unique cultural heritage site for future generations.

The Zamani team used the opportunity to train staff of Department of Archaeology and National Museum (DoA) within the Ministry of Religious Affairs and Culture in the use of laser scanning equipment in the field.

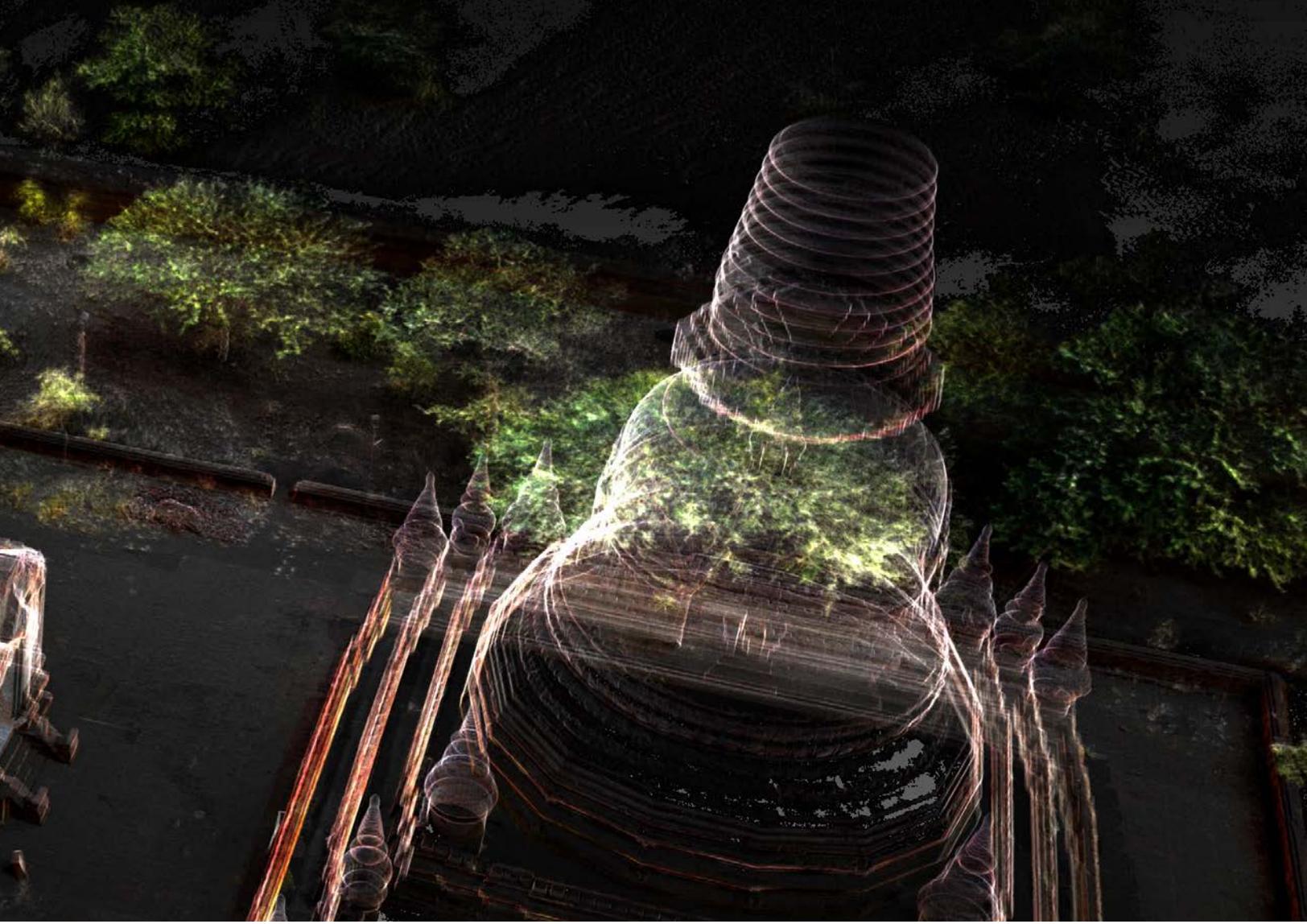
Also Zoller + Fröhlich gained a lot of useful experiences in the course of this project and would like to thank all the project partners.



Panorama of Sula-mani-hu-hpaya Bagan, Myanmar, Z+F IMAGER® 5016



Colourized 3D point cloud inside the Tha-peik-hmauk-gu-hpaya, illuminated with the integrated Smartlight of the Z+F MAGER® 5016



Transparent rendering of the 3D point cloud of the Sein-nyet-ama temple in Bagan, Myanmar, captured with the Z+F IMAGER® 5016



Close-up view of the 3D model of the monument Sein-nyet-nyima



Colourized 3D point cloud of the Sein-nyet-nyima temple



Top view 3D point cloud



3D model of Sula-mani-hu-hpaya temple



Head office - Germany
Zoller + Fröhlich GmbH
Simoniusstrasse 22
88239 Wangen im Allgäu
Germany

Phone: +49 7522 9308-0
Fax: +49 7522 9308-252

www.zofre.de
info@zofre.de

Subsidiary - UK

ZF UK Laser Limited
9 Avocado Court
Commerce Way
Trafford Park
Manchester M17 1HW
Großbritannien

Phone: +44 161 8717 050
Fax: +44 161 3125 063

www.zf-uk.com
info@zf-uk.com

Subsidiary - USA

Z+F USA, Inc.
700 Old Pond Road
Suite 606
Bridgeville, PA 15017
USA

Phone: +1 412 257 8575
Fax: +1 412 257 8576

www.zf-usa.com
info@zf-usa.com