Welcome to the ZEB REVOlution

by Stuart Cadge

In this article we will introduce the ZEB-REVO, and the attributes that make this a unique piece of surveying hardware. We will discuss how the ZEB-REVO is shaking up the surveying market, and will look at a number of industry applications in which the ZEB-REVO is making a difference.

Fig. 1 - The ZEB-REVO in action – handheld, pole-mounted, backpack-mounted – a truly versatile tool.

The surveying industry has witnessed rapid changes in the last few years - the increased use of mobile surveying devices and the utilisation of LiDAR technology (*Light Detection And Ranging*) to produce 3-dimensional point clouds of the survey subject are two such examples. Another major shift is the mapping of indoor spaces, utilising technology that does not rely on GPS.
Leading the fore in all of these technologies is GeoSLAM, a young, vibrant technology company based in the UK.

GeoSLAM specialises in the manufacture and supply of indoor, handheld mobile surveying units; the ZEB1 and the new ZEB-REVO, launched in March 2016.

Strong Beginnings

GeoSLAM was founded in 2012 as a joint venture between CSIRO (Australia's National Science Agency and the inventors of WiFi) and 3D Laser Mapping (a leading global provider of 3D LIDAR solutions). Coming from such strong pedigree has allowed GeoSLAM to grow rapidly in both range and scope, currently incorporating a global distribution network of 35 agents across 6 continents.
GeoSLAM launched their first mobile scanner, the ZEB1, in Q4 of 2013. With its spring-mounted head and nodding movement, the ZEB1 quickly gained notoriety and popularity. Early adopters were amazed by the speed of scanning, the ease of use and the quality of the results. Data processing was also a simple process – customers simply 'drag and drop' their raw datasets onto an online Uploader, in order to register and process their scan. In a matter of minutes, fully-registered 3D point clouds were obtained.
However, GeoSLAM did not rest on their laurels. The technology industry moves quickly, and GeoSLAM knew that a second, more sophisticated solution was required. ZEB1 customers spoke of their desire for a truly-mobile scanner – one that wasn't just handheld. They also wanted a fuller, more even point cloud that the 40Hz ZEB1 could produce. When the customers spoke, GeoSLAM listened.

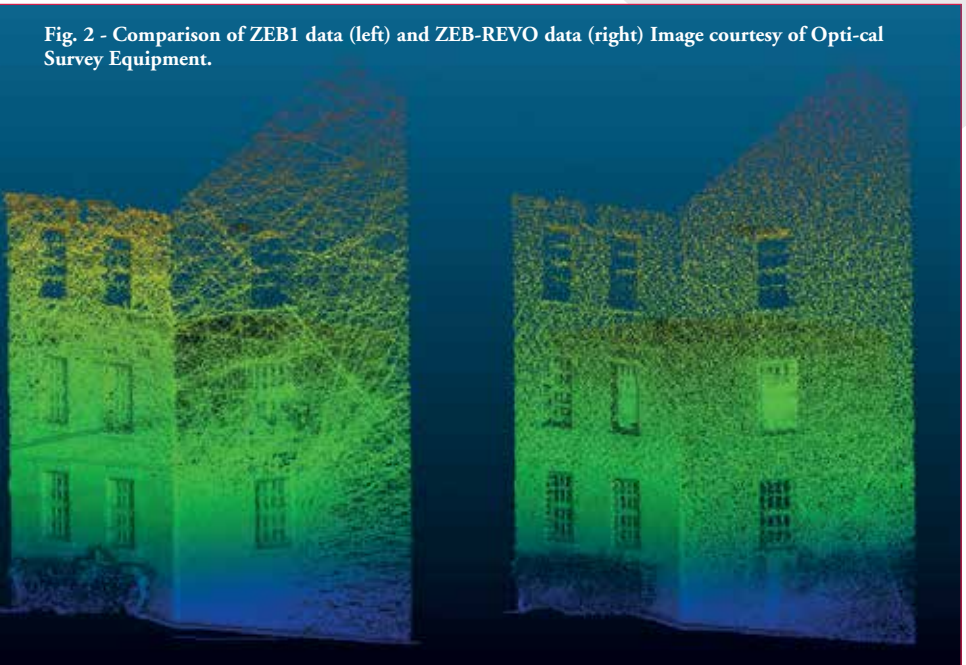

Fig. 2 - Comparison of ZEB1 data (left) and ZEB-REVO data (right) Image courtesy of Opti-cal Survey Equipment.

The REVOlution Begins

In March 2016, the ZEB-REVO was launched. Featuring an in-built motor to create 360° rotation, the REVO can, like the ZEB1, be handheld. However, it can also be mounted onto an extending pole, fastened to a backpack, secured to a trolley or vehicle, even strapped to a UAV for aerial surveys.

Fig. 3 - Building surveys (such as this family-sized home) are completed in minutes, not hours, with the ZEB-REVO.

The autonomous motion of the motorised scan head opens up a world of new applications for this clever little scanner. Little being the operative word; weighing just over 4kg (including the backpack) and with the scanner head measuring 9 x 11 x 29cm, this is a surveying tool that is truly mobile.

It's not just the outside that has evolved – inside the scanner head is a powerful yet safe (Class 1 Eye safe) 100Hz laser – making an impressive 100 rotations/second. The unit collects the same number of points per second as the ZEB1 – 43,200. So what's the advantage of this faster speed?

The increased scan speed (over 2.5 times faster than the ZEB1) means that the collected data points are spread out more evenly over a greater number of scan lines - giving the appearance of smoother, cleaner and less noisy datasets. More importantly, this even distribution of points allows the world-beating SLAM algorithm to work better. The SLAM algorithm works by dividing the scanned surface into sectors, and identifying points within each sector. If a sector is devoid of points, then it cannot be included in the algorithm. So, by having a more even distribution of points, the SLAM algorithm can build a fuller, more complete point cloud.

The difference is clear to see. Compare the two images below of the same elevation. The view on the left is ZEB1 data, which is characterised by a striated, lined appearance. There are a few gaps, especially higher up the elevation where the scan lines have hit the elevation at a more acute angle.

The right hand view is the same elevation captured with a ZEB-REVO. The point cloud is cleaner and the points are more evenly distributed – creating a much more 'complete' looking point cloud. Not only does this provide better results, it also supplies the user with vitally important confidence in the kit.

Versatility in Action

The upshot of these technological advances is the sheer number of new applications and industries that are now open to scanning with the ZEB-REVO. Whether it is simply improving an existing workflow of the ZEB1 (i.e. stockpile surveys and building scans) or opening up brand new uses (i.e. manhole and suspended ceilings, utility trenches) versatility is the word for the ZEB-REVO. A number of these new and improved applications are featured below.

Building Surveys

Building surveys have long been the 'bread and butter' work of the ZEB1 – the simplicity, ease of use, highly mobile nature of the unit lends it perfectly to multi-level, indoor structures. The ZEB-REVO has simply improved and built upon this success.

The increased scan speed creates a fuller, more complete point cloud, reducing the number of areas with low coverage. The ability to rapidly unscrew the handle and attach an extending pole allows the user to reach into spaces that may not otherwise have been available – into loft spaces, suspended ceilings, even to 'poke' the unit out of windows in order to obtain overlaps with the building exterior.

Underground Mapping

Another staple of the ZEB1, underground mapping includes both mine and cave surveys. Similarly to buildings, under-

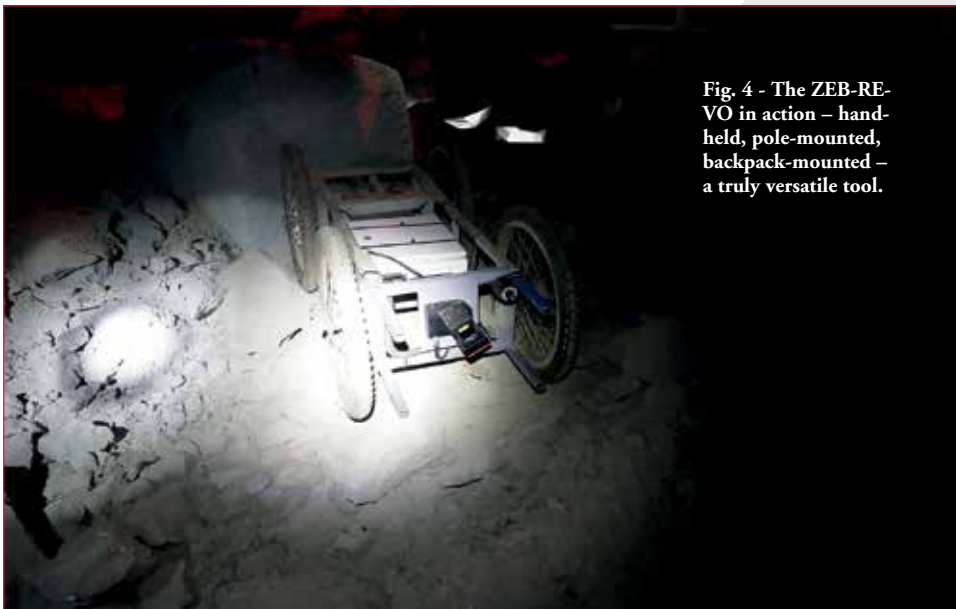

Fig. 4 - The ZEB-REVO in action – handheld, pole-mounted, backpack-mounted – a truly versatile tool.

ground is the perfect environment for ZEB systems, being devoid of GPS, totally enclosed, and often with many unique features for the SLAM algorithm to work with. Not only have ZEB systems been proven to increase survey quality and detail (over traditional survey methods), they have also slashed survey times by a factor of 3.
A major advantage of the ZEB-REVO in these environments is safety – and the ability for the REVO to access areas that human users cannot. The autonomous nature of the ZEB-REVO allows the unit to be attached to a remote-controlled trolley system and sent into areas that are either too small to access, or that are hazardous to health. The image shows the ZEB-REVO head mounted onto the front of a remote-controlled trolley in a mine. The datalogger sits just behind the head in the body of the trolley. The trolley was sent into a restricted area of the mine that was inaccessible to people, allowed to scan, and returned to its starting position.

Stockpiles
Another area of application where both the ZEB1 and ZEB-REVO excel. With these mobile scanning units, stockpiles of all varieties can be surveyed in a matter of minutes. The survey data can then be easily imported into a variety of third party software packages, where volumetric calculations can be carried out in minutes. The advantages of the REVO in this application are complete coverage and continuous scanning. A potential pitfall of using the ZEB1 for stockpile scanning was the chance that areas would be missed, especially the very top of the pile. It is not advisable to walk on the stockpile for obvious safety reasons. Therefore, a pole-mounted ZEB-REVO can be utilised to ensure that complete coverage of the stockpile is obtained, allowing for a complete point cloud model, and therefore, a more accurate volume calculation. The second major advantage is the ability to simply wall-mount the unit. For many stockpile applications (and particularly for indoor stockpiles), continuous analysis of the stockpile is required. With a remotely operated, wall-mounted unit, this is now a reality. It is simply a case for the unit to be switched on when a survey is required, and the autonomous motion will carry out the scan. The 360° vertical by 270o horizontal field of view (i.e. just a 90o blind spot to the rear) ensures that no parts of the pile are missed..

Marine
A rather newer application for the ZEB systems is in the world of marine surveying. Anybody who has been on a marine vessel will know that space is at a premium; this is even more so when it comes to submarine vessels.
A number of marine authorities and businesses have a requirement to accurately but rapidly survey their stock, either for the purposes of creating 2-dimensional blueprints, or for the creation of 3-dimensional, fully interactive models.
Both the ZEB1 and the ZEB-REVO can be rapidly deployed in a marine environment, and used to create a 3-dimensional point cloud of these hugely complex environments.

Forestry
Thought that ZEB units were for indoor use only? Think again. The ZEB1 and ZEB-REVO work best in 'enclosed' environments – not necessarily just indoor ones. A typical forest will naturally be considered to be an 'enclosed' environment by the unit, as the tree canopy creates a natural 'ceiling'.
Coupled with the proliferation of unique features that a forest holds, and it can be seen that forests are the perfect environment for ZEB scanners.
Over the summer of 2016, a number of different forestry studies are being carried out using the ZEB-REVO scanner. The first of these studies, carried out by the Geography department of University College London (UCL), focussed on measuring small deformations in the ground topography of a mechanically-harvested area of forestry.

Fig. 5 - Stockpile scanning is made simple with the pole-mounted ZEB-REVO.

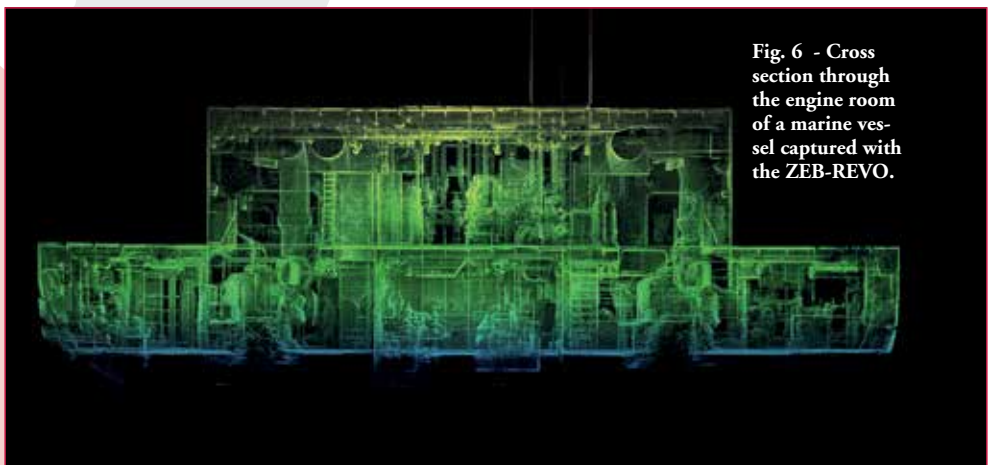

Fig. 6 - Cross section through the engine room of a marine vessel captured with the ZEB-REVO.

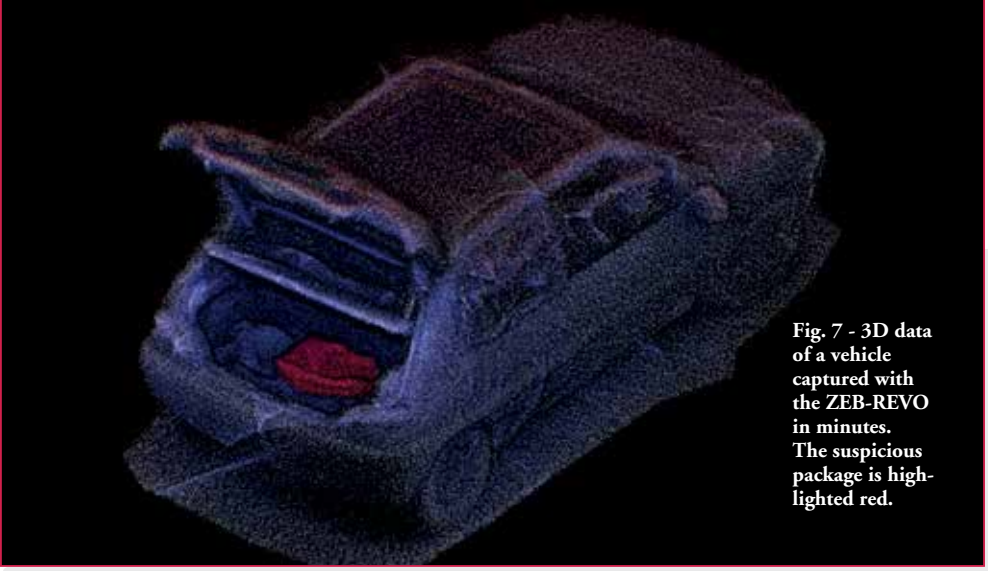

Fig. 7 - 3D data of a vehicle captured with the ZEB-REVO in minutes. The suspicious package is highlighted red.

From the data collected, the team were able to create a cm-accurate digital elevation model (DEM) spanning 100s of square metres. This data is then being used to measure the outputs of methane (CH_4) from these areas of felled forestry.
Another study, conducted in relation with the University of Leicester, involves the mapping of varying forestry habitats across the UK. The aim of this study is to make comparisons between different forestry habitats across the UK, and also to combine the data captured with the handheld ZEB-REVO with data captured from above, using spaceborne-rader and UAV-based imagery.
On a simpler note, both ZEB units can be utilised to rapidly and accurately scan an area of forestry, to obtain the point cloud data, and to make cuts or sections in the data at certain heights. One such important height is the breast height diameter (BHD), which is a measurement taken at 4.5 foot from the ground. This measurement is then used to create an estimate for the biomass of the area of forestry in question.

Security and Contingency Mapping

A final and possibly unexpected use for both ZEB units is in the ever-growing realm of security. In an increasingly uncertain world, governments, police forces, security agencies and indeed even companies are increasingly security-conscious and are turning to new technologies to increase their security. ZEB1 units have been in use by a number of police forces since their launch in 2013. Their speed, ease of use and high mobility make them the perfect tool for capturing the details of a crime scene, accident scene, or for mapping a building or site of interest. In the case where speed is of the essence (for example, after a RTC on a major road) the ZEB unit can be deployed in seconds, with a scan complete in a few minutes. This allows for a fully 3 dimensional image, accurate to within a few centimetres, to be gained.
The development of the autonomous ZEB-REVO has obvious benefits in these areas. In the case of a crime scene, the pole-mounted ZEB-REVO may be deployed, to ensure that areas of interest are not touched or disturbed.
Where there is a risk to human health (for example, a bomb threat, or an unsecure building), the REVO can be trolley mounted (as in mining) and sent in alone to scan the area of interest.
It is our prediction that the realms of security and reconnaissance, there will be increasing demand for this type of rapid, mobile, versatile surveying tools.

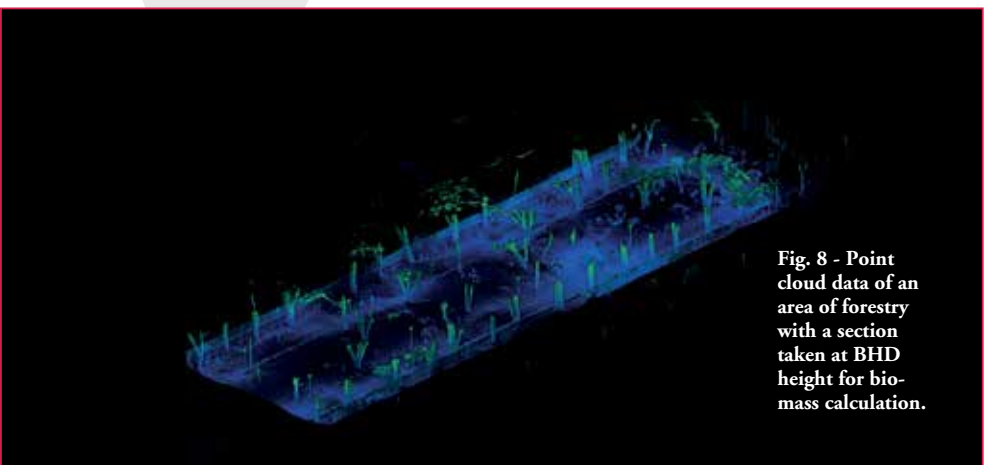

Fig. 8 - Point cloud data of an area of forestry with a section taken at BHD height for biomass calculation.

The Future

So what does the future hold for GeoSLAM? In a rapidly growing, rapidly changing industry, standing still is quite simply not an option. GeoSLAM will continue to respond to new challenges, new technological developments, and to identify new areas of application. Be sure to pay attention to forthcoming GeoSLAM announcements, to hear more about these highly exciting developments in the pipeline.

KEYWORDS
GeoSLAM; ZEB-REVO; scan

ABSTRACT
GeoSLAM is a manufacturer and supplier of handheld, 3D mobile mapping systems. Founded in 2012 and headquartered in the UK, GeoSLAM now has a global distribution network of 35 distributors across six continents.

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