A nostalgic look at 3D laser scanning

Allan Hosking

It all started around the millennium. You remember, the Y2K bug, the doomsday scare mongering. It was great if you were into the business of writing software. At that time I was based in Singapore working for a survey equipment supplier. The work was varied and covered projects all over south east Asia for both marine and land. There was lots of travel for someone single, footloose and fancy free.

It was during a discussion with an important customer in the opencast mining industry that I first heard of 3D laser scanning. They had just purchased one and were getting to grips with its operation and processing.

But hang on, how could this be? I was their survey equipment supplier but they had not discussed this important decision with me. Perhaps it had something to do with them being up the side of an 6,000 metre mountain in the back blocks of Irian Jaya. The air was quite thin and cold up there with a glacier curving down from the peak of the mountain. This was bizarre considering that at sea level, only 40 kilometres away, it was a tropical 32°C.

So it was time for a lot of professional development and getting up to speed with this new technology. I had no idea what it was, but I was soon to find out.

Laser scanning in the early days

A few months later we were the proud owners of a shiny new Mensi S25 3D laser scanner and the company bank account was Singapore dollars $250,000 lighter. It was a major investment, with me being the unlucky one chosen to make sure it made a successful return on investment.

Such a high investment required a high return. To do this we had to approach the large companies involved in oil and gas or shipbuilding. These firms had big budgets with big problems that needed to be solved. Survey fees of six figures hardly raised an eyebrow.

The equipment was portable if you had a mini van and one or two assistants to help carry all the gear. The equipment was spread over two very large flight cases with each weighing between 30 and 40 kilograms.

The logistics of getting the equipment to and from a site was often a nightmare. The site could be several hundred kilometres out to sea requiring a bumpy supply vessel ride to get it there. At other times it could be several stories of stairs into the bowels of an oil tanker's engine room.

Limitations of the first models

Power supply was always an issue. 3D scanners consumed large amounts of power and rechargeable batteries were not an option. A mains power supply or a portable generator were the only options. Programming and controlling the instrument as well as recording, was all done by a separate dedicated industrial computer. Standard off the shelf notebooks were not suitable in those days.

Another issue was sunlight. The Mensi S25 measured by triangulation. The instrument was shaped like a cylinder approximately a metre long. At one end of the cylinder was a laser which shone continuously and moved in a grid fashion over the work area. At the other end of the cylinder was a camera which tracked the laser spot moving over the work area. Every 3D point measured was an intersection of the laser and camera axis. It is simple in theory and very accurate over short distances of up to 20 metres. The limitation was that outdoors in daylight on a sunny day it would not measure as the camera could not see the laser spot. Work outdoors was restricted to night time or very overcast days. It had a 360 degree field of view for measurement by the cylinder rotating. However it was all worth it. Once set up on site it would measure an astonishing 100 3D points per second.

Major brand differences

Before making such a large investment we researched the market as thoroughly as we could. Mensi was a French government backed company which had developed the technology for decommissioning nuclear power plants. The instrument could be operated remotely via an RS422 cable several hundred metres long. This allowed the operator to suit up and enter the hazardous area to position the instrument, then retreat to a safe zone feeding out the cable as they went. Accurate and detailed surveys could be carried out, while at the same time limiting the exposure time of the survey personnel.

There were several other manufacturers of 3D laser scanners at this time. Cyra in California, Riegl in Austria, Callidus, IQvolution and Z&F in Germany were the major brands. Something they all had in common was their bulky size and weight, but they all varied significantly in other ways.

Cyra had a measurement method based on time of flight. This method sent out a pulse of laser and based on the time of flight and the direction the laser went out on, it could calculate the 3D point. Measurement speeds of several hundred 3D points a second were achieved. However the field of view for measurement was very limited. This meant a lot of setups were required to cover a work area. Office processing to register or stitch all the individual scans together was time consuming.

Riegl in Austria also used a measurement method of time of flight and were the leaders in this area at this time. They specialised in long range units which were ideal for opencast mining and specialist military applications. Callidus in Germany also used time of flight, but their 3D scanners had a very short range of measurement combined with a nice panoramic field of view.

Noise in the data was an issue with these early generation time of flight systems. Noise in simple terms is a blurring of the data around objects of interest. It affects areas of small detail like bolts on a flange. For example when trying to measure or model the bolt from the data back in the office it will be difficult to distinguish the exact shape, size and position of the bolt.

IQvolution and Z&F in Germany used a measurement method based on phase shift. The advantage of this method was very fast acquisition, with rates of up to 50,000 3D points a second possible. The downside was that the data was often very noisy and it would often refuse to measure to certain surface textures and colours. At the time the computer power struggled to cope with the huge data processing required.

Rapid development

Surprisingly none of the major survey equipment manufacturers were involved in these early days. Development of a 3D laser scanner takes several years and tens of millions of dollars.

The problem with the survey equipment manufacturers at the time was that they were all small, niche companies with very specialist skills. They had developed the technology for very specific


Tunnels in Ireland

applications based upon customer requests such as nuclear power, oil and gas, military, and manufacturing etc.

They often lacked the resources to adequately distribute, train and support their products to a worldwide market. To develop the products for a wider market with better distribution and support networks worldwide, an amalgamation with a larger company was required.

A monopoly game began. Leica purchased Cyra in California, and also establishing a reseller agreement with Z&F in Germany. Trimble purchased Mensi and has a reseller agreement with Callidus. Faro purchased IQvolution to incorporate with their industrial metrology measurement systems. This allowed the rapid development of the 3D laser scanning technology with solid research and development, distribution and support networks through the larger corporations.

Present day solutions

During the past 10 years I have been actively involved with 3D laser scanning technology, and it has developed at a phenomenal pace. It has quickly gone from a relatively unknown technology to an


Canal project Liverpool, England

Dock wall Birkenhead, England

everyday survey tool in the United States of America, Europe and United Kingdom as well as many other countries worldwide.

The latest 3D laser scanners are very portable and light, often weighing no more than a conventional total station. Rechargeable power supplies are now built in to the instruments, with a spare battery to ensure all day operation. Operating, programming and recording the data is all achieved via an onboard display panel.

The modern 3D laser scanners also have high resolution colour cameras to record images of the work area. Every 3D point has the real world colour applied to it from camera information. The speed of these instruments is incredible, recording just below a million 3D points a second. A far cry from the 100 points a second that could be recorded a short 10 years before. Transferring the huge datasets to an office computer is a breeze now and takes only a few minutes via SD memory cards.

Justifying its use

The return on investment is still a big issue. Although the instruments are built to last as long as any other survey instrument, it is unlikely they are economical to use after two or three years of ownership. The latest 3D laser scanners can complete a project in half the time of previous models of only two or three years ago. A company owning an older generation scanner will never be able to compete in time or price with companies using the latest scanners. The pressure to always upgrade the instrument to the latest model is very real.

In addition, the cost of ownership each year is significant with service and annual calibration and maintenance contracts not giving much change out of $10,000. Due to the specialised nature of the instruments and the calibration process, each manufacturer normally has only one or two calibration centres available worldwide. Having an adequate support agreement with the manufacturer for a loan unit while your instrument is away for several weeks for service and calibration each year is essential.

Just another survey tool

Even with such significant financial investment required to purchase equipment and software, and with rapid depreciation, purchasing 3D laser scanners is still a very appealing idea for many survey companies worldwide. In the six years I was based in the United Kingdom from 2004 to 2010, I saw 3D laser scanners become a survey tool that a majority of survey companies used either by owning their own or renting.

Now 3D laser scanners are just another survey tool. Projects should be priced to use the most efficient survey tool at their disposal whether that is a 3D laser scanner, GPS system, total station or the humble tape measure.

For example if a client requests a survey to generate floor plans of an office block and some external elevations of the building, the job priced could be the equivalent of three days of fieldwork using a total station. The same job can be completed with the latest 3D laser scanner in one day. Even though the day rate for survey using a 3D laser scanner would be significantly higher, the overall survey fee for the project would be substantially lower than that for undertaking the survey by total station.

The surveyor has then completed the survey in the quickest and most cost effective manner for the client without having to cut into the profit margins for the survey to win the job. In these tough economic times it is more important than ever to drive ahead using the latest survey technology that provides true time and cost savings to survey companies and their clients.

The future

Without doubt, the trend of continual improvement in technical performance of 3D laser scanners will continue. It is unlikely there will be much further reduction in size of 3D laser scanners in the near future, as the smallest units weigh five kilograms including battery and display. This is comparable to the smallest total stations currently sold.

The room for biggest improvement in the future is around price. The cost of the equipment alone is currently between $100,000 and $150,000 depending on the model chosen. On top of this, a variety of expensive software is required. Making a good return on the investment of a 3D laser scanner is tough for many companies worldwide.

The economic downturn has had an effect. In countries such as the United States of America, the United Kingdom and across Europe where the majority of the survey companies now own or rent a laser scanner, the rates for providing surveying services has plummeted. Lowering survey fees may keep the equipment and staff working in the short term, but in the long term lowering fees is not healthy or sustainable for business. The lack of profits or return on investment will mean the cycle of upgrading the equipment to maintain competitiveness will be broken. Eventually such a company would have to retire from 3D laser scanning without adequate returns to justify the reinvestment.

3D laser scanning is challenging and rewarding with a bright future assured. Although there are only a few companies in New Zealand currently offering the survey service, this will change over the years. As skilled workers from overseas migrate to New Zealand for short and long term contracts they will bring with them the knowledge and skills developed overseas on the use and benefits of 3D laser scanning on projects.

Allan Hosking obtained a Batchelor BSurv from Otago University, graduating in 1989. A further three years work experience with RPC Ltd in Whakatane lead to registration as a professional surveyor in 1993. Allan began his overseas experience in 1993. During the next three years he worked for the Ministry of Housing in Bahrain in the Middle East. Moving to Singapore in 1997, he then worked for seven years for Hydronav Services on projects all over South East Asia. In 2004 Allan relocated to England to work for Survey Supplies, one of the largest Trimble distributors in the world. In 2006 he began his own survey company and operated this in England for four years. In 2010 Allan relocated to Tauranga in New Zealand where today he operates his business Survey Solutions.