3D laser scanning software and point cloud registration – a comprehensive guide
3D laser scanners are powerful instruments capable of mapping 3D space in exacting detail. This kind of reality capture delivers huge advantages for all kinds of construction, surveying and engineering projects. Within each of these sectors, laser scanners are a major contributing force to the ongoing trend of digital transformation.

The disruptions caused by reality capture technology, laser scanners specifically, have been a focus of much discussion around the surveying industry. What is less prominent is the quiet revolution within survey technology behind these broader use cases.

Scanning hardware has become far more robust over the last decade — delivering reliable and standardised results. Transformations in the technology have resulted in widespread adoption and industry diversification. The widening and democratisation of this data capture tool has driven developments of laser scanning software away from being an exclusive venture of hardware vendors.

The guide below we hope will guide you through the choices available within the laser scanning software market.

It’s worth mentioning that the hardware choices you make impact the software you can use — and vice versa - along with the downstream modelling and visualisation software you will have available. Software choices impact the workflows you can create, how efficient your processes are, and the type of models and plans you can create. Ultimately, the choice of software will point you towards the jobs you can effectively take.

Our goal is to provide a guide for someone new to the industry as well as a valuable update for seasoned professionals. Up until now, many surveyors have focused heavily on their hardware choice and new developments in the market. Increasingly, this is the wrong priority. We are going to explain why and provide the context you need to make the best choice when it comes to your laser scanner software investments.
Before we move on, it is important to make sure everyone knows what we are talking about. If you understand the basics of LiDAR and point cloud processing — skip to the next section.

Laser scanners deploy a technique/technology known as LiDAR (Light Detection and Ranging), a term that also gets used to describe the laser scanners themselves, and the process of using them. LiDAR involves taking measurements from lasers to gauge the distances to objects. When scanning, millions of individual measurements are made per second. Together, these individual measured points are combined to create a ‘point cloud’: a geometrically correct collection of coordinated points in space.

To gain total scene coverage, you may need to occupy multiple scan positions to create a complete point cloud. These individual scans must then be stitched together with a high level of precision and accuracy in a process called point cloud registration, or point cloud alignment. Once you have a registered point cloud you can then begin the process of data extraction to create 3D models or visualisations based on that data.

Laser scanner software might focus on the ‘registration’ process, post-registration modelling, texturing or visualisation. Laser scanner software might also be considered to include the software that controls the scanner during scanning. Scanner control software is baked into the scanner, and basically comes down to a discussion about the scanner hardware used. Our focus will be on the downstream elements of turning raw laser scan data into usable information.

The basics: what is laser scanning software anyway?
Laser scanner software categories

When it comes to laser scanner software there are many packages available. All use different methods and approaches in processing the scanned data. There are registration solutions rolled into end-to-end packages, providing access to modelling and visualisation tools in one place. Conversely, there are tools that focus on each one of these stages individually.

There are two main categories: software introduced by laser scanner manufacturers specifically for their own devices; and software built from the ground up to work with many compatible file format outputs. Then there are a number of choices based around cloud compatibility and the approach taken to deliver registration.

You used to need software that "understood" the scanner — there were issues that only the manufacturers knew about and you had to deploy a solution which took into account those eccentricities. Now, the hardware is much more stable and robust, making hardware agnostic solutions a viable option and allowing for the development of solutions tailored specifically to your needs — not the hardware.

1. Registration Software

Registration is the first step involved in point cloud processing and 3D model generation. This stage is crucial to the quality of the final products since registration errors, if not mitigated and dealt with correctly, can easily propagate and multiply further down the process.

Registration software historically relied on the placement of physical ‘registration targets’. These physical objects were placed in the field of view of the laser scanner hardware; scan pairs are then created in the registration software. With advancements in computer processing power development has focused on utilising a 'cloud-to-cloud' approach where specialist algorithms find patterns in natural features within a scene. Typically now a combination approach is applied; this also enables cloud-to-cloud-alignments to be translated onto real-world or local-grid coordinates.

Traditional registration software has struggled with the rapid alignment of targetless scans; multiple manual cross-checks and significant scan overlap are required to deliver robust results. Both these processes are time-consuming and resource hungry. Modern techniques, by comparison, can employ multi-stage, vector-based algorithms which are able to automate a process that is already 40%-80% faster than traditional methods.

So, registering 3D scan data (scans) can be relatively easy or extremely difficult. But it’s not as simple as just learning the software or learning how to get the best out of the scanner in field operations to make the registration go well. Rather, it’s a combination of the two. Solving the problem requires clear communication in both the field and the office, especially if more than one person is involved in the process. This is also one of the areas which can be addressed by in-field, cloud-enabled registration — something we will outline later.

2. Visualisation and Modelling Software

The term 3D visualisation is used synonymously with 3D graphics, 3D rendering, computer-generated imagery (CGI), and other terms. They all basically refer to the process by which graphical content is created using 3D software. It’s a technology that has become mainstream over the last few decades and has evolved into one of the most viable options for producing high-quality digital content.

However, there are some common misconceptions regarding the terminology. 3D visualisation is the creation of realistic 2D images of modelled 3D objects. It’s much like taking a photograph of a model from a chosen viewpoint in a particular setting with the desired lighting. It can also be used to describe the processes of adding ‘visuals’ to a 3D model. Either way, it is not the same as 3D modelling.

3D modelling is a far more precise process (also called 3D design or 3D development) in which scale-accurate objects are created that can be used to form manufacturing plans, or used to digitally test objects in simulators. This is generally carried out using computer-aided design (CAD) files, which are created by engineers or industrial designers and intended for modelling or manufacturing.

You can, of course, use CAD files to develop 3D visualisations. This combines both the technical precision of CAD with the dynamic artistry of visualisations — creating rich visualisations that can often be viewed and manipulated in a wide number of ways by both specialists and end users.
Laser scanners in the cloud: registration, modelling and visualisation

When it comes to every type of software discussed so far, there is potential for cloud-enabled versions of the solutions so far grounded in on-premise hardware. Cloud-enablement is a more recent development and not all vendors have yet managed to provide viable cloud versions of their PC-based software.

One of the limiting factors in going to the cloud was seen to be the time taken to upload data sets produced by laser scanners. However, increases in fibre bandwidth and mobile connection speeds and availability have changed this.

The amount of data being captured and recorded by scanners is ever-growing. The large data sets that made cloud access a problem are the exact same reason that access to the cloud now is so valuable. The cloud provides the possibility of aggregating data from distributed sites with “infinite” scalability, and that is exactly what you need to accommodate large project scan files and demanding application processes.

With cloud-based registration, a distributed network takes on the burden of the processing, removing the hardware limitations of any single computer or internet connection. Instead of spending budgets on individual workstations with heavy-duty hardware, users can use the cloud’s processing power to shoulder the load.

The cloud solution also allows for much easier sharing of project data — rather than physically transferring and downloading files between workstations, the cloud-based data can be shared securely with anyone, anywhere. This improves collaborative capabilities, allows for simple sharing of end deliverables, easy access to client feedback and iterative changes. Processing and modelling software can integrate directly with existing cloud storage, and provide opportunities for customisation and even redesign of existing workflows.
Common point cloud registration software

With the basics out of the way, it's time to look at some real-world solutions. We are going to focus on registration software. This is for three reasons:

1. When it comes to laser scanner software, everything starts with registration. Particularly when it comes to modelling, you need an accurately registered point cloud to produce a viable outcome.

2. Point cloud registration is one of the most time consuming and technical aspects in creating any deliverable based on a laser scanner data set.

3. The choices you make when it comes to registration software set you down a path in regards to all other software investments you make, and can impact the hardware you are able to use.

For the following leading products, we will provide a description of the software, what it is used for, what it is best at and, potentially, what it could be better at. This will help you better understand the products on offer and start your journey towards creating a software solution best suited to your laser scanning needs.

We've split the suppliers into Hardware Vendor Suppliers and Independent Vendor Neutral Suppliers; with eight products in review. We could have added many more, but this will give you a pretty comprehensive guide to what is on offer.

**Faro Scene**

Faro offers a range of popular and widely used laser scanners, some of which are generalists, while others are focused on specific use cases. The company offers its own processing software (Faro Scene), but their scanners do pair easily with third-party options. The versatility and relative affordability of their hardware is one reason for Faro's popularity. Combined with the small size, fast scan speed, ease of use, and often multi-purpose capabilities, Faro scanners have long been the staple startup scanner of the surveying community.

Faro has a large number of scanners and modelling tools built to aid automated manufacturing processes. In the surveying and mapping community, the company might be better known for their hardware than software, but still offer a solution used by many in the industry.

**Software**

Scene software is specifically designed for the Focus scanner line. However, it is compatible with a range of third-party scanners. Once the point clouds are registered, users can perform simple measurements, create 3D visualisations and export to various point cloud and CAD formats. In addition, Scene features a Virtual Reality View, allowing users to experience and evaluate captured data in the VR environment.

**Features**

Scene features on-site registration, automatic object recognition, scan registration, and positioning. The software benchmarks an ability to register 40 (typical) scans per hour on a 12 core machine. It can also generate high-quality data in full colour by incorporating images from automated targetless and target-based scan positioning. Faro can run in the office on higher powered machines, or run off a tablet in the field, giving the ability to start an auto-registration of the scans as soon as they are captured.

**Cloud Capabilities**

Faro enables visualisation sharing and collaboration with Scene WebShare Cloud: a hosted web-based service for secure sharing of scan project data. The company also offers iPad/Surface access to the same functionality as Webshare Cloud including a novel virtual joystick for moving around the visualisation.

**User Interface**

Faro Scene has two user interfaces. One is its legacy and workflow-oriented interface, while the other is updated for increased usability by inexperienced users. These are known by Faro as Current and Classic UIs. Like a couple of other solutions on this list, inconsistencies on how things are done might potentially increase the learning curve and make it challenging for some users to get everything they need out of the software. On the other hand, two versions do allow existing users to build on their existing knowledge and experience of the software and new users to experience an updated UI.

**Import/Export Formats**

Import: fls, e57, ptz, ptx, ascii xyz

Export: cpe, e57, vrml, dxf, xyz text and binary, iges, fls, pts, ptx, pod

(source User Manual 2019)
LZ + F Laser Control

Zoller + Fröhlich are one of the leading suppliers of terrestrial and mobile laser scanners. Their 2D laser scanners are utilised as mobile mapping systems and the 3D laser scanners for terrestrial surveying. They are at the premium end of the market but their superb data quality has led to worldwide adoption in precise engineering, heavy industry, forensics, archaeology and construction.

Z+F offers a range of 3D laser scanning systems; the newest model on the market - the Imager 5016 - is a compact, fast, highly accurate system with integrated HDR camera. Many customers choose the Z+F brand due to the quality of the data and the HDR imagery. Z+F also manufactures the world’s only intrinsically safe 3D laser scanning system - the 5006EX - an ATEX rated scanner for use in sensitive and explosive environments.

Software
Z+F produces LaserControl to work with Zoller + Fröhlich laser scanners. There are two flavours of the software; LaserControl Office: licenced for use in the office, and also LaserControl Scout: licenced by the scanner for use in the field. Whilst the software is not exclusively for these scanners, again like Riegl they position the software as a companion for their scanners rather than a stand-alone product. Thanks to the export formats provided, data can be imported and further processed in most common 3D software applications.

Workflow
Z+F LaserControl Scout has been created specifically to register scans automatically on site. The software keeps a constant link to the scanner via wifi to a tablet. After a scan is complete, the data is synchronised to the tablet. If you choose, a full data set is downloaded onto the tablet PC automatically. Once completed, the software immediately attempts a preliminary registration. Should the automatic process fail, tools are provided for manual adjustments. Scout further provides a new tool for complex geometries to manually align scans quickly in 3D. The software is optimised for Windows touch tablets.

Features
The functionality of LaserControl is limited to Registration, Colourisation and Filtering in the main. There are some additional modular tools for specific Forensic applications however this has a small specific audience. Additional processing tools in terms of modelling capabilities are found in the LFM processing suite. Both LaserControl Office and Scout offer on-site registration through targets and cloud to cloud. Additional registration tools are available via the Scantra plugin to the Office platform. Imagery and thermal imagery can also be processed in both the main Office and Scout packages. Utilising Scout onsite will certainly speed up office processing; Scout enables both a full cloud to cloud registration and colourisation. The standard synchronisation of data from scanner to tablet will action this as soon as capture is complete.

Cloud Capabilities
Z+F LaserControl does not offer the same cloud based interactions as seen with Faro WebShare Cloud. However, data is synchronised from the scanner to a windows tablet; therefore with a 5G enabled device, it should be possible for the synchronisation location to either be cloud based or stream to a cloud location.

User Interface
Both LaserControl Office and LaserControl Scout have a similar graphical layout which can be icon rather than menu-driven. This enables easy transition of operation from one platform to another. There is a standard flow of actions required to ‘process’ raw data ready for use in a 3rd party drafting environment; Registration, Colourisation, Filtering and Export. Due to both the interface and the restricted functionality means that there is a short learning curve enabling easy adoption.

Import/Export Formats
Import: zfs, zfprj, zfi , zfc, sat, ptx , asc, txt, pts, ptg, e57, iv,v rml, wrl, jpg, png, bmp, gif, k, idx , las, osf, mpc, dp

Export:  zfs, zfprj, zfi , ptx ,asc, ,txt, pts, xyz.asc, pdf, ptg, e57 ,iv ,vrml, wrl, jpg, png, bmp, jpw , tiff , dxf, rcs, ,rcp, las, osf
Riegl RiSCAN

For long-range scanners, Riegl is really second to none. They dominate the aerial market and are used heavily in the mining sector. Whether or not range is a priority is one of the main decisions you should make if thinking about investing in top quality Riegl hardware. Their scanners are really powerful and accurate, they are also expensive. Generally speaking, the company leans more towards bespoke-type solutions. Their expense and low volumes allow them to build tailored customer solutions that are not offered by some of the other mass-market providers.

Software
RiScan PRO is described as the companion software for Riegl Terrestrial 3D Laser Scanner Systems - not as a product in its own right. The software is project-oriented, i.e., the data acquired during a measurement campaign is organised and stored in RiSCAN PRO's project structure. This data includes scans, fine scans, digital images, GPS data, coordinates of control points and tie points to transform the data of multiple scans into a common well-defined coordinate system.

Features
- Straightforward Global Registration
- Support of Photogrammetry Features
- Geodetic tools
- automatic filtering/registration
- multi-station adjustment
- colourisation of point clouds

Cloud Capabilities
RiScan does not have a cloud capability. However, RiPANO software is offered for visualisation of terrestrial laser scan projects. It allows CAD users to extract ortho views and plots for further use in CAD software. The software runs plugin-free in a browser or stand-alone on Windows or MacOS computer.

User Interface
RiScan is a mature product — now on Version 2.8. The User Interface has a Windows 95 feel to it and may seem daunting for new users. Existing users seem to like it and appreciate the usability enhancements that are regularly added.

Import/Export Formats
Import: 3pf, csv, dp, dtm, dxf, las, laz, mpc, obj, ply, pol, ptx/pts, rdbx,vtp
Export: 3pf, asc, csv, dm, dtm, dxf, e57, las, laz, obj, pod, pol, ptx/pts, rqx, stl, wrl

(source Data Sheet)
Leica Cyclone / Cyclone Register 360

Leica Geosystems is widely thought of as a ‘premium player’ in the surveying industry. They create high-quality products with a number of specialisations focusing on providing a complete end-to-end user solution. Rather than depending on third-party integrations, Leica encourages users of their scanners to rely on their in-house processing software. In fact, with the exception of a few limited partnerships, Leica scanners are only compatible with Leica processing software.

Leica stands out in the market because of their closed ecosystem. They deliver high-quality products, with limited software choices. There are benefits to this — compatibility guarantees, access to knowledgeable technical support that understands your software and hardware, and quality assurances. However, it means you are dependent on Leica to keep up with cutting edge solutions. The benefits of their closed environment has to be balanced; does the elimination of data compatibility headaches outweigh the potential frustrations of being ‘trapped’, particularly due to its modular nature costs can easily spiral.

Software
The Leica ‘Cyclone’ suite of software is focused on being a complete solution. The various Cyclone modules take users from start to finish for point cloud projects. These products support a range of industries and workflows including civil engineering, as-built 3D models, topographic surveys, BIM models and much more.

There are modules dedicated to generating deliverables from reports to maps and 3D models, movies/animations, and lightweight 3D data formats distributed over the web. One example of a Cyclone module is the Field 360 mobile-device app. This app links 3D data acquisition with the RTC360 laser scanner or BLK360 imaging laser scanner. On-site, the user can, via a tablet, automatically capture, register and examine scan and image data for subsequent processing if needed.

Leica’s registration software modules, Cyclone Register and the more recent Cyclone Register 360 can be used with third-party scanners, and exports point clouds that can be paired with different 3D modelling software. It also offers 3D modelling capabilities. Like Leica scanners, it is reckoned to be high-quality, accurate and robust.

Features
Cyclone Register 360 is a revamped modern version of Leica Cyclone Register. Cyclone Register is one of the oldest (and most revered) solutions on the market and would be the Leica tool of choice for large projects. Its large-project capability allows you to link together separate scan databases, to register small portions and then link those sub-projects together throughout the course of the job. Leica suggests no more than 500 scan worlds per registration in Register 360, so if you plan on clouds larger than this it would be better to go with Cyclone Register.

Register 360 was built from the ground up to be a multithreaded application, so depending on your hardware, the speed at which you complete registration may improve over Cyclone Register. Users of Cyclone Register tend to view Register 360 as a companion app to full Cyclone.

For visualisations, there is the option of Leica TruView software. TruView comes in several flavours depending on your needs. At its most basic level TruView Local is a free viewer add-on to Internet Explorer that lets you open and view Truview exports from your registration software. TruView Enterprise lets you host the files yourself on your own server and distribute them.

Cloud Capabilities
TruView Cloud lets users navigate a scene by panning, rotating and zooming. They can also add notes, markups, GeoTags and hyperlinks. TruView Cloud packages are purchased by the number of setup positions allowed. All new users purchase a base package of 250 scan positions and can buy additional positions in 250 or 500 scan position increments.

User Interface
Cyclone Register’s ageing interface and level of complexity may be a challenge to new users. But it is a powerful tool and may justify the investment in time to master it, especially if using Leica scanners.

Import/Export Formats
Import: e57, fls, frp, fws, ptg, ptx, zfc, zfprj, zfs.
Export: lgs, e57, pts, ptg, ptx, truview enterprise, truview cloud, jetstream

(source Register 360 DS)
Leica Cyclone / Cyclone Register 360

Trimble is a US leader in both point cloud processing software and hardware production. Founded in 1978, they have annual revenue nearing $3 billion. Trimble develops laser rangefinders, UAVs, inertial navigation systems and GNSS receivers. Their technology has a reputation for being fast, clean and consistent.

RealWorks provides a set of tools for processing 3D point clouds and 2D images. Generally, this processing can be divided into three modes: Registration, OfficeSurvey and Modeling.

In Registration, you can register scans with other scans and/or a set of survey points. The registration method is either target-based or cloud-based. In OfficeSurvey you can extract different types of 2D drawings (polylines, contours, cross-sections, profiles) from the point clouds. These extracted results can then be exported into CAD systems including, but not limited to, AutoCAD and MicroStation. In Modeling, you can create a geometry: Spheres, Planes, Cylinders, etc. The creation can be based on a point cloud selection (or not). The created geometry can then be duplicated, modified or moved.

All RealWorks products can support a large volume of points. They include tools for:

- managing Trimble FX data
- importing Trimble 3D scanning files (raw, jxl, tzs, tzf)
- creating scans
- extracting targets
- registering created stations
- creating sampled scans with spatial resolution
- converting to Trimble LASERGen format

Import/Export Formats

Import: e57, fls, frp, fws, ptg, ptx, zfc, zfprj, zfs.

Export: lgs, e57, pts, ptg, ptx, truview enterprise, truview cloud, jetstream

(source Register 360 DS)
Topcon Magnet Collage

Topcon is a Japanese company that has become a well-established name in the construction and geospatial industries. Topcon supplies a range of equipment to meet the demands of construction and geo-businesses.

Magnet is a suite of software and services created to plan, manage, and oversee projects, as well as track and manage assets. Topcon has partnerships with both Autodesk, for their BIM 360 offering and what seems to be a closer relationship with Bentley, linking Bentley ContextCapture with Magnet Collage. Topcon’s software provides data processing of disparate data sets into one 3D environment. It can accommodate laser scanner, mobile scanning and mapping, road resurfacing scanners, and photogrammetric point clouds.

Features

- Faster point cloud processing and mass data handling
- Combine Civil, Mapping, BIM, and survey data
- Advanced matching and ground control functionality for a variety of sensors
- Extensive projections and geoids exports
- Segment and reduce point clouds to facilitate import into third-party software
- All in one mass data processing software

Magnet Collage Web works with Magnet Collage so you can publish and share 3D datasets online. Features include:

- Web-based point cloud and mesh visualisation
- Measurement and annotation tools
- 3D, panorama, and map views with split-screen functionality
- Strategic partnership with Bentley to integrate Magnet Collage Web, with the Bentley ContextCapture Cloud Processing Service.
Laser scanners in the cloud: registration, modelling and visualisation

It isn’t uncommon for businesses to operate with multiple laser scanning hardware systems, and with so many systems on the market – each having their own set of application benefits – the software market has had to change. The ‘closed ecosystem’ has been forced to open up. The demands of lean construction are driving change; choosing the right tool for you as a business to enable you to be fast, agile, efficient and optimised are imperative. Hardware independent software can facilitate those industry driven demands. Multiple data formats to be processed in the same common environment, delivering efficiencies through cloud enabled platforms.

Correvate Vercator®

On this list, Vercator software is the category example of a specialist. There are a number of other brands that have taken this approach, particularly when it comes to modelling and visualisation solutions. The Vercator offering is unique in that they offer a Cloud based suite of point cloud processing tools. The current focus is on registration; opting to integrate with third-party scanners and modelling tools. However development works focus on data classification and extraction through machine learning.

It is not Vercator software’s intention to deliver an end-to-end closed product set. The goal is to increase functionality and efficiency in one area of workflow — and an open ended capability to partner and link to other specialists for you to create your own vendor-independent solution.

Software
The Vercator solution rests on the use of vectors to augment the registration process. By making each point in a point cloud into a directional vector, entire point clouds can be collapsed into abstracted vector spheres which retain their unique, defining characteristics. A vector-driven approach allows for these vector spheres to be rotationally aligned independently. Once rotational alignment is achieved, rapid 2D point density methodologies can be used to rapidly achieve horizontal and vertical alignment.

The end result of this multi-stage, vector-based alignment are registration procedures that are 40%-80% faster, even using targetless registration. Maybe more importantly, the robust characteristics of this registration procedure removes the need for cross-checks and allows for the automation of coarse registration under most circumstances. Automating processing leads to significant improvements to workflows, including the hands-off registering of scans.

Features
One of the strengths of Vercator software is the ability for the company to partner with other solutions — opening the door to best in class use of modelling and visualisation software - and scanners.

• Major input/export formats supported
• Integrate with your existing cloud storage
• Share secure data with anyone, anywhere
• No need for computer or software upgrade

Vercator software has recently launched a mobile app. This enables the user to upload a hand-drawn sketch, 2D floor plan or photograph to support the scan network plan. Adding new projects, levels and scan details by simply dragging scans to the right spot and linking them together. Once set, a CSV of network locations is exported for use in the registration software.

Cloud Capabilities
As any modern software should be, the Vercator engine was built with the cloud in mind. The same robust processing using standard office-based hardware creates interesting possibilities when transitioned into the scalable environment of the cloud.

Using robust and automated processing algorithms, in the cloud, the number of virtual cores available on-demand is effectively infinite. Practically, there are limits, but real changes to outcomes can be seen. For example, internal benchmarking shows a more than 80% reduction in processing time between standard desktop processing and the Vercator Cloud for large data sets.

Import/Export Formats
Import: rdbx, ptx, e57, fls, pts, zfs
Export: xyz, ply, e57, pts, las, laz, rcs
AutoDesk ReCap Pro

Autodesk is a huge company with many software products. ReCap ("Reality Capture") was really one of the first point cloud registration solutions on the market not tied to a specific scanner, and continues to be a popular tool. Autodesk does not produce scanners, and specialises in end-to-end software capabilities.

Although ReCap was an industry leader in point cloud processing, most of the company’s software portfolio focuses on modelling tools — AutoCAD, Revit, Fusion, BIM 360 and more. When it comes to CAD software, Bentley is the only thing that really can be considered a competitor to Autodesk. The two basically split the market, with AutoCAD the industry standard for building projects and Bentley for rail and road projects. Bentley does some point cloud processing, but not registration, and also has a strategic partnership with Topcon.

Although a quality tool, Recap does lack some features that more up-to-date solutions possess. ReCap, for example, lacks multi-core optimisation for simultaneous registration. However, it’s usually the system of choice for the end customer. What that means is that the easiest way to get data into a user’s hands is to give them Recap format files.

While Recap does offer a simple tile-based interface, it is not necessarily considered intuitive and may be considered too simple when compared with detailed scanning options available in other products.

The limit to the number of scans supported by Recap means companies would have to consider JetStream and CloudWorx. In terms of data storage requirements, it is worth noting that raw scan numbers can triple when you consider, say, a combination of the Cyclone databases and resultant ReCap files which are created as the scan data is sent through the pipeline.

Import/Export Formats

Import: cl3, clr, e57, fls, fws, lsproj, las, jpg, pcg, prj, ptg, pts, ptx, rcs, rds(3d), txt, xyb, xyz, zfs, zfprj

Export: e57, pts, pcg, rcp/rcs, fbx, obj, rcm, rcs, ortho/tif (geotiff)
Strategies for building the best software solution for laser scanning

There are two ways to approach laser scanning software.

• **Scanner-driven;** where you invest in an end-to-end solution that delivers in-house capabilities from registration through to modelling and visualisation. This solution could be built for a specific suite of scanner hardware, like Leica Cyclone.

• **Best-of-breed;** where you could opt for crafting your own laser scanning software system built complimentary independent elements. A hardware-agnostic platform of software tools that provide for your laser scanning needs.

A vendor-agnostic and hardware-agnostic approach brings the benefit of flexibility. It does allow you to update your technology to the best the market has to offer. When you commit to one vendor, you are not committed to their roadmap or their stance on data formats and cloud services.

What you lose by opting for this open best-of-breed solution is perceived simplicity and out-of-the-box functionality. Not being locked into a particular solution does have other benefits. It makes it easier for you to collaborate with others. In reality, it is almost impossible to keep every workflow within a single vendor system. Freelancers, clients and specialists are likely to bring their own tool to every job. If you are already prepared to handle integrations, this kind of partnership is made easier.

Understanding the needs of your business

In the end, the right choice for you depends on what your business needs, how you work internally, and the kinds of job you take on. For example, if groups within your business are fast-moving or work on cutting-edge, complex projects, they may require the advanced functionality that only a best-of-breed approach can provide.

On the other hand, in a highly centralised business, easier access to shared systems and common skills may likely take priority. If you spend more time collaborating with different departments within your own business that outside contractors, you might benefit from the kind of end-to-end simplicity that a single provider delivers. However, you need to weigh that against what you potentially lose. How important is cloud integration? How flexible are the margins on the projects you currently take?

You also need to consider the legacy tools you have to use. For example, if you are committed to using Bentley solutions for infrastructure projects, you are going to need a different tool for point cloud registration. In this example, you won’t gain anything from investing in an ecosystem with modelling capabilities because you won’t use them.

Understanding your priorities for the future

Although it is critical to understand what your business needs today, nothing stands still for long. When thinking about the kinds of investments you want to make, you need to take into consideration the business you may want to be tomorrow. Consider the following:

**Speed**

Time is money and it is important to constantly look to accelerate end-to-end processes — from scanner to outcome — whether the outcome is a report to a client, a rendering of an image, or a model of a building or structure.

Let’s take a large building, such as an office block made up of over 170 laser scans. Registration utilising the Vercator Cloud environment processed the data in only 3 hours; a significant reduction in processing time over conventional methods and without operator intervention. Only by looking at how you would use these savings to accelerate the whole process do you gain real advantages.

**Innovation**

Technology areas that are very dynamic, such as 3D scanning and modelling, will need regular enhancements which best of breed vendors are more suited to provide. Specialised vendors will be quicker to take advantage of cloud-enablement, 5G mobile apps and other technological advances. As single vendor systems are fighting on all fronts, it will take longer to re-write, re-engineer and release updates for a whole suite of applications and hardware.
The Cloud
The cloud delivers some very interesting possibilities for laser scanners. Collaborative sharing, remote access and iterative design are just some of the benefits the cloud brings to visualisation and modelling tools. Like other industries have already experienced, this changes possibilities when it comes to workforce enablement, contracting with specialists, and bringing clients closer to the design process. You also get improved storage options and dynamic scaling. If undertaking large projects, this will increasingly become a capability that is required to compete.

Making a purpose-built registration system work
If you decide to move toward a more purpose-built solution there will be some transformation process that you will need to go through. After all, very few companies will start from a “clean sheet”. You will usually have existing scanners, such as Leica or Faro; existing CAD software like Bentley or Autodesk; or just have an immediate need for a modelling solution or visualisation for a specific client. Following these steps will help:

Create a Plan
By putting together a plan, you will prepare for risks and better manage the process. Steps will usually include a roadmap to monitor progress, a plan to ensure deadlines are met and a business case to ensure the expected value is realised.

Evaluate options
If possible, pilot new technology alongside any existing legacy technology on existing data or on a simpler project. Avoid a big-bang implementation at all costs. Suppliers will usually be helpful in supporting a proof-of-concept. Involve clients if possible to ensure what they ask for and what they want is aligned to what you are looking to deliver.

Communicate Change
You should plan for change to the way people work, and you should plan to communicate what those changes will be. Promote the benefits and acknowledge the challenges.

Have a fall-back
If you can, have a fall-back plan in place, just in case you are overtaken by events.

No lock-in
Whether you have to go for a one-stop shop or adopt a best of breed approach, there are still areas you can focus on to get the best from the solution you choose and avoid the dreaded “lock-in” to a vendor. Ensure you negotiate both an entry and exit strategy upfront with your vendor. There are always termination elements that should be written into contracts. For example, to ensure your vendor assists if you want to migrate to another vendor. It’s a good idea to have a backup vendor at the ready. However, this may be easier said than done. For example, if you have already invested heavily in Leica scanners, you may need to stay with Cyclone to some degree.

Focus on cost/benefit
If you are looking to go down the specialist build route, it is likely benefits will be based on a combination of increased efficiency, better customer outcomes and the potential for increased revenue. Outlining these benefits in monetary terms is not always easy, but planning ahead to ensure they are specific and measurable will be key.
We are on the cusp of a revolution in laser scanner software: are you ready?

The 3D scanning market, including hardware, software, and services, is dynamic. Major segments are already experiencing rapid product innovation. This market has tremendous opportunities with growth driven by the replacement of older mechanical methods and by improved workflow with lower overall process and project costs. The accessibility of reality capture technology has never been greater, and forward-thinking firms are capitalising on the new use cases to deliver growth and innovation and deliver a step-change improvement in efficiency.

For example, the top-line goal of Faro is ten times more productivity. In terms of process, their strategic goal is to enable their clients to be in and out of a site 10 times faster than today — instead of taking two weeks, it will take just one day. Just imagine what that could do to the supply chain. That is a move from transformation into market disruption.

But let’s not just look at making existing processes go faster. The unique capabilities of 3D scanning software is acting as a catalyst for novel applications driven by cross-industry movements. These include developments such as digital twins, the Internet of Things (IoT), and Industry 4.0 initiatives.

Building Information Modelling (BIM) is the focal point of transformations within the construction industry. It is giving architects, engineers and construction teams access to single-source-of-truth databases covering the whole built environment. This in turn leads to innovations like the prefabrication of critical building components off-site through the use of 3D printing and other manufacturing techniques.

Buildings, themselves, are now being constructed with a 'build and check' technique, checked by laser scanners at every stage construction. These developments are revolutionising construction and are being driven directly by scanning software and point cloud technology. The exciting part is that beyond construction, almost any design process will benefit from the precision and iterative capabilities of software-driven 3D models and point clouds.

Our challenge is to think creatively and spot opportunities for new use cases. Times of change are times of opportunities. The potential of registration software, the maturity of the laser scanners and the introduction of cloud computing have created a powerful force for change. It is up to us all to make the most of the opportunities they present.

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