



# Traceable Construction™

FARO's Ecosystem for an Informed Construction Lifecycle



**CONSTRUCTION BIM**  
Informed Lifecycle

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# Introduction

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## What is BIM?

Whilst many think of BIM as a 3D model of a building, it's better to think of it as the process of 'Building an Information Model' or dataset that is used from project conception, through to operation, reuse and demolition.

With this approach in mind, the benefits of working this way are:

- open to many more built environment sectors (linear infrastructure and coastal design for instance)
- much more far-reaching (the process is not just for use in design)

In this respect, clients can specify what information they require throughout the design and construction process and also that required to operate the asset over its lifetime.

Typically, this information will be delivered as documents (written reports etc), graphical models (drawings, models & GIS data etc) and non-graphical information (data, spreadsheets, calculations etc). The combined project dataset will be formed of information contributions by a range of designers, builders, product manufacturers, asset operators and facility managers along the way and will increase in its 'completeness' throughout the asset's life as a virtual representation of it.

This publication looks at FARO's contribution to this wider process at numerous stages through the introduction of their 'Traceable Construction' concept. It is the ecosystem of products and solutions that FARO offer to leverage the benefits of measured data throughout the various stages.

It is fairly well understood that the benefits of digital laser/LIDAR capture are easily realised during initial evaluation and briefing stages and through design – particularly when working within a BIM process.

Furthermore, the use of digital capture is increasingly evident on construction sites and is offering even further benefits such as increased accuracy, less re-work and better planning and coordination.

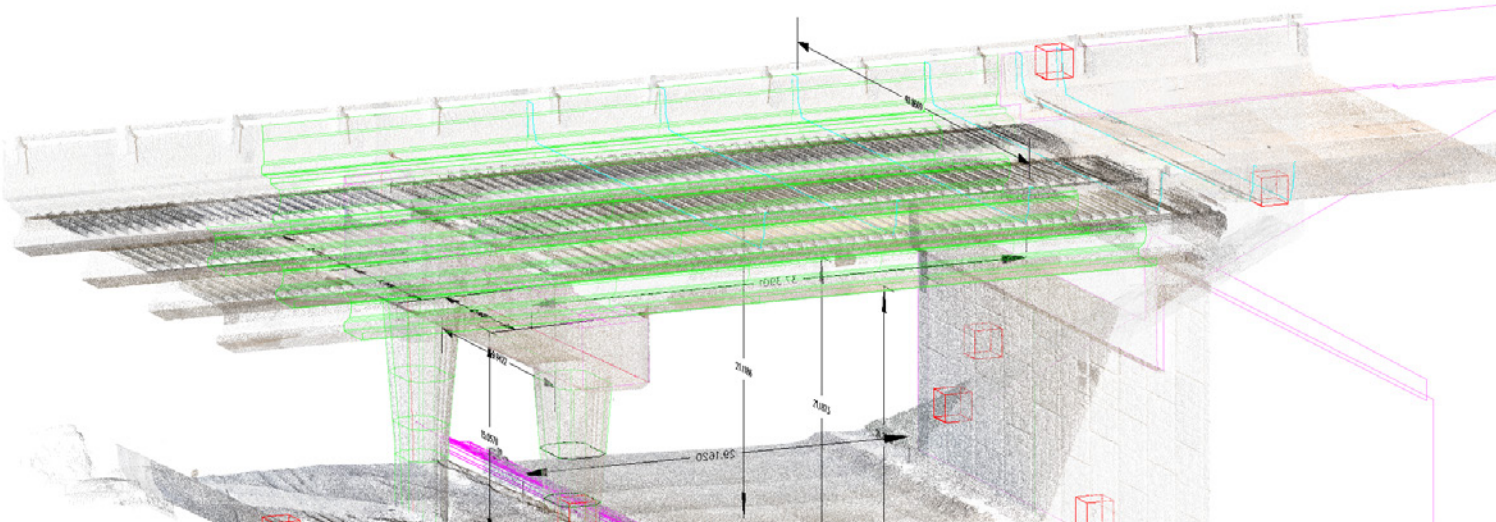
FARO solutions offer much more than measurement hardware... it's time to start thinking of FARO as an AEC-focussed company that provide complete solutions that integrate survey measurement and data into existing procedures. By focusing on digitizing the real world of construction, verified and quality-checked complete documentation becomes a reality.

'Traceable Construction' will mature and evolve over the coming years - introducing new products and tools to customers (those who purchase the hardware and/or software) as well as the users of the resulting measurement or analysis data. By adding value where reality data is needed or where reality data meets design or construction, FARO's solutions provide quality assurance and project confidence.

FARO have linked products and solutions (and the data created by them) to the building /asset lifecycle. This enables industry professionals to 'see' what tasks can be undertaken with which products and what data will be created and how it can be used.

It is widely acknowledged that many projects still focus on the design and construction aspects of BIM and mostly through 3D model creation and coordination to ultimately create 2D drawings. Whilst this is encouraging, the real gains sit firmly with the 'data' aspects of Building an 'Information' Model.

Whilst 'Traceable Construction' identifies and links FARO's significant portfolio of products that already assist many thousands of people, future product developments will help stakeholders plug the measured survey data gaps in their projects throughout all stages.



# Introduction



## Onsite Capture

Site features are captured quickly, accurately and easily using FARO hardware. In a BIM process, understanding what you have to start with or what has been built is essential.



## As-Built Model & Design

FARO software solutions enable the efficient evaluation of 3D measurement data from different sensor types. These help with the conversion to 3D models for further downstream use. The solutions work directly in industry-leading design software tools with simple, intuitive workflows.



## Design Layout

FARO hardware and software solutions together enable the display of modelled or drawn objects into the real world. The position of components and assembly points are determined, prefabrication is aided and CAD geometry is marked out in reality.



## Quality Control

FARO workflows compare CAD and 3D measurement data and identify deviations. The deviations are visualized in an easy-to-digest image or output as computable values. Deviations in construction can be corrected on-site or taken into account in further planning.



## Data Connect & Share

FARO solutions integrate the data of different measurement methods used in surveying. They work with standard file formats and facilitate data exchange. FARO Cloud solutions enable the secure, worldwide exchange of 3D data and models and collaborative work in real time.

# Applications & Industries



## Surveying

It's commonplace that surveyors now deliver their work digitally. The decrease in hardware costs and increase in demand for more detailed requirements from the industry are enabling surveyors to provide more value to their customers. Surveyors using laser-scanning workflows demonstrate great time savings in the initial survey, reduced health and safety risk through an overall reduction on site-time and fewer site visits than previously to capture missing or additional information. Additionally, the demand for 3D BIM deliverables is increasing with surveyors contributing to the documentation of existing conditions.



## Architecture

Architects gain huge benefits by working in a BIM process by standardizing the delivery of information (to international standards). Whether a micro SME or multi-national organization, companies are afforded more time to design and focus on 'outcomes' rather than documents. Simply using BIM modelling software will simplify teams and provide better coordinated documentation - all quicker than traditional methods. The initial capture of a site – whether a topographic or building survey for rebuild or refurbishment – with laser scanning, will produce a dataset which conveys much more information than a traditional 2D survey. We can already see design efficiencies being made.



## Building & Plant Engineering Structural, MEP, Electrical & Public Health

Building engineers benefit from BIM and laser scanning like Architects do – as a team, they are under increasing commercial pressure to deliver building environment solutions in an ever-evolving, fast-paced world. Adopting new processes supported by new hardware and software technology enables BIM dataset creation efficiently, representing the building structure. Spatial design and coordination models can be used for structural analysis as well. Survey data is the starting point here, ensuring engineers will use correct site data for their design decisions. Using all relevant data through design and detailing phases minimizes risks of failures like clashes detected on site.



## Civil & Infrastructure Engineering

Civil and Infrastructure Engineers typically work on large datasets, with complex requirements, that have a great interaction with the environment and sometimes cross multiple landowner boundaries. Managing information is vital. BIM for civil or infrastructure design is, therefore, the same as for buildings but the tools may be different. The use of modern and precise 3D measurement solutions within the scope of infrastructure projects is now commonplace. Whether for heap volume calculation, road cross section recording or the extraction of complete geographic topography, FARO provides comprehensive software tools for evaluating the surveyed point cloud data by civil engineer and surveyors.





# Applications & Industries

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## Construction, Quality Assurance/Quality Control

Laser scanning offers a way to increase efficiency and reduce waste. Updating Design data with scanned site information enables the compilation of the final handover documentation to meet today's rigorous requirements. As a task identified as offering huge cost efficiencies, clients are more often requesting that what is constructed is a true reflection of the as-designed documentation and that it performs as-designed in engineering terms. Laser scanning forms part of this verification process, ensuring that construction is geometrically checked for accuracy throughout the process – perhaps before they are 'covered' by interior fit out elements.



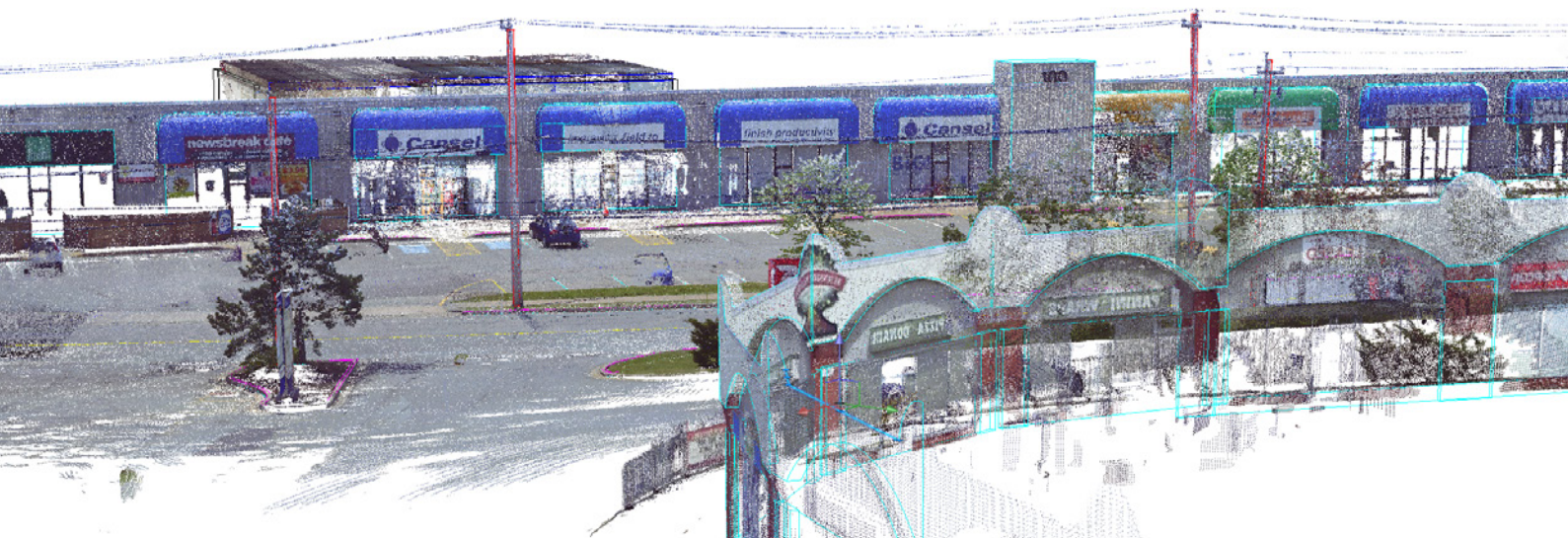
## Historic Preservation

Historic buildings are a treasure to mankind - their complete and accurate documentation is important to preserve. BIM as a process allows us to record this data in structured ways. When documenting historic buildings, grave sites, sculptures or caves, 3D laser scanning has established itself as the leading measurement method. Complex objects are quickly captured, shared online and can be used for more advanced applications such as the creation of 3D models or virtual tours. Information can then be linked to the dataset to communicate the life and condition of the object and used to inform decision-making about future preservation.



## Facility Management

With built asset operational costs typically being 95% of the total cost over 30yrs you can see why information management plays a large part in the owner's business - how the asset is operated, maintained and repaired is a significant factor in financial considerations. Acquired 3D data provides valuable support for operation and facility managers - from technical system management to estate management. Utilising a BIM dataset that has migrated to an Asset Information Model enables the client to understand the impact of design decisions on operational costs and also to understand the long term financial effects of operational decisions.







## Surveyors target five-fold increase in efficiency...

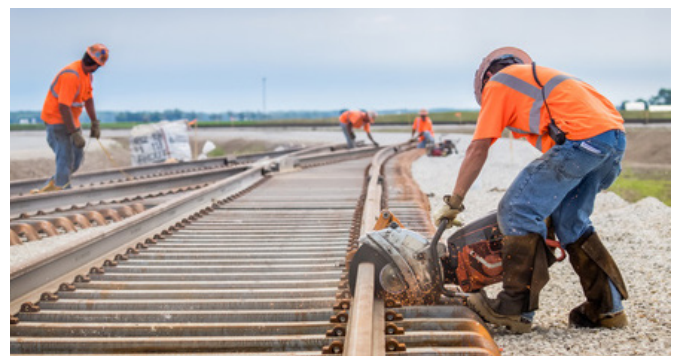
Surveyors are increasingly looking towards new technology to enable them to deliver the services and products that modern clients expect. After selecting the appropriate method of measuring, the surveyor can benefit in many ways. Hardware and software developments in recent years have reduced both the cost of purchasing a scanner and the time taken to obtain scans on-site. Surveyors can now capture more information quicker and more accurately than ever before. In this sense, many surveyors will realize the time, quality, safety and cost benefits very quickly.

The FARO Focus Laser Scanner reduces office-based time too - the on-site registration within FARO SCENE enables 3D scan data to be wirelessly transmitted, processed, aligned and registered directly to an on-site mobile device or PC in real time.

Surveyors are now challenging software providers to create tools that can keep up with the pace of data collection to reduce the time taken to convert the data into formal drawn or modelled deliverables.

FARO software enables the extraction and conversion of point cloud data to final deliverables to be a much quicker process than ever before. With technology such as FARO's object recognition algorithms, the software can semi-automatically create drawings, images, wireframe models or BIM files in a fraction of the time of traditional methods.

Additionally, the software can highlight where 3D models are out of tolerance with the specification,





# Solutions for Survey



demonstrating perhaps one of the most important aspects of the conversion to 'other' deliverables – that the scan data will (currently) ALWAYS be more accurate and complete than an approximated model – regardless of what software is used.

The benefits gained here are calculable against traditional methods - with some already reporting five-fold increases in overall efficiency, this is just the beginning of a stream of benefits in a BIM process.



## Tools

Hardware: FARO Focus Laser Scanner | FARO Tracer Projector | STORMBEE UAV

Software: FARO SCENE | FARO SCENE WebShare Cloud | FARO As-Built Products | FARO BuildIT Construction

*“Office processing time is greatly reduced... it forms the majority of the work but new tools enable much more efficient working”*

## Advantages

- Greater accuracy.
- More survey measurements in less time.
- Fewer return site visits.
- Use of modern technology to provide better quality products (2D drawings, 3D models etc).
- Better commercial aspects.





## Enabling a more 'complete' understanding of the site



and then digitizing it, producing risk from the very outset. To minimise this, FARO offers several end-to-end workflows, from capturing the existing conditions to their CAD and BIM representation – always with efficiency and accuracy at the forefront.

Scan data can be available much sooner than traditional methods, allowing Architects to start design earlier with more reliable information. Additionally, scan data provided as a 'coloured' point cloud can be viewed and evaluated in a web browser thanks to

Architects need to understand the dimensional aspects of an existing site or building as its local context. In the past, survey data from 2D plans, sections and elevations was used, missing many of the aspects relating to the 'look and feel' of a site.

In some cases, gathering the survey data could have meant working from incomplete or inaccurate archives







FARO's cloud services or in a VR headset with the FARO SCENE software, enabling stakeholders to view, interrogate and comment upon aspects of the site – both incredibly valuable communication tools.

Point cloud data can then be directly referenced into BIM authoring tools for design. In some cases, manipulation and modelling is assisted with FARO add-ons which enhances standard software in the 'Scan to BIM' workflow. This is especially useful when modelling site features as accuracy is maintained throughout. In cases where new construction is proposed adjacent to or within existing structures – designers can make more informed decisions.

Working in such a BIM process then allows the models to be easily used in more advanced communication tools such as 3D printing and Virtual/Augmented/Mixed Reality. Architectural models are then used to show existing conditions, required demolition and the proposed scheme in ways that allow non-professionals to understand. In addition, drawing output is created in timescales and quality measures that traditional methods cannot achieve.



## Tools

Hardware: FARO Focus Laser Scanner | FARO ScanPlan | STORMBEE UAV

Software: FARO SCENE | FARO SCENE Webshare Cloud | FARO As-Built Software

*“Architects are provided with a greater understanding of a site - not only spatially but now the look and feel of the local environment”*

## Advantages

- Significant better Project site understanding.
- Quicker access to large quantities of survey data.
- Valuable incidental survey data is collected.
- Reliable decisions
- Easily shareable formats available.
- Greater communication opportunities (web-based, 3D printers, Augmented/Virtual or Mixed reality etc).



# Solutions for Building & Plant Engineering







## Complex geometry captured, processed and translated faster than ever before

FARO solutions for building engineers working in a BIM process start with and build on those outlined for architects. With point cloud data viewable by the entire team using FARO's cloud services and applications and available for use within BIM management software, each design discipline can start from an accurate, more complete and informed position.

Engineers responsible for coordinate systems and setting out points of a site, can use the GPS location data stored within the point cloud. This can be acquired by BIM authoring tools to ensure models are created in the same virtual location. FARO's plant and BIM specific software add-on simplifies and enhances this process - ensuring design coordination exercises are possible and providing correct results.

With a BIM process, engineers working with existing structural or MEP plant areas require fast, accurate and economical survey measurement of often complex MEP systems weaving their way around structural elements.

FARO Laser Scanners measure components, such as pipes, steel beams and factory walls, quickly and precisely, producing up to one million 3D measurable points per second, providing a complete spatial image, even in difficult lighting conditions.

Semi-automated object recognition tools for component extraction in FARO software ensures efficient translation of scan data. The following modelling and applications can be implemented quickly:

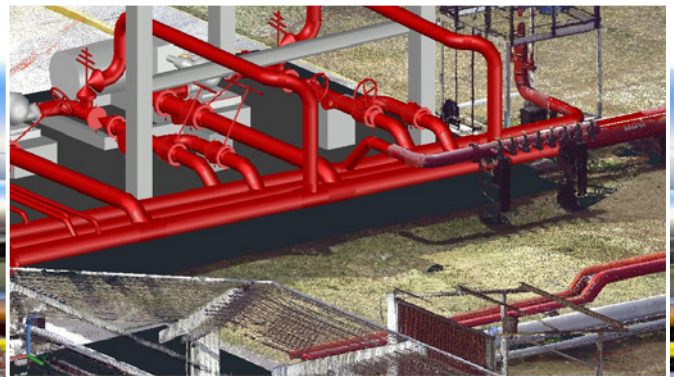
- Documentation of pipelines (pipes, flanges, tie-in points etc.)
- Modelling of steel, timber and concrete structure
- Modelling of pipes, ducts and cable trays
- Volume calculation and deformation analysis of tanks and boilers
- Verification of 'as-built' against design geometry
- Creation of parts lists for future fabrication

### Tools

Hardware: FARO Focus Laser Scanner | FARO ScanPlan | FARO Tracer Projector | STORMBEE UAV

Software: FARO SCENE | FARO SCENE Webshare Cloud | FARO As-Built Products | FARO BuildIT Construction

*"Capturing complex pipes and structure has never been so effective – the combination of FARO hardware and software is seamless"*



### Advantages

- Significant better understanding of the project site.
- Full 3D survey information rather than 'limited 2D and assumptions'
- Modelling from scan data ensures less ambiguity.
- Software solutions allow easy translation from point clouds to BIM datasets.

With FARO Laser Scanner hardware and FARO SCENE software, real-time, on-site registration of recorded point clouds is possible – saving yet more time. The completed scanning project forms a perfect digital basis for the subsequent processing with your chosen BIM software.





## Accurate measurement of large sites in a fraction of the time...

The measurement of objects in the infrastructure and civil engineering sector places particularly high demands on modern 3D measurement technologies. In addition to the detection of the objects, which are often very remote and difficult to access, the measurement is often carried out in challenging weather conditions.

FARO Laser scanning solutions offer reliable, fast and accurate data collection to help meet these challenges. Using the latest FARO hardware and software solutions, the following surveying tasks are optimized and accelerated:

- Creation of location and elevation plans
- Topographic survey
- Deformation and control measurements
- Flow profile and track measurements
- Measurements of cables and high-voltage objects

The FARO Laser Scanners with long range and integrated GPS functionality, allow measurement of large structures without necessarily placing operatives and equipment in precarious locations.

Once the data is captured, with FARO's registration and as-built evaluation software it is possible to quickly and efficiently extract data for engineering and design. In addition to the digitization of topography and volume calculation of stockpiles, engineers can create longitudinal profiles and road cross-sections, bridge models and analyse terrain surfaces.







## Mobile Mapping

The versatility of FARO Scanners enable them to also be mounted upside down on various mobile solutions (road vehicles/drones/trains/robot arms etc). The scanner's GPS data is supplemented with velocity, pitch and roll sensor data which cancels out the 'movement' using on-board calculations, enabling accurate geo-referenced measurement.

Software has a role to play too and allows the instant translation of coordinate systems, automated 'feature extraction' that recognizes terrain/surfaces and line-work such as road markings and even 'classification' of the identified objects to allow linking to other data sources such as GIS datasets– a true BIM approach.

In using what is essentially a highly effective combination of existing solutions it ensures accuracy and veracity of the survey data.

### Tools

Hardware: FARO Focus Laser Scanner | FARO Road-Scanner C | STORMBEE UAV

Software: FARO SCENE | FARO As-Built Products | FARO BuildIT Construction | FARO SCENE Webshare Cloud

*"Solutions like this allow swathes of land, road or rail infrastructure to be measured or fine movement to be monitored safely and quickly"*



### Advantages

- Fast data capture of vast areas of infrastructure.
- Larger, more complete datasets are collected and usable for design and operation.
- The ability to link and share accurate data with various stakeholders.
- Visualizing infrastructure (horizontal) and building (vertical) aspects of projects together.









## Construction quality improved and re-work reduced

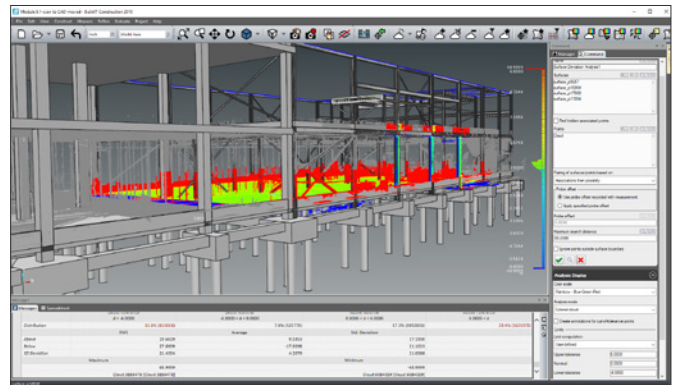
Complete, efficient and accurate documentation of construction projects is essential today. The necessary surveys for any given project can be swiftly carried out at various stages of the construction process - adding value to the delivery process and to the 'as-built' dataset.

In the context of construction planning, the compact FARO Laser Scanners support Engineers and site managers in the construction field, on-site. In just a few minutes, the scanner captures the construction site - completely and precisely. The acquired 3D data can be used for 4D programme planning as well as determining the volumes and masses of excavation pits for 5D (cost) related uses.

Even more valuable is the use of laser scanning in building supervision. Timely monitoring of construction progress is ensured by the rapid recording of construction work. The data collected not only supports the precise positioning of formwork in concrete and columns in steel construction for example, but also serves to control construction work and to record progress, structural damage, health and safety compliance etc. The high risk of liability, which is mainly due to building uncertainties, is minimized.

The data can be viewed by construction workers using FARO's web services. All project partners can then simultaneously work on reliable data, which significantly speeds up common processes.

Other FARO solutions perform surface flatness analysis to determine the highest and lowest points on wet concrete, for example - projecting the results directly on the affected areas. Checking ongoing construction work in almost real-time dramatically reduces abortive work and ensures elements are constructed in the correct location, to the correct standards.



By seamlessly integrating scan data into the FARO software, completed construction can be verified against the 'as-designed' models and the models updated if required - finally providing a true 'as-built' record for the client.

### Tools

Hardware: FARO Focus Laser Scanner | FARO Tracer Projector

Software: FARO SCENE | FARO SCENE Webshare Cloud | FARO BuildIT Construction

*"We've entered a new era of quality control on site with real-time feedback on construction works and augmenting reality with the analysis results"*

### Advantages

- Vastly improved Quality Control.
- The ability to reduce costly re-work.
- A better understanding of construction progress.
- Better links with offsite fabrication companies.







## Heritage meets modern technology

Laser scanning and BIM processes have a significant role to play in recording and preserving our most culturally precious structures around the world.

As part of a BIM process, the impetus for capturing heritage sites in 3D can be different depending upon the situation:

- **Reconstruction:**  
Detailed 3D data for reconstruction of lost appearance of components.
- **Restoration:**  
Creation of overall 3D models for restoration design, planning and monitoring of movement or weathering.
- **Conservation:**  
Precise 3D condition surveys for preservation and protection of historical/archaeological sites.

FARO offers several end-to-end workflows to suit the above situations. No matter what the application, with FARO's terrestrial and handheld laser scanners objects of all types can be documented quickly, without contact. Together with high-resolution photos captured by the scanner, the hardware documents the geometry and surface of the historic objects in detail and reliably, even at greater distances. In hard to reach areas

the FARO's Handheld Scanner serves as a perfect complement to gather scan data of smaller, detailed surfaces. Combining both technologies churches, castles, caves and excavation sites, for example, can be captured completely within hours or days, inside and out.



In the case of managing culturally significant structures, conservation teams have the same requirements from a documentation process as architects, engineers and operational teams. In most cases with heritage sites, information about the existing state is more critical than unlisted buildings due their age, fragility and higher value. Additionally, during any refurbishment or adjacent construction work, actual states must be





monitored and documented to ensure a careful use and appropriate planning of conservation and restoration measures.

True-to-scale, rectified digital images of plane or surfaces of cylindrical objects projected into a plane can be created using FARO software and used to create plans e.g. of façades or acquire geometrical data of ceilings and wall frescos.

## Tools

Hardware: FARO Freestyle Handheld Scanner | STORMBEE UAV

Software: FARO SCENE | FARO SCENE Webshare Cloud | FARO As-Built Products

*“Projects like CyArk are digitally preserving ‘at-risk’ global heritage sites. As well as documenting these sites, the organisation makes heritage accessible to the masses for educational purposes”*



## Advantages

- Highly accurate records of fragile historic structures.
- Accurate monitoring of structures for movement.
- Ability to share and experience historic sites without travelling (for education etc).
- Possibility to capture textures (colors) of scanned objects.
- Ability to fabricate replacement parts (stone gargoyles for instance) accurately and true to the original.



# Solutions for Facility Management







## The right information, to the right people, at the right time

Specifically, for clients or facility management companies, delivering a verified dataset that enhances accuracy, provides bigger picture context and gives greater confidence in decision-making, is changing the way professional services are provided in our industry.

Whether semi-automatically generating a GIS (Geographic Information System) Asset Management database through object recognition software or delivering a point cloud to someone who will model a 3D representation of it using a BIM authoring tool, the process begins with the best possible dataset about the site. This minimizes error, improves accuracy and increases the accessibility of the information.

In asset operation, FARO's cloud services can be used as a more intuitive way to access information. Tags displaying information can be added to locations in the point cloud and document hyperlinks included, allowing users to navigate and access documents easily and naturally.

Even where 'design' is not required, solutions such as FARO's mobile mapping system affords clients the opportunity to practice cost-effective infrastructure condition inspections – covering swathes of land/assets in periods of time previously unachievable.

The task of Facility Management (FM) is to manage properties, to reduce operational and management costs, to make fixed costs more flexible, to secure the technical ability of MEP systems and to maintain or increase the value of assets in the long term. To guarantee this today, the use of BIM processes and CAFM (Computer Aided Facility Management) systems is more common.

With FARO hardware and software solutions, existing legacy plans and models can be easily compared with real objects. Facility Managers can use clash detection or heat maps to check whether their old CAD plans accurately reflect the current reality and BIM datasets and, if necessary, update them.

FARO solutions allow building operators and Facility Managers to bridge the gap between reality and its representation in a BIM process.

### Tools

Hardware: FARO Focus Laser Scanner | FARO ScanPlan

Software: FARO SCENE WebShare Cloud | FARO As-Built Products

*“Accurately recording our surroundings is vital to the ongoing transformation of the built environment industry – how can we have smart cities without a smart starting point?”*

## Advantages

- More accurate understanding of built assets when purchasing real estate.
- Production of a virtual representation of the physical building – with data and geometry.
- Guaranteed 'as-built' documentation if validated against scan data.
- Ability to simulate virtual scenarios ahead of physical changes.



# FARO Offices

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