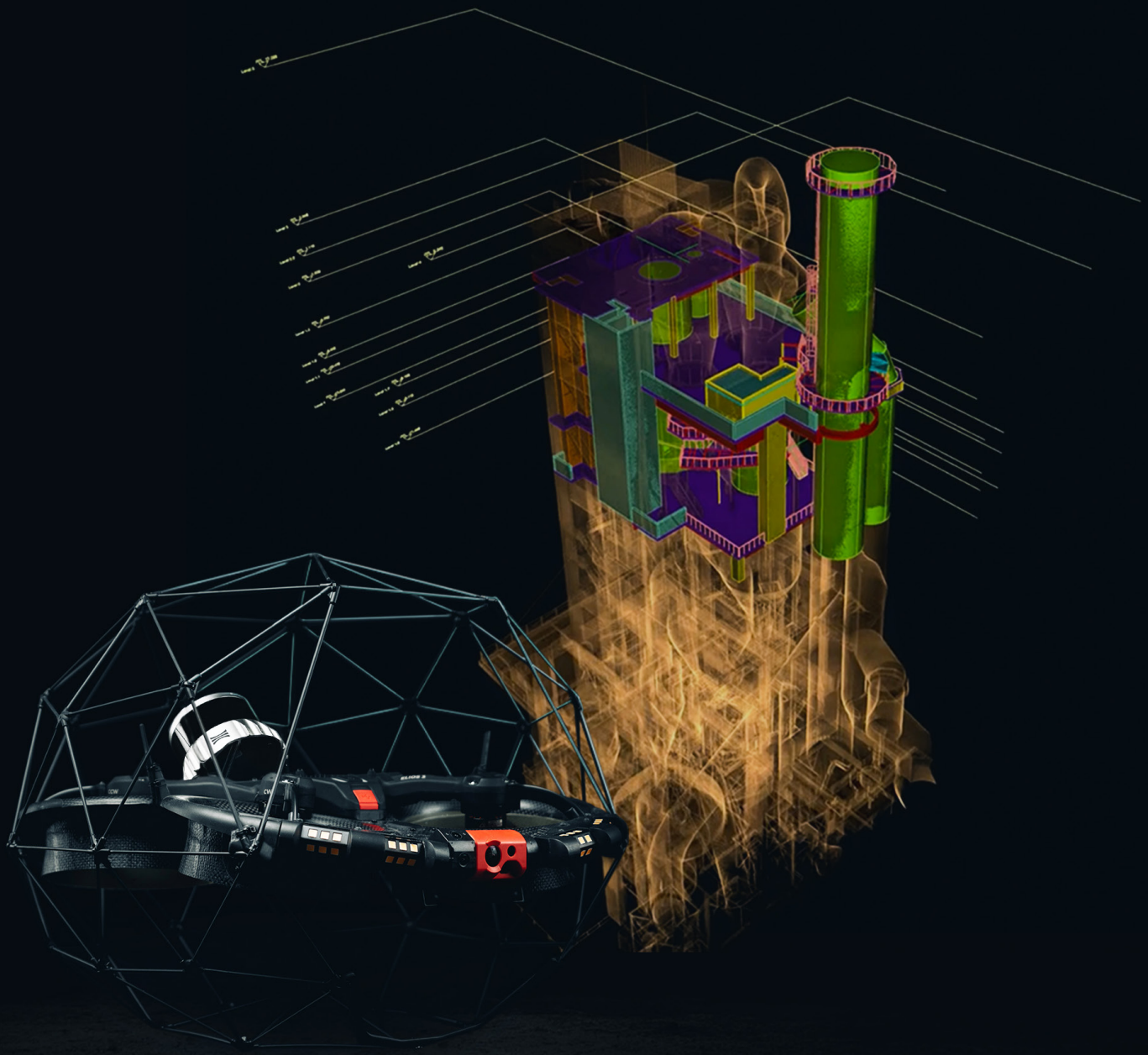


Producing accurate BIM models with Elios 3

Discover how the Elios 3's high-quality point clouds can be used for BIM modeling. This paper explains the achievable Level Of Detail (LOD), the processing workflow, and provides example applications.

FLYABILITY

Introduction

The **Elios 3 drone** is a rugged inspection tool that was enhanced by the addition of its **Surveying Payload**. With this highly accurate LiDAR scanner, the drone has been used to precisely map sewers, mines, and general infrastructure.

In this paper, we will discuss and demonstrate the utilization of the Elios 3 for producing high-quality “Scan to BIM” models for infrastructure mapping, with a particular focus on challenging, confined spaces. We will cover this in the following order:

1. **An introduction to the Elios 3**
2. **Overview of BIM and LOD 200**
3. **Comparison with traditional methods**
4. **Example Workflow: Scan to BIM with the Elios 3**

Traditional infrastructure mapping relies on the use of terrestrial instruments including Total Stations, TLS static scanning instruments, or Disto single-point laser devices. These tools are used to map the internals of buildings. However, they are often slow to collect data and require prolonged set-up time from multiple angles, which can be inhibited by a lack of access to some areas. With ever-increasing safety controls, this makes it harder to reach all areas to collect data safely, which can result in missing data or shadowing, and a final 3D model that does not have full coverage.

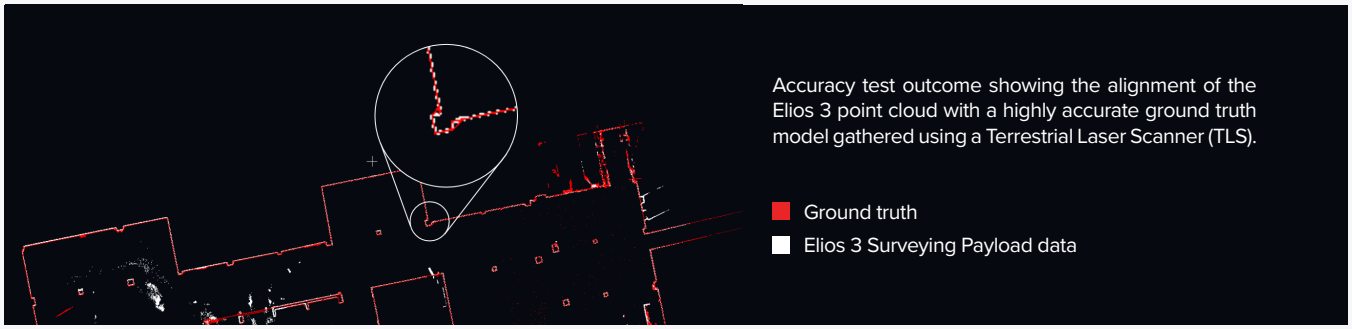
The Elios 3 with the Surveying Payload mounted

The Elios 3 as a modern surveying tool

The Elios 3 presents itself as a useful contender compared to traditional surveying methods through a variety of features. Its Surveying Payload is composed of a high-resolution Ouster OS0-128 Rev 7 LiDAR sensor in combination with the world leading FARO Technologies Connect SLAM algorithm to create incredibly accurate 3D maps and digital twins of the most inaccessible spaces with centimeter precision - for accurate measurements and greater insights.

Survey package accuracy deep dive

> **The Surveying Payload is capable of achieving 0.1% drift accuracy = 10cm error 100m away from take-off, or on a 100m measurement.**



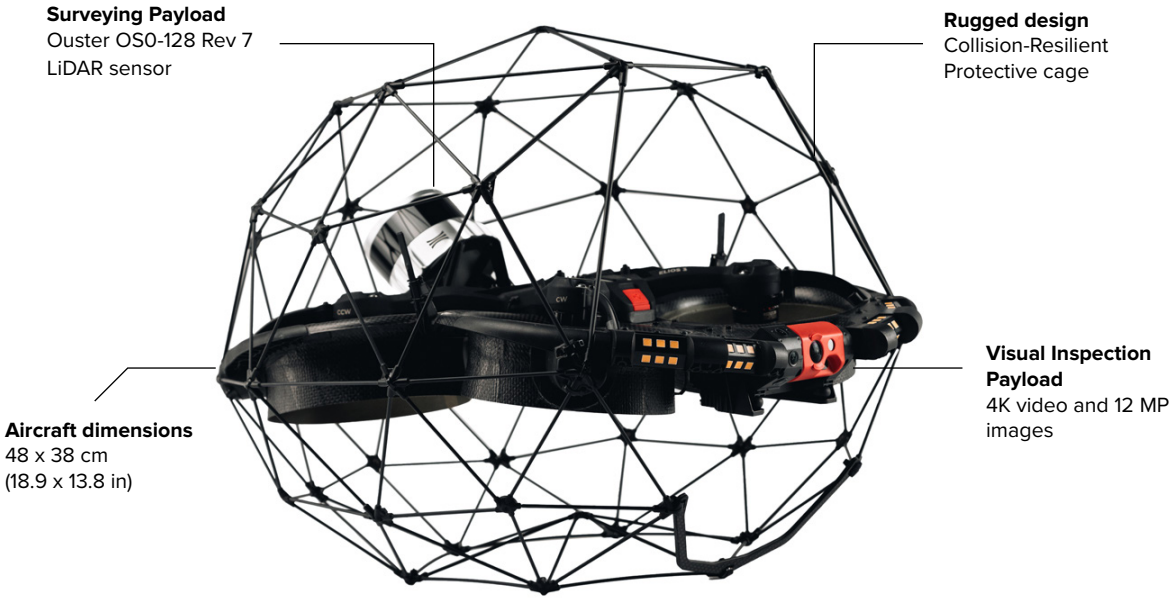
Accuracy test outcome showing the alignment of the Elios 3 point cloud with a highly accurate ground truth model gathered using a Terrestrial Laser Scanner (TLS).

Accuracy test results for the Elios 3 Surveying Payload in complex surveying environments.

		Configuration **Elios 3 Surveying Payload and FARO Connect**
Structured environments	• Buildings, stockpiles, containment areas • Little to no symmetry • Geometric features • Diameter/distance between walls >2m (6.5 feet)	**~0.1-0.2%**
Nominal symmetrical environments	• Tunnels, stacks, shafts • Diameter >2m (6.5 feet) • Regular geometric features	**~0.25-0.5%**
Challenging symmetrical environments	• Tunnels, stacks, shafts • Diameter >2m (6.5 feet) • Light geometric features	**0.5-2%** (50-80% success rate)
Very challenging symmetrical environments	• Tunnels, pipes, stacks, shafts • Diameter <2m (6.5 feet) • Light geometric features	**2-5%** (50-80% success rate)

Beyond its highly accurate LiDAR scanner, further critical features of the Elios 3 include:

1. A rugged cage to help protect it in confined spaces and collision-tolerant design
2. Detailed data collection, through the integrated visual inspection payload featuring 4K video and 12 MP images, as well as the powerful Ouster OS0-128 Rev 7 LiDAR sensor
3. Points of interest are automatically geolocated inside the LiDAR scan, enabling clear reporting
4. Ease of use - the drone can be used with just 1 day of training, and its tailored stabilization features ensure ease of data collection when the drone is in flight



The Surveying Payload for the Elios 3 comes with FARO Connect, a desktop-based software suite by FARO Technologies that facilitates managing, processing, and collating 3D measurements. It has custom presets to optimize processing the Elios 3's data which include data alignment, point cloud filtering, georeferencing, and ease of export in various point cloud formats.

The use of this drone for surveying, mapping, and inspecting across industries has seen testimonials praise many of its features and highlight benefits that include:

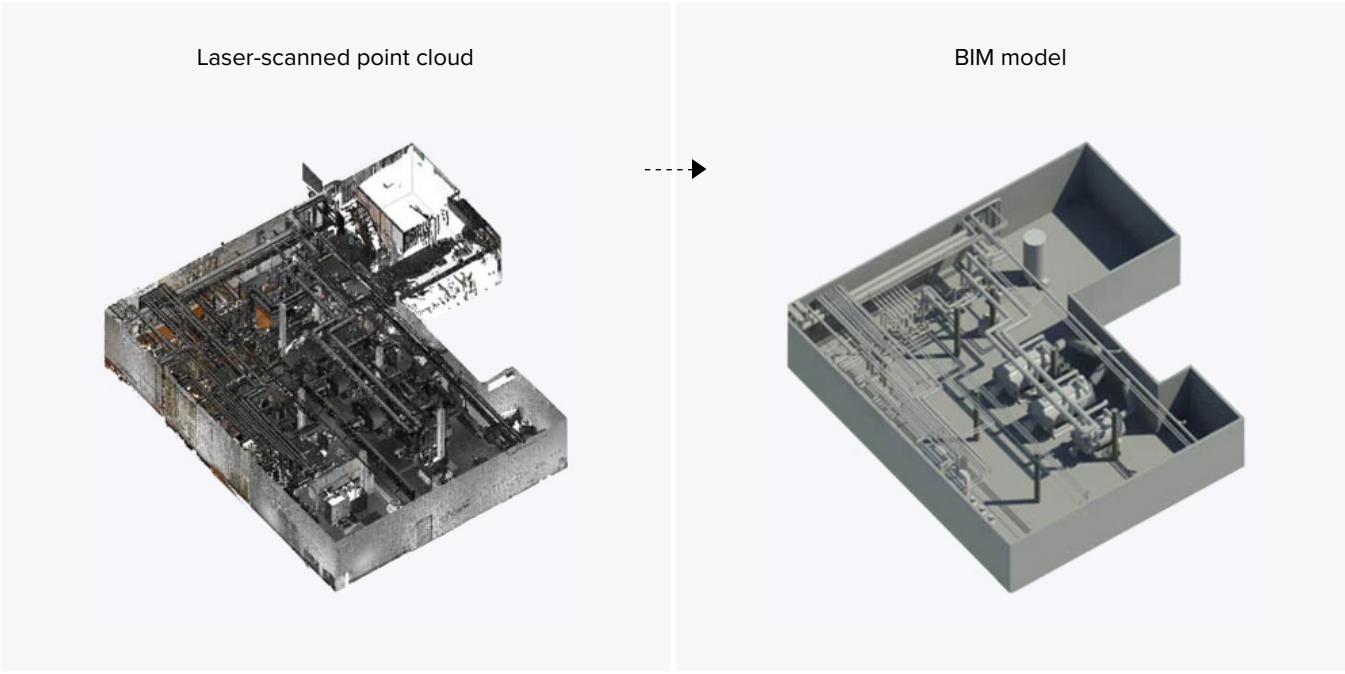
- ✔ **Faster and more efficient data collection.** The Elios 3 can navigate through indoor spaces quickly and capture high-resolution images and LiDAR data in a fraction of the time it would take to manually survey the area by terrestrial means
- ✔ **Increased safety.** The Elios 3 can access hard-to-reach or hazardous areas without putting human surveyors at risk.
- ✔ **Cost-Efficiency.** Using the Elios 3 for internal mapping can be more cost-effective than traditional surveying methods, as it requires fewer personnel and equipment, even in complex environments. The access to space with the Elios 3 avoids unnecessary additional equipment as well.
- ✔ **Accurate and detailed mapping.** The Elios 3 can capture precise measurements and detailed imagery, allowing for more accurate and comprehensive mapping of indoor spaces with 100% coverage.

Overview of BIM

Building Information Modeling (BIM) is the holistic process of creating and managing information for a built asset. This method of presenting data is based on an intelligent model and/or enabled by a cloud platform. It collates multidisciplinary data that can show an asset across its lifestyle from planning to construction to operation. BIM standards can be best defined by the ISO 19650 and 12006 series of standards.

Scan to BIM

Scan to BIM is a workflow or process that translates laser-scanned, point-cloud digital models into BIM platforms that interpret the data and integrate it into a 3D site or building model for development, design, and construction teams. These details offer visual accuracy and granular spatial awareness and help to automate building documentation.



Laser-scanned point cloud of an industrial building translated into a BIM model.

The amount of information captured in a BIM model is represented through its LOD - the level of detail. This defines the amount of detail and degree of development of elements within a BIM model. LOD categorizations span from LOD 100 to LOD 500.

Levels of Detail in BIM

LOD 100 - Conceptual Design	At LOD 100, the BIM model represents elements in a very basic form. It provides conceptual information such as massing and volume, allowing stakeholders to understand the overall shape and size of the building.	
LOD 200 - Schematic Design	LOD 200 adds more detail to the BIM model, including approximate sizes, shapes, and locations of individual elements. It allows stakeholders to begin analyzing spatial relationships and conceptualizing design alternatives.	
LOD 300 - Detailed Design	LOD 300 represents elements in the BIM model with specific dimensions, shapes, and relationships to other elements.	
LOD 350 - Construction Documentation	LOD 350 expands on LOD 300 by incorporating additional information required for construction documentation. It includes detailed fabrication and assembly information, such as connections, joinery, and material specifications.	
LOD 400 - Fabrication and Assembly	LOD 400 provides information suitable for fabrication and assembly of building components.	
LOD 500 - As-Built	LOD 500 represents the as-built condition of the building, incorporating accurate information on the installed components and systems. It includes data collected during construction or renovation, such as serial numbers, installation dates, maintenance records, and warranty information, to support facility management and operations.	

BIM LOD with the Elios 3 Survey Package

With regards to using the Elios 3 Survey Package for capturing point cloud data in infrastructure mapping, the Ouster Rev 7 level of range, precision, and accuracy enables the capture of LOD between 200 - 300 for systematic design and detailing for specific dimensions, shapes, and relationships to other elements.

LOD 200

LOD 200 aims to provide a model of the building containing the footprint of structural elements such as walls, columns, beams, and slabs. The position, orientation, shape, and size of geometric objects are correct but the compositions are not visible. LOD 200 therefore offers a reliable source of information, sufficient to start an architectural project.

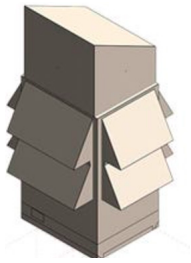
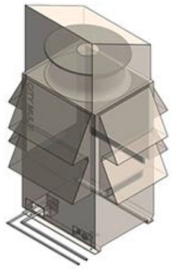
When a 3D model contains production lines and machines, these are represented by geometric bounding boxes (assembly of several parallelepipeds). These more accurately represent the shape and size of the machine.

As part of a construction or renovation project, a model at LOD 200 is enough to start the SIA 31 phase (Preliminary Project). The LOD 200 makes it possible to provide a technical proposal for a project, concerning in particular the general architecture, or the estimation of the SIA 116 and 416 volumes and therefore the cost of the work.

At the same time, the LOD 200 is suitable for the use of layout simulations and the site layout plan for all types of structures.

Example of LOD 200. The model contains the footprint of structural elements such as walls, columns, beams, and slabs.

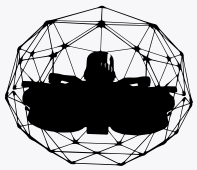
Capabilities and practical uses of Elios 3

LOD 200 - Schematic Design	Columns, beams, floors, walls, doors, windows, and MEP systems are represented as generic 3D shapes (e.g., rectangular or cylindrical) with approximate dimensions. They are positioned within the asset with centimeter-precision.	
LOD 300-350 - Detailed Design and Construction Documentation	Concrete connection points, ducting joints, nuts, bolts, and architraves are accurately represented with precise dimensions and positioned within the asset with sub-centimeter precision.	

Elios 3 Surveying Payload

Elios 3 vs Terrestrial means for BIM data collection

When it comes to capturing detailed 3D data of existing conditions for use in Scan to BIM modeling, both the Elios 3 Surveying Payload and terrestrial scanning have distinct advantages and use cases. To make the decision of which tool to use, the choice will likely come down to the four main pillars of Speed, Data Quality, Access, and Safety.

	 **TLS**	 **Elios 3**
Accuracy	Sub-millimeter precision	Centimeter precision
Data output	Point cloud	Point cloud, 4K images, opt. sensors
Coverage	Shadows, limited to safe access	No shadows, beyond safe access
3D live map	No	Yes
Mobility	Low	High
Speed	Fixed scan frame	2x faster vs TLS on average
Takeaways		
Wins	MUST-HAVE tool, others are incremental. Extremely precise	Uniquely suitable for scanning large, complex, hazardous areas. 100% data coverage thanks to live map & exceptional mobility
Trade-offs	Less suitable for large surfaces (slow process), significant shadows, and limited to safe access	Limited by flight time with trade-offs on accuracy

Speed and Efficiency

- In terms of speed and efficiency, the Elios 3, depending on the complexity of the environment in question, can capture equivalent data to terrestrial scanning methods but in a fraction of the time. For example, when it comes to simple block and beam structures with internal walls and passageways, the Elios 3 offers X2 - X2.5 times the capture efficiency in comparison to terrestrial means. In more complex environments like plant structures with multiple sections of MEP, this efficiency can increase to 5x-10x fold and even offer scan data that is sometimes impossible to capture due to the environment geometry, access, or hazards. The terrestrial equipment is generally bulkier and less portable than Elios 3, requiring more effort to transport and set up for each scan, which in turn, hampers the efficiency of terrestrial usage.

- A final limiting factor with terrestrial vs Elios 3 is terrestrial equipment requires more care when setting up each station point. In some cases, multiple scan setups are required (anything from 10 -50 sets) to cover the same area as the Elios 3 in one flight. This can lead to accumulation or alignment errors over the entire project, which can be very costly to rectify.

Data quality

- In terms of data quality, alignment, and accuracy, while the Elios 3 Survey package data is suitable for general schematic design assessments and inspections, the data resolution may not be as high as that of terrestrial scanners for detailed modeling. This is one of the general disadvantages of dynamic LiDAR applications for surveying in comparison to Static or kinematic scanning systems.

- Due to the nature of dynamic LiDAR and SLAM, drift can be a major cause of error in the project so great care must be taken, and following best practices on site is a must. When using the retro-reflective target workflow, especially for georeferencing, this requires more preplanning and additional sets in the process to make sure that the target workflow methodology is correctly followed and in coordination with the Flyability training material.

  With modern static or kinematic terrestrial scanners, features such as auto-calibration, self-leveling, and automatic scan rectification and merging, it means that less training is required to use such a device. The Elios 3 requires skilled operators to navigate the drone and ensure accurate data capture.

- A LOD of 200 is achievable with the data quality of the Elios 3 Survey Package, which in basic terms means that the data is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. This falls within the bracket of Schematic design, meaning the BIM model becomes more refined, incorporating approximate quantities, sizes, shapes, and locations of elements. It helps in analyzing spatial relationships and early design concepts.

  With Terrestrial laser scanning the achievable LOD is in the regime of 300-350 where the modeling elements are graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems.

Access

- Elios 3 can access areas that are difficult or impossible for terrestrial scanners, such as inside pipes, tunnels, and hazardous environments. This makes the survey package a defining solution for these types of environments.

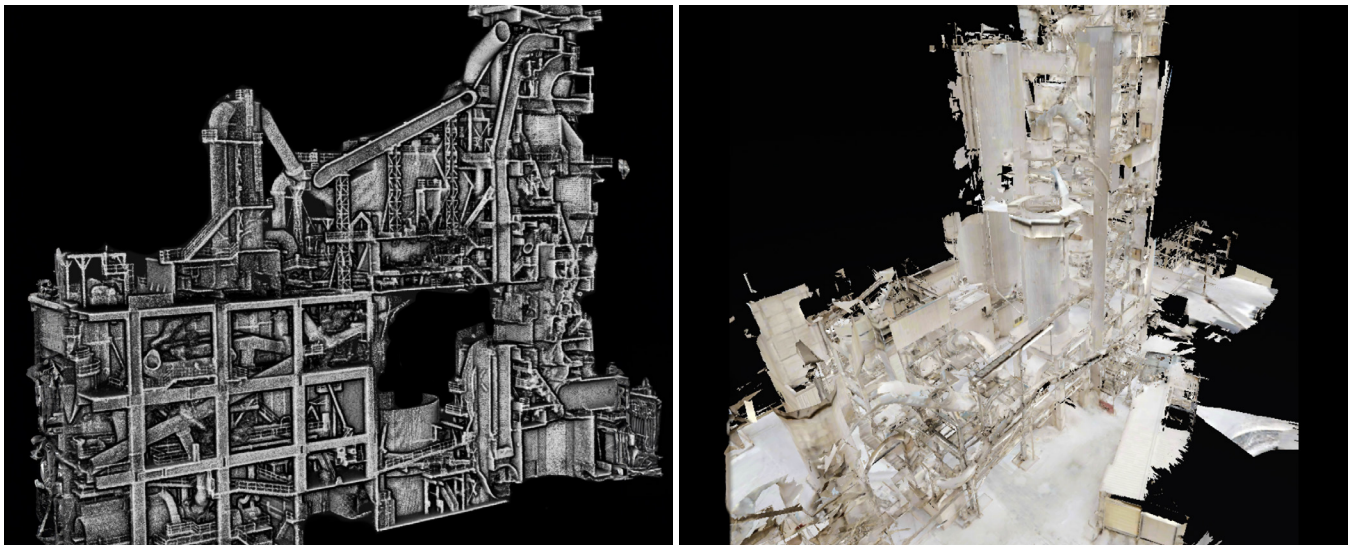
  A limiting factor with the Elios 3 can be operational range which is limited by battery life and signal strength, however, this can be combated by good pre-flight planning.

- For access to terrestrial equipment, more physical contrasts are in place. Terrestrial scanners may struggle to access confined or hazardous areas without additional equipment or measures such as confined space training, MEP or Electrical lock-out, chemical hazards, or even rope access requirements. One of the main limitations also is that terrestrial scanners require a clear line of sight, which can be challenging in complex environments with many obstructions.

Safety

- The Elios 3 can be operated remotely, reducing the need for human presence in confined or complex environments, which results in needing less advanced training for confined spaces, gas hazard environments, and also plant MEP lockout. In most cases, operations can continue and operation shutdown can be avoided.

- The Elios 3 is also less invasive and is less likely to disturb the environment, making it ideal for sensitive or delicate sites in comparison to terrestrial scanning where sometimes access is needed with the aid of model lift platforms or scaffolding.



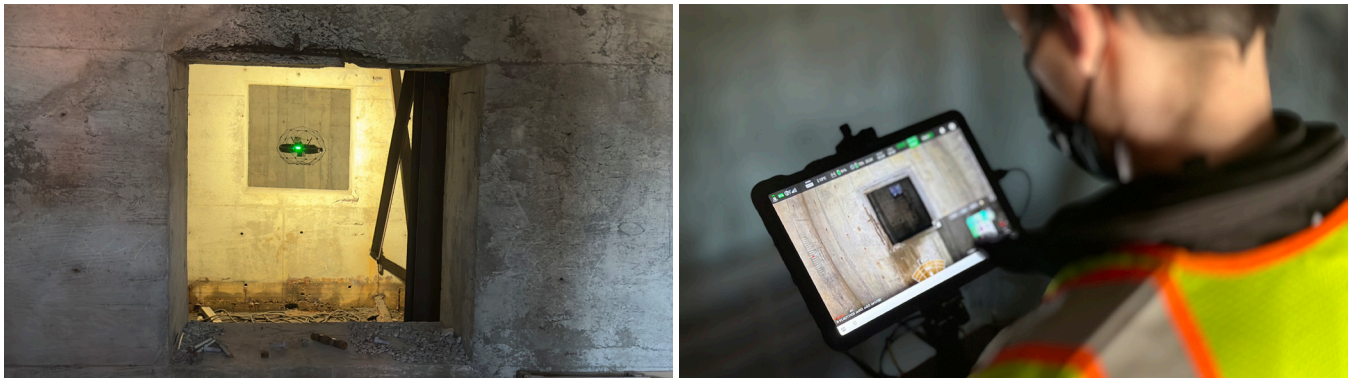
An example of the Elios 3 vs TLS in a similar plant: The Elios 3 on the left vs a traditional laser scanner on the right.

Example Workflow: Scan to BIM with the Elios 3

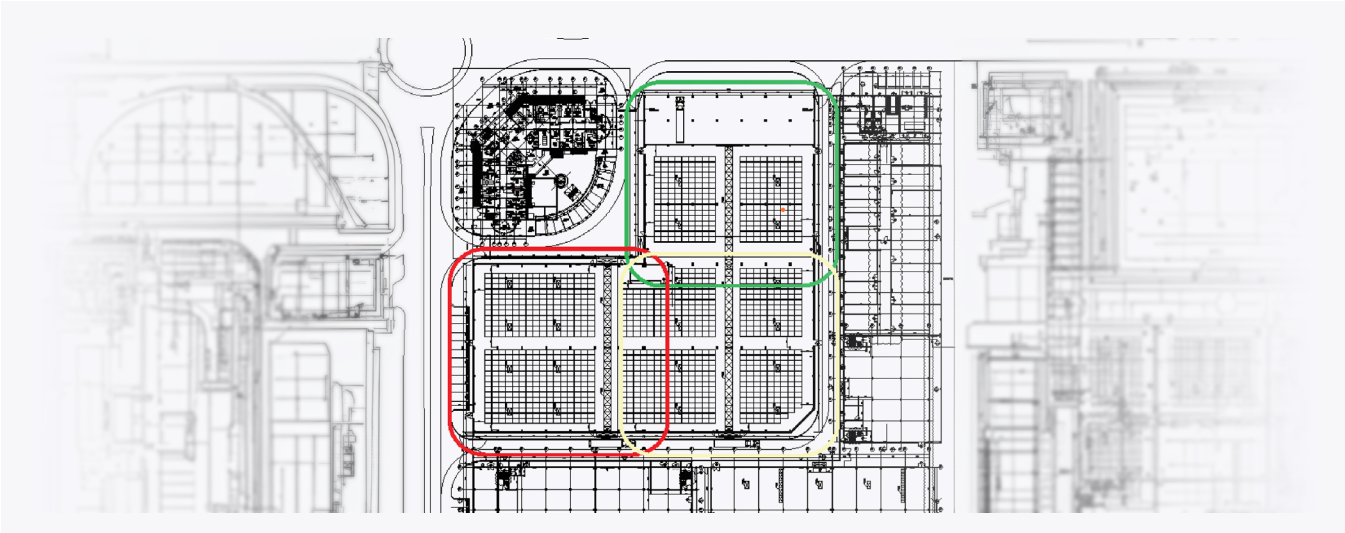
Using the Elios 3 for Scan to BIM is a safe, fast, and reliable process. The workflow typically covers about 3 steps.

01. Data capture

The Elios 3 can fly around the desired environment, such as around industrial plants, bridges, dams, and roof structures. Pilots should follow Flyability's best practices - as suggested in **Flyability's knowledge base** - to ensure they capture data that can be easily merged across datasets from different flights.



Data collection on-site with the Elios 3.

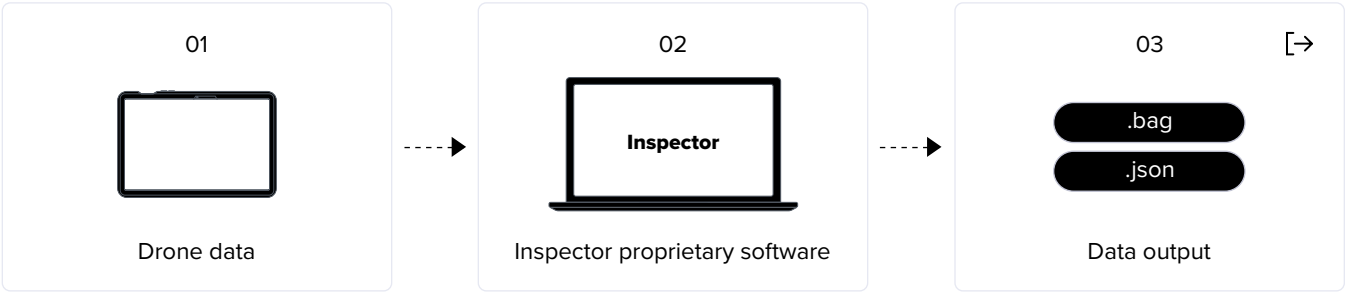


Flight mapping and planning on an industrial site, using existing floor plans

This type of work focuses on the quality of the LiDAR scan, so it is recommended to use the Elios 3's Surveying Payload, as it is the more powerful LiDAR sensor and thus provides better results than the standard LiDAR payload.

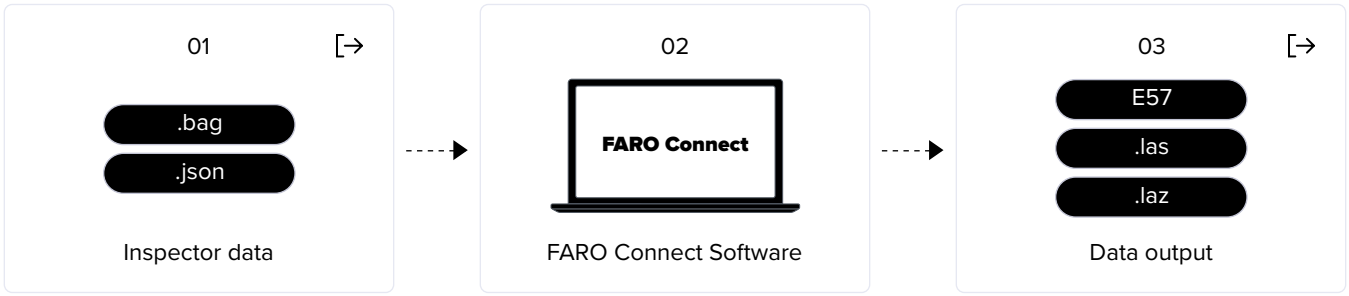
After the flight, the Elios 3's data can be imported into Inspector, Flyability's companion software for the Elios 3. In Inspector, flight data is organized by asset and can be instantly visualized in a digital twin—with no additional processing required. Inspector 5 allows for reviewing flights, checking and annotating points of interest, and generating formatted reports as needed.

The output at the end of this stage would be a .bag and .json format file that can easily be exported to FARO Connect software to further process and manage the Elios 3's LiDAR data.



02. Processing to point cloud

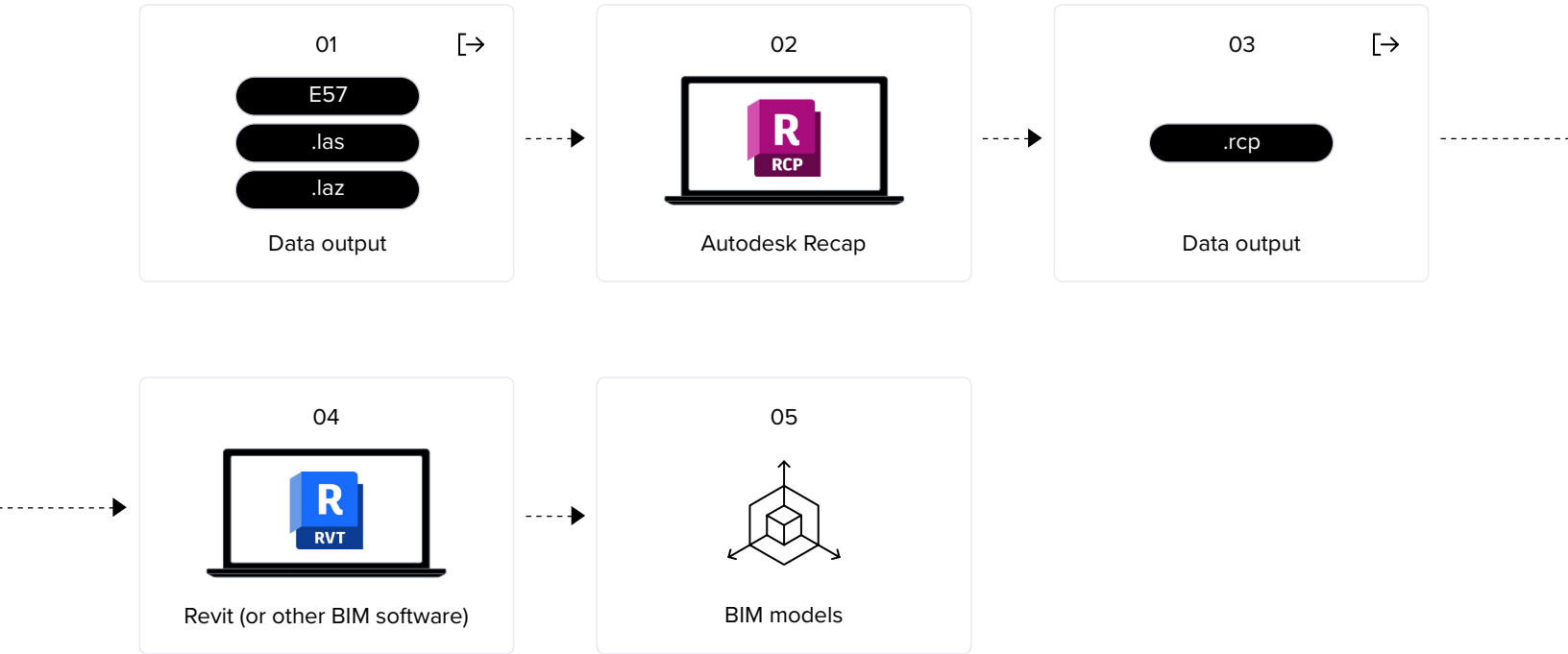
During post-processing of the point cloud, the data is treated and prepared for importation to BIM software. In the example of flying around an industrial plant, the BAG and JSON files would be imported to FARO Connect, Flyability's partner software for surveying. The point clouds could then be aligned using custom features and pre-set filters in the software that are tailored to the Elios 3. A noise filtering workflow can also help remove outlying data points on planar surfaces, providing cleaner overall results. The output at the end of this stage would be a .las or E57 format file that can easily be exported to other software.



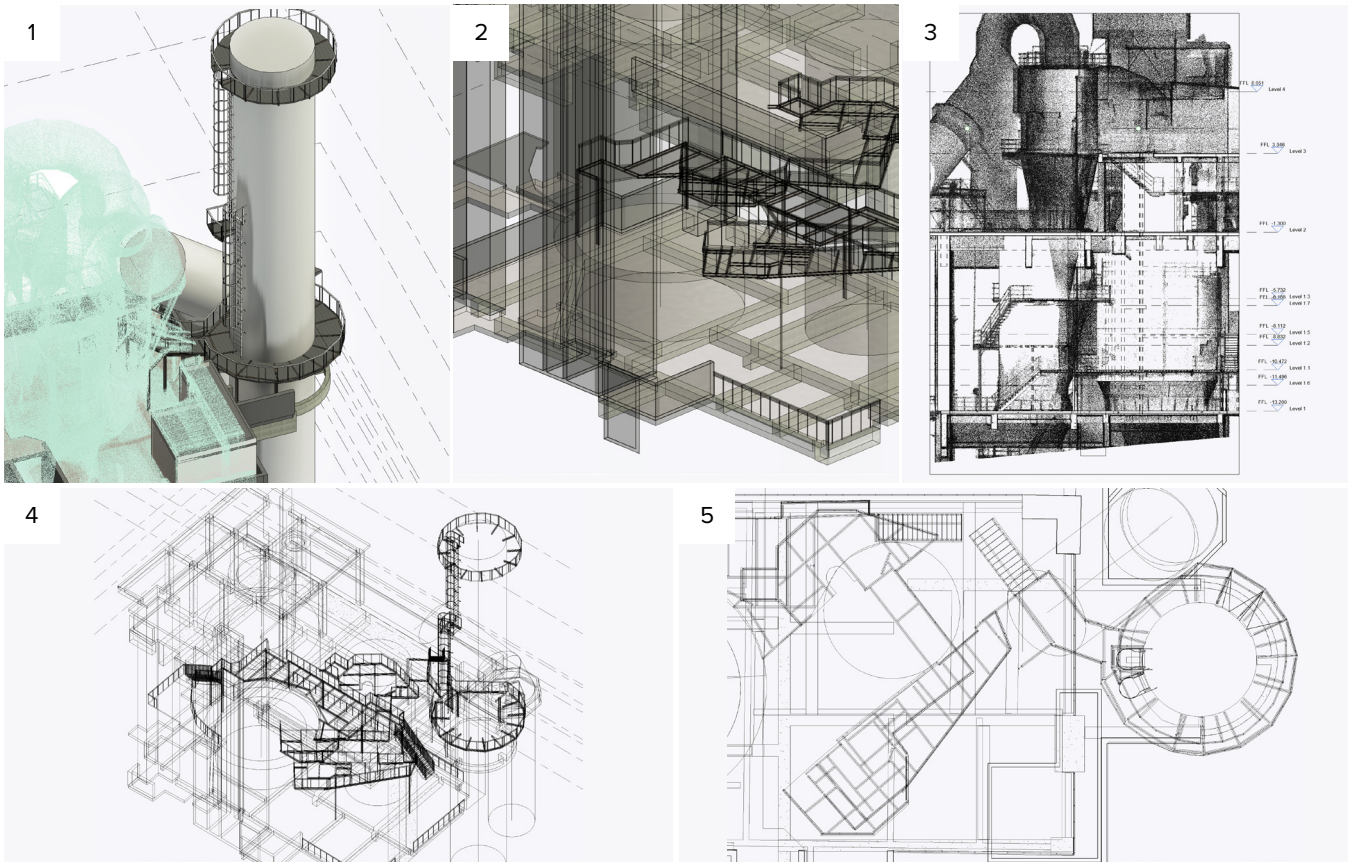
03. Processing to BIM

Now the data can be imported into Scan to BIM software. The right software for this step depends on the needs of the project, the existing system (eg if the various processing software can share files), and the feature set desired.

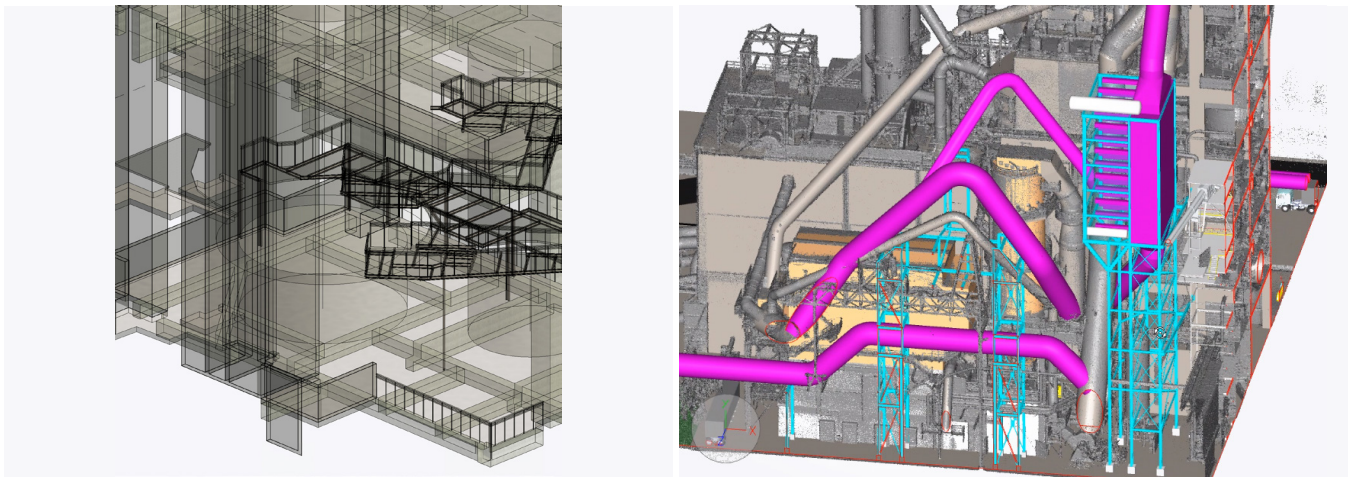
Flyability datasets have been successfully used to create BIM models with Autodesk Recap and Revit by converting .las files into RCP files. Once in BIM software, the data can be visualized and clipped, removing areas of scan coverage that are unnecessary. The data is then exported as a .rcp file and imported into CAD software, ready for designing, modeling, and documenting building projects.



Examples of applications for BIM models in Revit:



Examples of applications for BIM models in Revit: 1) MEP system layout and design, 2) Structure and substructure layout, 3) Cross section, 4) Isometric wireframe views, and 5) Floor plans

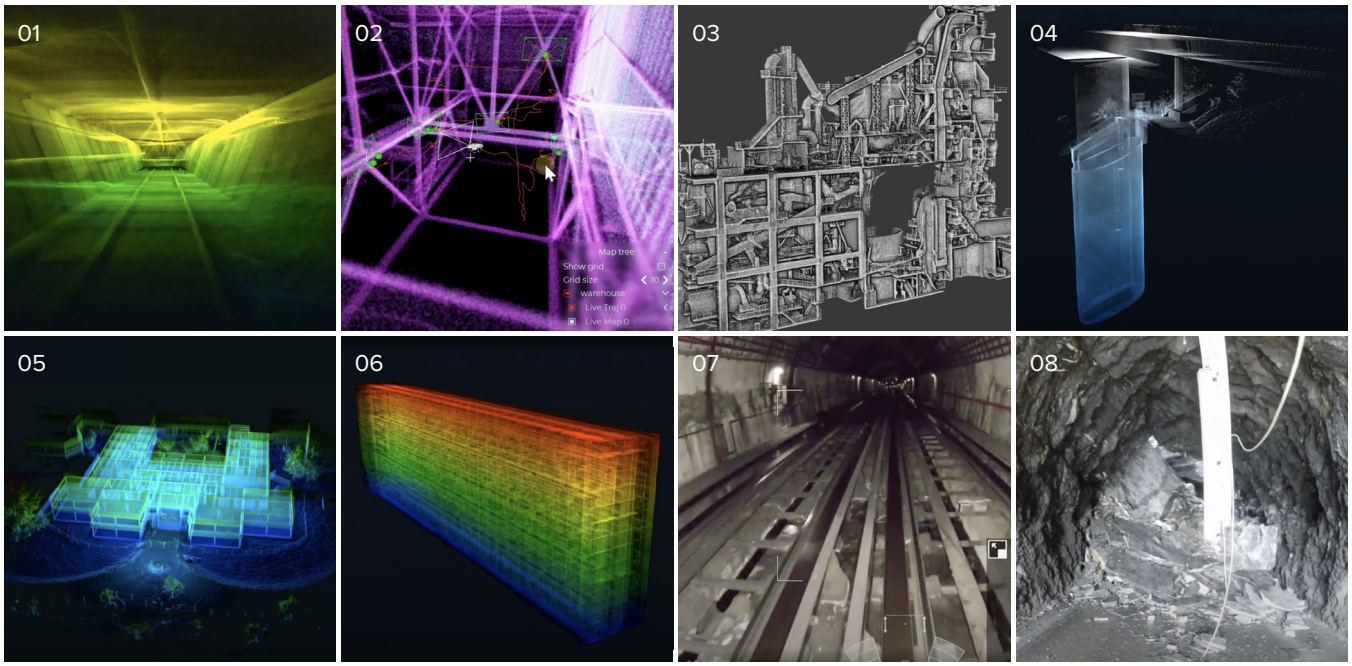


Example of Schematic design for engineering layout and spatial design of new structure and MEP.

Example Applications of Scan to BIM with the Elios 3

As an adaptable drone, the Elios 3 can capture Scan to BIM data in a variety of sites, making it hugely useful in a range of inspections. Some examples include inspections for:

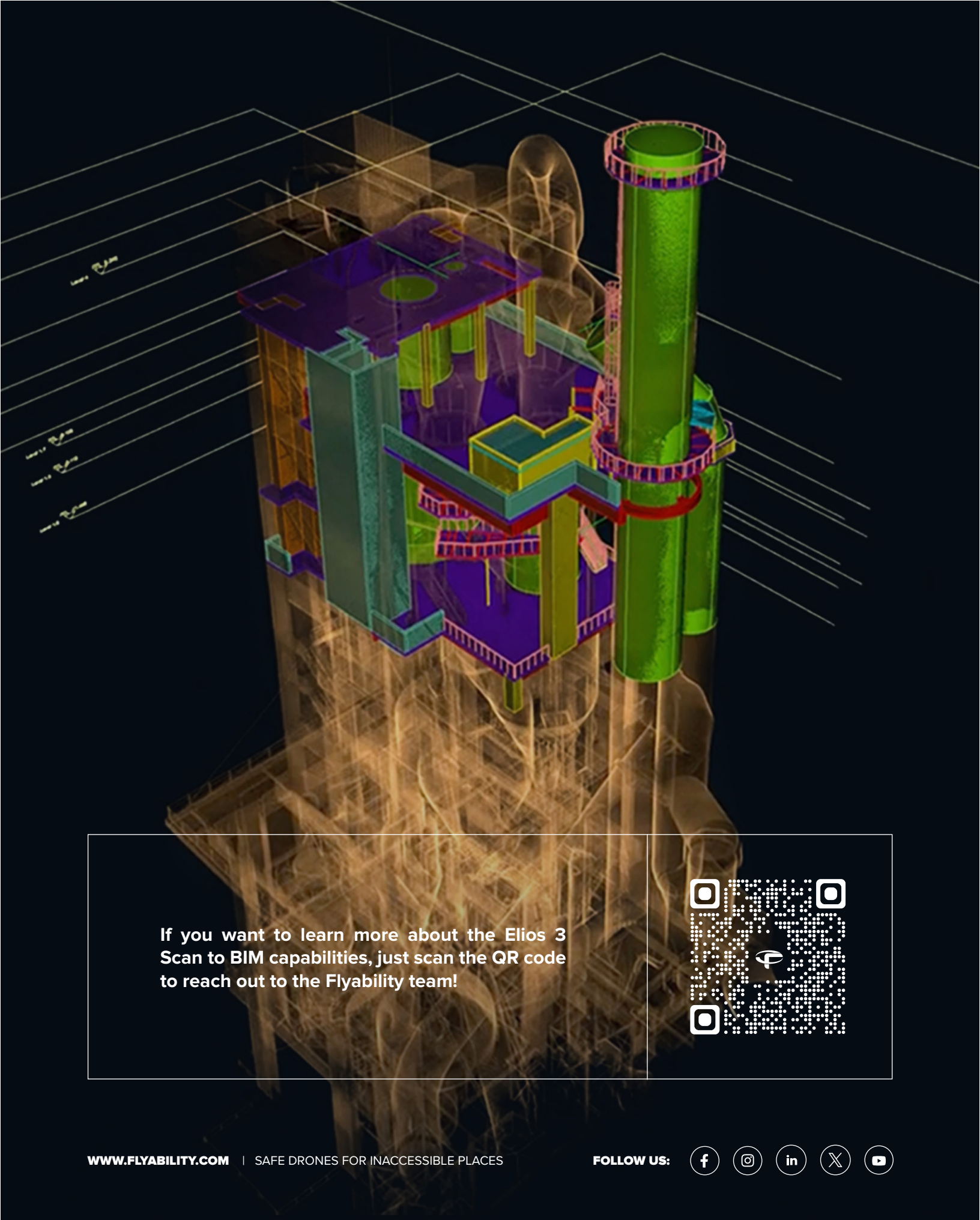
01. Bridges
02. Roof structures
03. Industrial infrastructure
04. Vertical structures (such as pylons or lift shafts)
05. Limited access buildings (construction sites included)
06. Warehouses
07. Underground transport
08. Emergency response



Conclusion

It is estimated that almost 70% of construction companies are using BIM at various levels, with a focus on architecture companies. The clear visualization is making it possible to communicate more clearly across stakeholders of a project, from conception and design to breaking ground and tracking progress. As BIM models can be updated with as-built changes, it is a critically useful tool for reporting and documentation amongst many other benefits. Now, with the Elios 3, it is possible to get the data for BIM models in a better, safer way.

The Elios 3 and its Surveying Payload are poised to collect vital data for Scan to BIM projects, whether in confined spaces or surrounding a major construction site. The speed, data quality, and accessibility improvements offered by the Elios 3 make it a strong competitor to traditional laser scanners. With the rise of new technology like the Elios 3, it is possible to achieve more with BIM than ever before, including generating complete, gap-free models of previously inaccessible environments.



If you want to learn more about the Elios 3 Scan to BIM capabilities, just scan the QR code to reach out to the Flyability team!