3D Visualisation Capability and Experience

ABSTRACT:

As part of its structural engineering and inspection services, SIE has developed a comprehensive suite of 3D modelling and visualisation capabilities. These include reality capture and photogrammetric modelling, integration with Bentley iTwin and other visualisation platforms, and the creation of accurate 3D drafting models which may be stand-alone models or that can be embedded within reality-capture environments to visualise changes to existing structures. SIE's in-house UAV assets and CASA-approved pilots ensure high-quality data collection suitable for engineering-grade modelling. By combining structural engineering expertise with advanced drone technology and high-end modelling workflows, SIE delivers modern 3D visualisation solutions across a wide range of structures, plant, and industrial components.

KEYWORDS: *Photogrammetry, Reality Modelling, 3D modelling, Drafting*

1. INTRODUCTION

SIE is a specialist structural engineering consultancy, specialising in the provision of structural engineering advice to our Port, Mining and Heavy Industrial client base. We have substantial experience and expertise in the execution of the condition assessment and subsequent remedial works design for a range of mine, port and maritime assets including mines infrastructure, machines, wharves, jetties, mooring dolphins, transhipping equipment, and navigation aids.

For this work, we have invested in the use of technology associated with 3D photogrammetry and modelling, integration with Bentley iTwin, plus the capacity to create 3D models of other items for insertion to the digital twin.

SIE has internal UAV / drone assets and CASA approved pilots to ensure data capture at the quality levels required to produce the necessary models.

We leverage our structural engineering and drafting experience and expertise with drone and modelling technology to provide tailored solutions to 3D visualisation requirements.

2. SIE CAPABILITY AND EXPERIENCE

2.1. COMPANY PROFILE

Structural Integrity Engineering Pty Ltd (SIE) is an Australian owned engineering consultancy with Engineers in Perth, Brisbane, and Newcastle. We specialise in the provision of expert engineering advice to the mining, ports, heavy industrial companies, and large infrastructure asset owners.

Key capabilities that form the basis of SIE's 3D visualisation capability include:

a) UAV inspections.

b) UAV and handheld photography and video capture.

c) Processing UAV and handheld imagery to 3D reality models.

d) Engineering 3D modelling and drafting.

e) Visualisation of proposed modifications to existing structures in 3D reality models.

2.2. SIE EQUIPMENT AND RESOURCES

SIE operates under a CASA Remotely Piloted Aircraft Operator's Certificate (ReOC), ensuring full compliance with Australian aviation regulations. Our team consists of a Chief Remote Pilot (RePL) and an additional Remote Pilot (RePL), both CASA-accredited and experienced in aerial operations.

Key aerial assets available to SIE for inspection, photography and capture projects include:

a) DJI Matrice 350: A robust, enterprise-grade platform designed for high-precision aerial capture with RTK positioning for improved accuracy.

   Payload options available to SIE include the Zenmuse P1 (45MP) full-frame camera for photogrammetry and the Zenmuse H20 (20MP) multi-sensor camera for versatile imaging and inspection.

   If necessary, other specialised payload options (for example, LIDAR) may be sourced to meet the specific requirements of 3D visualisation project.

b) Skydio X10: Combines cutting-edge automation and AI-driven obstacle avoidance with RTK precision for efficient, safe, and accurate data collection.

   SIE have adopted the VT camera payload which offers high-resolution visual and thermal imaging, enabling advanced inspection and situational awareness. Compact, airline-compliant batteries allow transport via commercial flights, simplifying mobilisation and accelerating deployment.

"SIE has the equipment, expertise and software to meet our clients 3D visualisation requirements"

These aerial assets are supplemented by terrestrial / handheld photography capture for areas where drone operations are unsafe or not possible.

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2.3. DATA CAPTURE / OPTIONS

SIE have experience and proven capabilities in capture for the purpose of reality modelling and 3D visualisation using the following methods:

a) Manually piloted aerial capture using either the Matrice M350 or Skydio X10 drone.

b) Automated aerial capture (via flight planning software) using either the Matrice M350 or Skydio X10 drone.

c) Fully autonomous aerial capture leveraging the Skydio X10's advanced AI-driven automation.

d) High resolution handheld capture using high quality handheld cameras and where appropriate, gimbals.

e) Semi-automated handheld capture using phone camera's and specialist capture app's (which may be exported for processing in SIE's preferred processing software).

2.4. SIE 3D MODELLING AND VISUALISATION SOFTWARE – REALITY MODELLING

SIE has the capability to capture and process high-resolution aerial and handheld imagery into 3D reality models. These have been used to support asset inspections, populate with defect data for graphical reporting, and to assist with planning and designing remedial works or modifications to existing structures.

SIE have successfully prepared reality models of various sizes in a range of industry software and can tailor processing and deliverables to meet our clients preferences and requirements. This modelling experience has included use of the following software packages:

a) Bentleys iTwin package;

b) Trendspek;

c) Pix 4D Cloud (limited to 4000 images);

d) Autodesk's Recap (limited to 2000 images), and;

e) Asseti.

Figure 1: *Example of a complex 3D reality model of a large iron ore reclaimer prepared and shared with our clients using the Trendspek software.*

The primary reality modelling software currently used by SIE is the Bentley iTwin Capture Modeller, which we have linked to the Bentley iTwin Experience for annotation and sharing of models with clients.

The advantage of this software is that our team can manage the entire process, from data capture through model generation to online sharing with our clients.

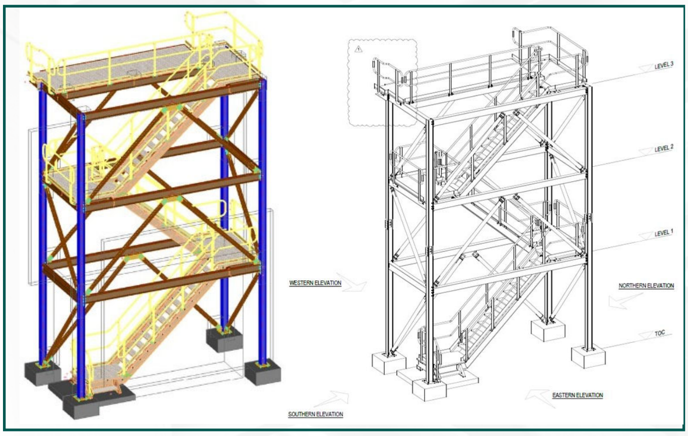
Figure 2: *Example of a complex 3D reality model of a large iron ore bargeloader prepared using the Bentley iTwin Capture Modeller software and shared with our clients via the Bentley iTwin Experience software.*

2.5. SIE 3D MODELLING AND VISUALISATION SOFTWARE – DRAFTING AND 3D MODELLING

In addition to the reality modelling capabilities, SIE have a range of capabilities and drafting / modelling options. These include:

a) Drafting with Autodesk Software - SIE has the capability to produce accurate technical drawings and detailed design documentation using Autodesk AutoCAD, Advanced Steel, and Revit. These tools allow us to deliver 2D drafting, structural steel detailing, and 3D visualisation for our engineering projects.

Figure 3: *Example of a detailed 3D model of a new multi-level stair tower retrofitted to a large product storage warehouse, created in the Autodesk advanced steel software. This model was used to produce engineering drawings for fabrication of the new steelwork.*



b) 3D Modelling with Rhinoceros - SIE uses Rhinoceros for advanced 3D modelling, particularly where complex geometries or freeform design elements are required. This capability enables us to create precise, adaptable models suitable for integration into broader design workflows. For example, as an input into detailed Finite Element Modelling or to produce engineering drawings.

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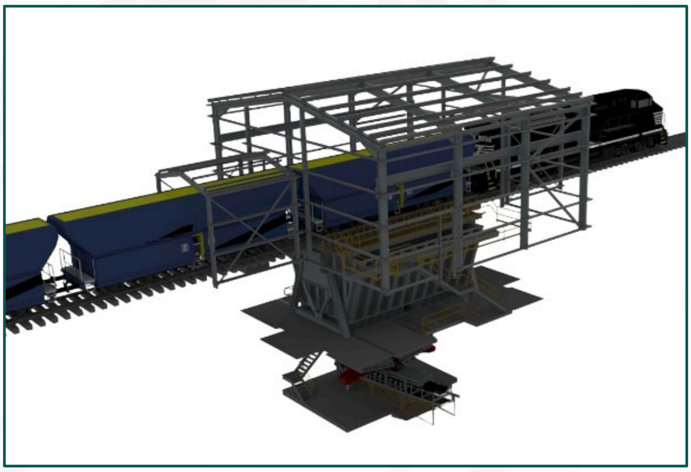
Figure 4: *Example of a detailed 3D model of a train unloading facility prepared in the Rhinoceros software. This modelling was used as part of an Engineering project for the development of repair designs for the remediation of this facility.*



c) Drafting with Bentley MicroStation - SIE has capability in Bentley MicroStation for producing detailed drawings and models within Bentley's design ecosystem. This allows us to support projects that require compatibility with Bentley-based workflows and standards.

d) Access to Bentley Civil WorkSuite - SIE has access to the Bentley Civil WorkSuite, which includes tools for civil engineering design and analysis. We can utilise these tools for specific project requirements where Bentley civil design integration is necessary.

3. USE CASES AND EXAMPLES

3.1. ASSET VISUALISATION

In its most basic form, reality modelling can be used as a basic 3D 'map', which may be used to quickly understand site layout, access constraints, and the spatial relationship between key assets.

It can serve as a simple, shared visual tool that helps align stakeholders and eliminates ambiguity in discussions about site conditions.

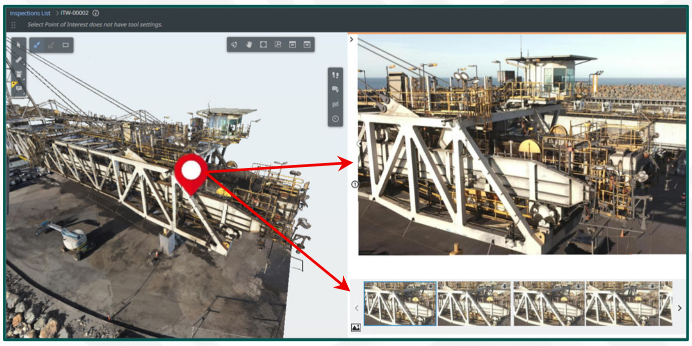
3.2. STRUCTURAL INSPECTION

Our development of this reality-modelling capability was driven by the need to streamline structural inspections. Instead of reviewing thousands of photos or hours of video footage, high-fidelity 3D models allow engineers to navigate the asset visually, locate areas of concern instantly, and understand context that traditional media often fails to capture.

Platforms such as Trendspek and Bentley iTwin Experience further enhance this process by allowing users to open the original source images for any point of interest directly within the model environment, providing both spatial context and detailed visual evidence in one place.

This significantly accelerates inspection workflows, particularly for difficult to access areas, and improves the accuracy and consistency of engineering assessments.

Figure 5: *Screenshot from the Bentley iTwin Experience shows an inspector viewing / inspecting the raw drone imagery for a point of interest on the Bargeloader model (from Figure 2 above), directly within the reality model environment.*



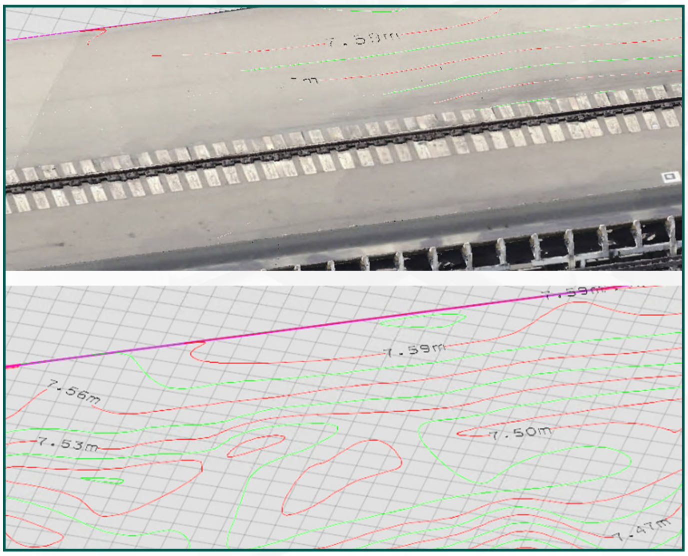
3.3. TRACKWORK INSPECTION

Due to the scale and length of trackwork that typically supports bulk handling machinery, traditional 'on-foot' detailed inspections can be time-consuming. SIE has demonstrated the capability to rapidly capture high-quality imagery of trackwork using our UAV assets, enabling the creation of reality models for inspection, condition assessment, and defect reporting.

This approach improves efficiency by reducing the time required onsite, as engineers no longer need to record detailed notes or photographs for every component. The reality model provides all necessary detail for follow-up review in the office, allowing the on-site portion of the inspection to be completed much more quickly.

In addition to defect identification, these reality models can also provide a first-pass assessment of drainage, settlement, or alignment issues. By leveraging the GPS-enabled accuracy of the UAV data, contour maps and cross-sections can be generated from the underlying mesh, offering a practical means of detecting gross trackwork anomalies that may require more detailed survey or engineering follow-up.

Figure 6: *The below example shows (a) a section of the base reality model of a machine track (top) and (b) a sample contour map (with fine 15mm contour spacing) for the same segment of track created from the model's underlying geometry mesh (bottom).*



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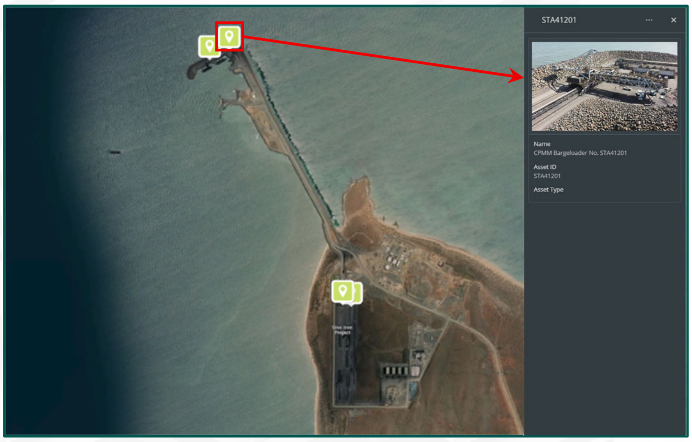
3.4. ASSEMBLY OF MODELS INTO PORTFOLIOS

Assembly of reality models of various items of plant and equipment into a portfolio of assets, is possible using platforms such as the Bentley iTwin Experience or Trendspek software's.

Organising assets into portfolios within reality-modelling platforms like Trendspek or Bentley iTwin Experience makes large, complex sites far easier to manage. Related structures can be grouped logically by facility, location, or asset type, so engineers can quickly move from a high-level overview to individual components without searching through disconnected files.

This structure supports clearer comparison of asset condition, more consistent inspection workflows, and faster identification of emerging risks.

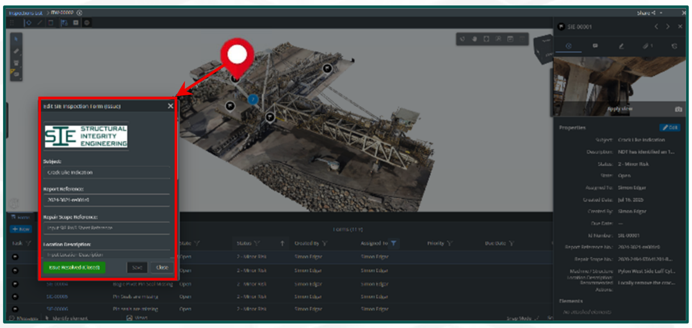
Figure 7: *The example below shows a portfolio of four assets which were captured, modelled, and annotated with defect data from SIE's structural inspections of these plant items. Additional assets will be added to this portfolio as inspection works of the sites plant progress.*



3.5. VISUAL REPORTING AND DEFECT TRACKING

Reality models provide a powerful platform for visual reporting, enabling defects to be identified, annotated, and tracked directly within a 3D environment. Engineers can place annotations at the exact spatial location of each defect, creating a clear and intuitive record of condition issues across the asset. Additional information, such as engineering sketches, repair scopes, photographs, or inspection notes, can be attached to each annotation, consolidating all relevant data into a single accessible source.

Figure 8: *Screenshot from the Bentley iTwin Experience which shows the Bargeloader model (from Figure 2 above), annotated to show the locations of defects identified during a structural inspection.*



This approach allows the overall condition of an asset to be understood at a glance, as the visual distribution and density of annotations immediately highlights areas of concern. Defects can be sorted, filtered, and categorised by type, severity, risk rating, or required action, enabling targeted reviews and efficient prioritisation of maintenance activities. The result is a structured, traceable defect-management process that enhances communication between inspectors, engineers, and asset owners while improving the clarity and quality of reporting.

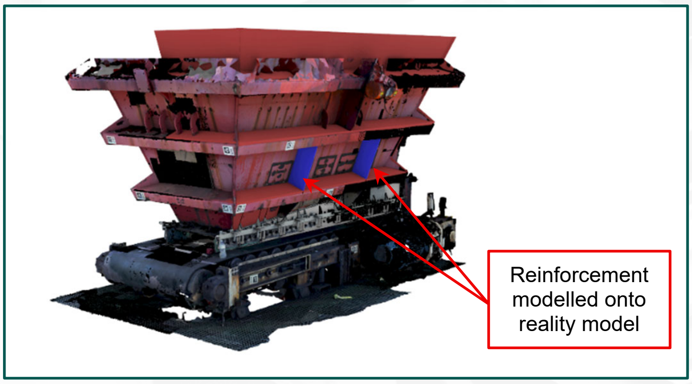
3.6. REPAIR SCOPING AND DESIGN

Reality models provide a highly effective platform for scoping and designing repairs, as they give engineers an accurate, spatially-rich view of defects and surrounding structural context.

Instead of relying solely on photos or written notes, engineers and designers can inspect the model to confirm defect dimensions, access constraints, connection details, and interactions with adjacent components. This enables more accurate definition of repair extents and quantities, and supports a more reliable definition of repair extents during early scoping.

The 3D environment supports clearer communication between inspection teams, designers, and maintenance crews. Proposed repair locations can be tagged directly within the model, allowing all stakeholders to visualise exactly what needs to be addressed. In many cases, the model provides sufficient information for preliminary design development, such as confirming member sizes, measuring clearances, or assessing the geometry required for temporary works or access systems. This leads to more efficient design workflows, reduced site re-visits, and better-coordinated repair planning.

Figure 9: *Example showing a use case where stiffening designed to address excessive hopper wall deflection was modelled onto the reality model of the hopper wall, to check for clashes and appropriate fit up.*



3.7. STRUCTURAL ANALYSIS

The geometric mesh underlying reality models can be used as a direct input into detailed finite element modelling, providing a practical solution for analysing structures with complex or irregular geometry that would be difficult and time-consuming to reproduce through traditional drafting methods.

By importing the mesh generated from a high-quality reality model, engineers can rapidly build FEA models that represent the true geometry of the asset. SIE has applied this approach to assess bollard design capacity, where the existing shape and load path interactions were critical to understanding structural performance.

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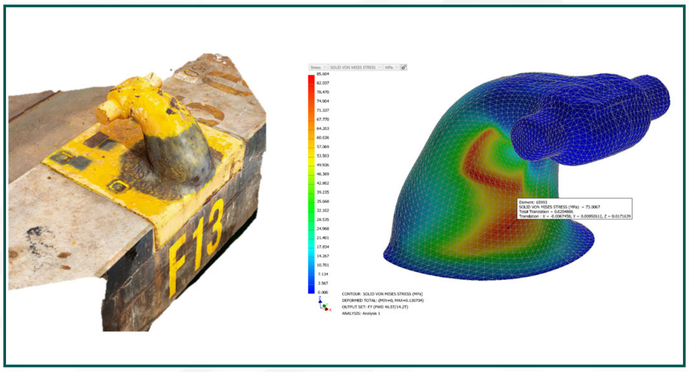
This method is best suited to 'clean' structures (those where the surfaces of interest are unobstructed by secondary steelwork, services, or other components) and where a high-quality, continuous mesh can be captured. When these conditions are met, reality-derived geometry provides an efficient and reliable pathway to generate detailed FEA models, improving confidence in the assessment while reducing the effort required to manually model complex forms.

Figure 10: *Example showing the base reality model of a mooring bollard on the left, which was used for the creation of the geometry of the finite element model shown on the right.*



3.8. DESIGN MODELLING AND DRAFTING

SIE provides high-quality 3D modelling and drafting services to support the design, assessment, and fabrication of structural components across a broad range of industrial and mining assets.

Our modelling workflows allow complex structures to be accurately represented in three dimensions, giving engineers and stakeholders a clear visual understanding of geometry, interfaces, and load paths early in the design process.

Our 3D models are developed using common industry drafting platforms and can capture ranging in size and complexity from large, intricate machines to small, discrete steelwork assemblies.

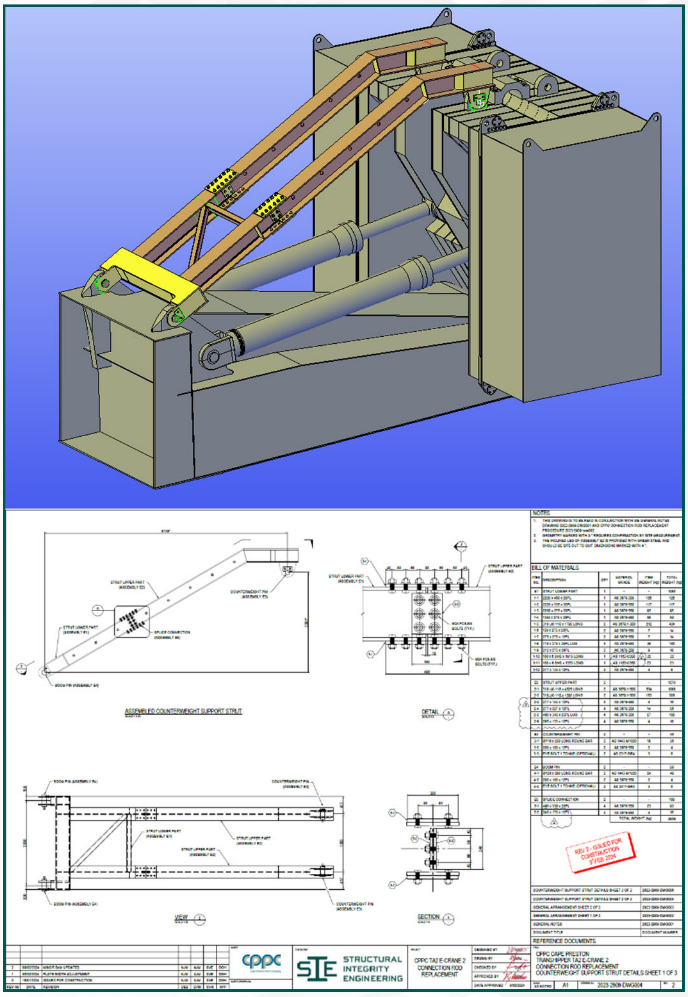
Figure 11: *Example showing detailed 3D modelling of a bucketwheel reclaimer, which was created using the 3D modelling software Rhinoceros.*

The models can be used to form the basis for generating detailed 2D engineering drawings, ensuring that fabrication outputs are consistent, accurate, and aligned with design intent. In these cases, by maintaining a single, authoritative 3D source model, we minimise rework and streamline the transition from concept through to workshop documentation.

Whether developing a full machine model or a localised modification, SIE's approach ensures that structural designs are clearly communicated and readily understood by designers, fabricators, and site crews alike. The result is efficient, well-coordinated design delivery with a high degree of confidence in constructability.

Figure 12: *Example showing a detailed 3D model of steelwork used to temporarily restrain a machine counterweight during maintenance works (top) and its conversion into 2D engineering drawings for the fabrication of the steelwork (bottom).*

This model was created using the Autodesk Advanced Steel software package. For this job, the Advanced Steel model was also used to rapidly develop shop drawings of the temporary support steelwork.



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4. SAMPLE PROJECT HISTORY

Since SIE's development of drone imaging and reality modelling capabilities in 2019, SIE have completed numerous reality modelling and visualisation projects, including:

Alcoa – 2026 - Handheld capture and reality modelling of 14x crawler assemblies supporting residue handling equipment as part of a structural inspection of these components.

Pilbara Ports Authority – 2025 – Aerial capture and reality modelling of 1x Shiploader as part of a structural inspection for this machine.

Cape Preston Port Company – 2025 – Handheld capture, reality modelling processing and then modelling of modifications into the reality model, to visualise modifications to a hopper structure.

CITIC Pacific Mining – 2024 – Combined aerial and handheld capture and reality modelling of 1x Shiploader and its trackwork, as part of a structural and trackwork inspection campaign.

CITIC Pacific Mining – 2024 – Handheld capture, reality modelling processing and then modelling of modifications and clash detection for modifications to a walkway access platform and ladder assembly.

Pilbara Ports Authority – 2024 – Aerial capture and reality modelling of 1x Shiploader as part of the structural inspection for this machine.

Pilbara Ports Authority – 2024 – Handheld capture and reality modelling processing of 1x aged mooring bollard, and import of reality modelling geometry into Finite Element Analysis software for strength assessments of the deteriorated bollard.

Pilbara Ports Authority – 2024 – Handheld capture and reality modelling processing of 22 mooring bollards, to capture and record the condition of these items, as part of a mooring hardware inspection campaign.

CITIC Pacific Mining – 2023 – Aerial capture and reality modelling of 1x Bucketwheel Reclaimer and 1x Stacker, as part of a structural inspection campaign.

Alcoa – 2023 – Processing of a reality models from imagery captured by Alcoa in-house drone team for 1x Bridge Reclaimer and 1x Shiploader, as part of a structural inspection campaign.

Figure 13: *Example showing a sample crawler assembly reality model, which was processed from handheld photography captured during an inspection of the crawler steelwork.*

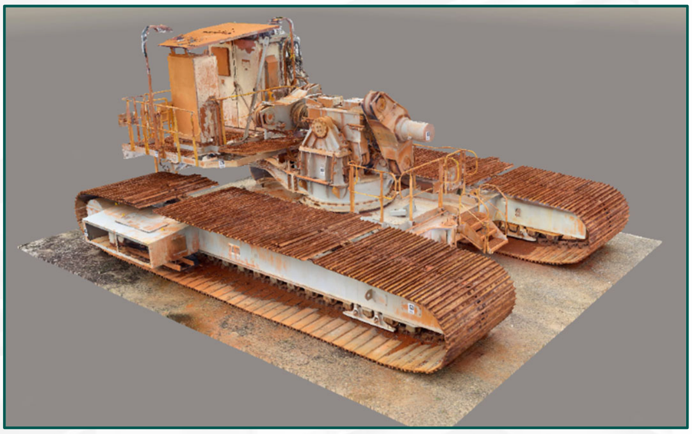

Figure 14: *Example of a reality model of mooring hardware, processed from an aerial photography of the wharf, captured during a structural inspection of that wharf.*

5. CONTACTS

For additional information or enquiry, please contact SIE at info@siepl.com.au