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Digital Surveying and Highway Design

DIGITAL SURVEYING AND HIGHWAY DESIGN
(ACBA4017)

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Part 1: Planning and Purpose of the Survey

The purpose of this survey was to undertake a professional digital building survey of the Dylan Thomas Centre in Swansea Marina using terrestrial 3D laser scanning technology, supplemented by traditional manual measurement techniques. The primary objective was to capture accurate spatial data representing the internal geometry of the building, including room layouts, structural features, door and window openings, and floor-to-ceiling heights (RICS, 2014).

In addition to laser scanning, the survey was planned to include the use of a tape measure and a digital distance measuring tool to record key dimensions manually. Hand-drawn sketches annotated with dimensions were also planned as part of the survey methodology. This combined approach reflects common professional practice, where traditional methods are used alongside digital technologies to aid spatial understanding and provide a means of validating survey data.

The Dylan Thomas Centre is a publicly accessible cultural and exhibition building, making it an appropriate case study for a real-world survey environment with operational constraints such as public access, fixed opening hours, and internal obstructions. The survey data could be used for applications including as-built documentation, facilities management, refurbishment planning, or heritage recording (DylanThomas.com, 2025).

Traditional measured surveys can be time-consuming and prone to cumulative error, particularly in complex internal environments. The use of 3D laser scanning allows for rapid data capture while maintaining a high level of accuracy and completeness. This project aimed to replicate industry-standard surveying practice, from planning through to data interpretation (RICS, 2021).



Figure 2 - Image of 3D Laser Scanner (CADSSurveys.co.uk)

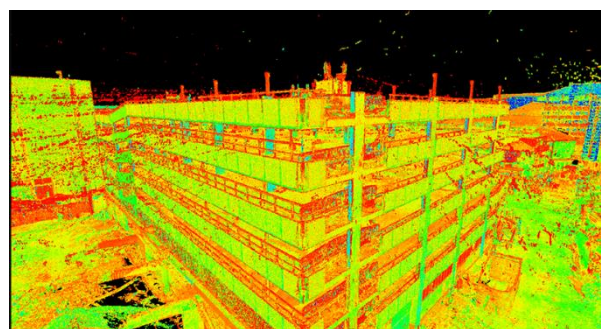


Figure 1 - Example of results using a 3D Laser Scanner (cadssurvey.co.uk)

Survey Area Definition

The defined survey area focused primarily on selected internal spaces within the Dylan Thomas Centre. These included circulation areas, exhibition rooms, and associated internal architectural features. External scanning was limited, as the primary learning objective was to capture and interpret internal building geometry rather than full site context.

The required level of detail was suitable for measured building survey outputs, including:

- Overall room dimensions
- Wall thicknesses and alignments
- Door and window sizes
- Floor-to-ceiling heights
- Fixed architectural features such as columns and recesses

A level of detail equivalent to RICS Measured Survey Guidance was targeted, ensuring the data would be suitable for producing scaled floor plans and sections if required. High-resolution scans were planned in smaller rooms to ensure sufficient point density, while larger spaces were scanned from multiple positions to minimise shadowing and occlusions. Manual measurements were intended to record key dimensions and assist with orientation and understanding during the survey. Hand sketches were planned to act as a visual reference and to support later interpretation of the digital data. Both surveys were compared afterwards to compare accuracy of both surveys (*RICS, 2014*).

Site Assessment

Access and Logistics

The Dylan Thomas Centre is located in Swansea Marina, with good pedestrian access and nearby public transport links. Access to the building was controlled, requiring coordination with staff to ensure scanning could be undertaken safely without disrupting visitors. Internal access was generally good, with level floors and wide circulation routes, allowing tripod-mounted scanning equipment to be moved easily between scan positions.

Scanning Positions

Scanning positions were planned to maximise coverage while minimising the total number of scans. Positions were selected at room corners, central locations, and along corridors to ensure sufficient overlap between scans for accurate registration. Particular attention was given to doorways and connecting spaces to maintain continuity across the dataset. Manual measurement points were planned to coincide with easily identifiable features such as wall

junctions, door frames, and ceiling edges, allowing for later comparison with point cloud measurements.

Lighting Conditions

Lighting conditions consisted of a combination of artificial lighting and natural daylight from windows and glazed areas. As laser scanning does not rely on ambient lighting, this was not considered a constraint. Manual measurement and sketching were also unaffected by lighting levels.

Safety Considerations

As the building is open to the public, safety was a key consideration. Tripods and scanners were positioned to avoid creating trip hazards. Scanning was carried out during quieter periods to minimise interaction with visitors and reduce the risk of movement artefacts in the scans.

Risk Assessment Summary

A summary risk assessment was carried out prior to the survey and considered both digital and manual survey activities.

Public Interaction Risk:

Visitors could interfere with equipment or walk through scan areas.

Mitigation: Surveying undertaken during quieter periods, clear communication with building users.

Trip Hazards:

Tripods, tape measures, and surveyor movement posed potential hazards.

Mitigation: Equipment placed away from main walkways and supervised at all times.

Equipment Damage:

Risk of laser scanner or digital measuring tool being knocked or dropped.

Mitigation: Stable tripod setup and controlled handling of all equipment.

Manual Handling and Fatigue:

Repeated movement of equipment and manual measuring could cause fatigue.

Mitigation: Regular breaks and efficient survey planning.

A key objective of this assignment was not only to conduct a measured building survey, but also to critically evaluate the effectiveness of digital surveying technology within a real-world context. As such, the planning stage was informed by the intention to assess how 3D laser scanning performs in comparison to traditional measured survey techniques.

By planning a combined methodology that incorporated laser scanning, manual tape measurement, digital distance measurement, and hand sketching, the survey was designed to allow direct evaluation of accuracy, efficiency, data completeness, and practical usability. Consideration was given to how each method would perform within a public, operational building, and how constraints such as time, access, and environmental conditions might affect data quality.

This evaluative approach ensured that the survey was not solely focused on data capture, but also on understanding the strengths and limitations of digital measured surveys in professional practice.

Part 2: Practical Survey Execution

Evidence of On-Site Presence

Evidence of on-site activity was recorded through photographs showing the laser scanner set up on a tripod within the Dylan Thomas Centre, various scan positions, and the surrounding internal environment. Additional evidence of manual measurement activity and hand-drawn sketches further demonstrate active participation in the survey process and the results

Please find below, results of manual measurements taken on site:

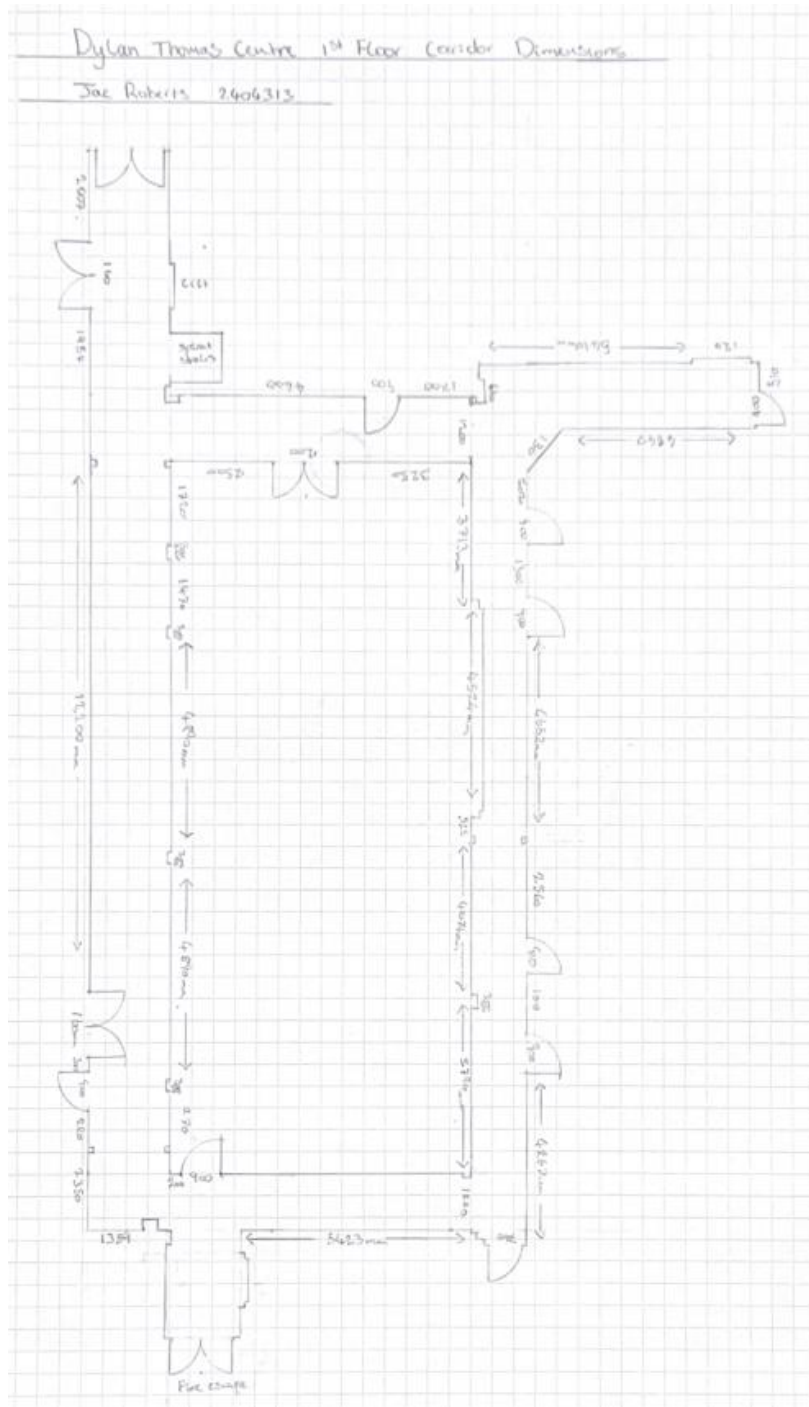


Figure 3 - Sketch of manual measurements taken of the Dylan Thomas Center.

Survey Execution Summary

The laser scanning survey was carried out broadly in accordance with the original plan. Scan positions were established to ensure adequate coverage and overlap, and the scanner operated effectively throughout the survey. Manual measurements were also taken as planned, using a tape measure and a digital distance measuring device to capture key dimensions (Booth, Hill and McCaffrey, 2017).

Hand sketches were produced during the site visit, with dimensions written directly onto the drawings. These sketches assisted in understanding the building layout in real time and provided a useful reference for later interpretation of the point cloud data.

Minor adjustments to the plan were required due to temporary exhibitions and visitor movement, which occasionally restricted access to planned scan positions or manual measurement points. These were addressed by repositioning equipment and prioritising key spaces.

The on-site survey represented a practical application of a digitally enabled measured building survey. The laser scanner was used as the primary data capture tool, allowing the internal geometry of the Dylan Thomas Centre to be recorded rapidly and with a high level of detail. This method significantly reduced the need for prolonged manual measurement across multiple spaces.

Manual measurement and sketching were deliberately undertaken alongside the digital survey to support evaluation of the digital process. Recording dimensions by hand provided immediate spatial awareness and highlighted the difference in workflow between traditional and digital techniques. While manual measurements required active decision-making on site, the laser scan allowed for a more comprehensive capture without needing to identify all measurement requirements in advance (*Uren and Price, 2010*).

This combined approach enabled the survey to be conducted in a manner consistent with modern professional practice, where digital technologies are increasingly integrated but not used in isolation.

Problems Encountered and Responses

Visitor Movement:

Movement through scan areas affected both laser scanning and manual measurement.

Response: Scans were paused or repeated, and measurements were taken during quieter moments.

Occlusions from Displays and Furniture:

Temporary installations obstructed some views and measurement lines.

Response: Additional scan positions were added, and alternative manual measurement points were used.

Time Constraints:

Surveying had to be completed within operational hours.

Response: Manual measurements were focused on key dimensions, while laser scanning captured comprehensive data for later analysis.

Part 3: Measurement and Analysis

The processed laser scan outputs provided an opportunity to evaluate the effectiveness of digital technology in delivering a measured building survey. The point cloud data allowed measurements to be extracted accurately and consistently, demonstrating the suitability of laser scanning for producing reliable dimensional information (*Tang et al., 2010*).

One of the key advantages identified was the ability to interrogate the dataset after the site visit. Unlike traditional surveys, where missing measurements often necessitate return visits, the digital dataset allowed additional dimensions to be obtained retrospectively. This highlights the efficiency and completeness of digital measured surveys, particularly in buildings with complex layouts or restricted access.

The use of paper-based scan outputs still retained the accuracy of the digital capture while allowing measurements to be taken in a familiar, accessible format. This demonstrates how digital survey data can be adapted to different workflows and levels of technical expertise.

Measurement Extraction from Survey Data

Measurements were extracted from the processed laser scan outputs provided in paper format, including overall room dimensions, door and window sizes, and floor-to-ceiling heights. These were obtained by identifying clear point intersections and planar surfaces within the scan data.

Manual measurements recorded on site using tape and digital measuring tools were used as a reference to verify selected dimensions extracted from the point cloud. In most cases, the values closely aligned, increasing confidence in the accuracy of the laser scanning data.

Comparison with Traditional Measurement Methods

The use of both laser scanning and manual measurement methods allowed for a direct comparison between digital and traditional surveying approaches. Manual measurement

proved effective for capturing individual dimensions quickly and aided spatial understanding through hand-drawn sketches. However, it was limited in scope and required decisions to be made on site about which measurements to record.

Laser scanning, by contrast, captured a complete three-dimensional representation of the surveyed areas in a relatively short period of time. Measurements could be extracted retrospectively, reducing the likelihood of missing information and eliminating the need for return site visits (*Booth, Hill and McCaffrey, 2017; RICS, 2021*).

While manual methods are less equipment-intensive and suitable for small or simple spaces, laser scanning offers superior accuracy, completeness, and flexibility for complex public buildings such as the Dylan Thomas Centre. The combined use of both methods reflects current professional practice and demonstrates the benefits of integrating traditional surveying skills with digital technologies.

In evaluating the measured building survey undertaken, it is evident that digital laser scanning offers substantial advantages over traditional measurement methods in terms of accuracy, efficiency, and data richness. The ability to capture millions of data points provides a level of detail that cannot realistically be achieved through manual methods alone.

However, the survey also demonstrated that digital technology does not remove the need for traditional surveying skills. Manual measurements and sketches played an important role in validating digital outputs and supporting on-site decision-making. This reinforces the importance of professional judgement when conducting digital measured surveys.

Overall, the survey successfully met the objective of conducting and evaluating a measured building survey using digital technology. The integration of laser scanning with traditional methods provided a balanced, professional approach and demonstrated an understanding of both the capabilities and limitations of digital surveying within a real-world building environment (*RICS, 2014*).

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