

Planning a Building Survey Using Digital Technology.

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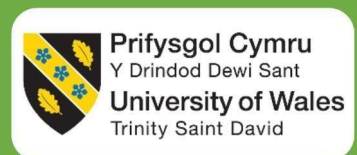


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Planning a building survey using digital technology.

Introduction.



In the world of construction, the safety, and functionality of buildings are evaluated through building surveys. For a long time, these surveys have been more labor and time intensive. However, as the construction industry modernizes through a digital transformation, the chance of conducting these surveys more efficiently and accurately has emerged.

This assignment will produce a clear, detailed, usable plan for executing the process of building surveying, in our case surveying structures using digital technology.

To meet the aims, we will concentrate on a few essential things - the construction type, the techniques and tools needed for a survey, and the location of the property, using such devices as the World Coordinate System (WCS) to assist us. This report will evaluate the building's overall state of repair, doing either a full building survey or a series of well-aimed, partial building surveys, to spot the most urgent target areas for repair. All this information will go into a digital model of the building.

This assignment will describe the technologies used to create a successful survey. The survey will serve several purposes and have substantial benefits for stakeholders. First, the survey will enable us to recommend detailed solutions to problems they find to the client - so the building performs better for its users. Second, by integrating the survey with existing building information models (BIMs), we shall provide useful updates for their periodic maintenance processes. The third benefit lies in the knowledge of information produced, allowing the client to utilise this if they are planning on upgrading the building. For example, this could be upgrading acoustic or thermal properties, or simply adding on additions to the building. Furthermore, this will futureproof the building and ensure the building will maintain their use and value for many more years to come.

What type of survey is required by the client?

To determine what type of survey is required, an evaluation of that specific circumstance, presented by the client, is required. It's very important to understand the reasoning why a survey has been requested, this information along with the technical guidance from the relevant bodies such as The Royal Institution of Chartered Surveyors (RICS) (*RICS Home Surveys, n.d.*) or The Chartered Institute of Building (CIOB) (*Georgieva (2024)*) will ensure the correct survey type for the client's needs. There are three main types of building surveys:

Condition Survey; Level 1

A basic report of visible defects and urgent issues, suitable for newly built homes and standard homes in good condition.

Home Survey; Level 2

A more detailed report on the condition of the property, any issues and repairs needed, suitable for normal homes in reasonable condition. These can also include a valuation of the property to help with insurance, for example.

Building Survey; Level 3

A comprehensive review of the property's structure and condition, which can also include estimates of repair costs, usually for homes older than 50 years, large or unusual properties, and those in poor condition such as structural issues or buildings damaged by fire or flooding.

(RICS, n.d.)

After you have selected a survey type, it's imperative to get all instruction and correspondence in writing to avoid any unnecessary confusion or misunderstanding with the client.

Preparations before the inspection.

After thoroughly determining the correct survey type suitable, some preparations are needed before attending site, such as access arrangements, ensure the correct equipment is selected, and personal protective equipment (PPE). A desktop study is advisable to gather all the relevant information.

This will entail a few things, sourcing the "as built" plans and drawings, these are "documents that allow a compare and contrast between the designed versus final specifications" (Ellis, 2023) allowing us to gather vital information such as dimensions and original construction methods. Along with this, an ordnance survey of the area is helpful. These are, "Used to provide information about land, buildings, roads, waterways, and other features of the built environment. " (ConstruO, n.d.) allowing us to foresee any restrictions that may occur whilst on site, along with access requirements. This paired with a geological map of the area "which provides details about rocks, sediments, faults and a whole range of observations to do with the composition and structure of the Earth" (British Geological Survey, 2022) will enable surveyors to view the terrain type and the ground makeup of the building, this may be helpful if there are structural issues like subsidence.



There are sometimes existing documents that help get a thorough understanding of the building's history, such as any previous planning permissions or building control approvals, these will provide critical information regarding major changes or additions to the building.

Finally, depending on the age of the building, surveyors may be able to source from the Royal Commissions on Ancient and Historic Buildings (Historic England, n.d.). These are official bodies in the United Kingdom for architectural and archaeological heritage, their purpose is to carry out surveys on buildings of significance and heritage to ensure these buildings be preserved for as long as possible, and publish detailed records, often including photographs, drawings, and descriptions. There are three regional variants of this, however in Wales we have "The Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW), established in 1908. " (RCAHMW | About Us | Our Recording Work, n.d.)



What tools are going to be needed to conduct this survey?

There is quite a vast selection of tools that surveyors can choose from to ensure they are conducting our survey in the most efficient and effective way. All these tools will provide different data that can be incorporated to produce the survey. With the advancements of digital technologies in surveying, it subsequently has a direct impact on the health and safety out in the field. Some of these technologies has benefited the industry in a way that once was a major health and safety issue, such as accessing difficult, hazardous places, and allowing workers to reduce the time on site to mitigate any unnecessary risks of being around a functional building or construction site.

Drones (Unmanned Ariel Vehicles).

Small Unmanned Aircraft Systems (better known as drones or UAVs) have substantially changed the way buildings can be surveyed, they enable surveyors to get an aerial view of the area. They can be used in this case, to take pictures, scan and make videos from the air, helping to gather extremely accurate data. Several types of sensors can be mounted, namely Thermal imaging cameras, Laser Scanners and high-definition cameras (Faro, n.d.B) allowing data to be captured to be used for mapping the building, model development and area analysis, whilst allowing surveyors to get to inaccessible areas like roofs, that require specialist equipment such as scaffolds or lifting equipment. These require the operator to have a specialist license and have restrictions put in place from the Civil Aviation Authority (CAA). (Drones | Civil Aviation Authority, 2024)



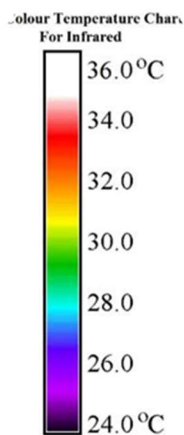
(Propelleradmin & Propelleradmin, 2024) (Drone Surveying Software | Mapping Software | AutoDesk, n.d.)

Thermal Imager (Infrared Camera).



Thermal technology is an excellent tool to use whilst surveying buildings, as in this case it enables surveyors to conduct tests to see if there are any problems in the building, they can be used to detect overheating electrical and mechanical components, water leaks, the buildings heat loss, airflow in buildings and finally any large clusters of bugs, rats, rodents, and other wildlife. Infrared Cameras work by utilizing the infrared that all things emit, this is a type of radiation, which is harmless at normal levels. The camera will pick up this radiation and use 'a focal plane array sensor' in the camera that then converts the infrared radiation into an electrical signal, then using software that is built-in can produce an image that is relevant to the heat of the objects, as seen in the blog from a market leading manufacture of thermal imaging products, Fluke (n.d.). Warmer objects may appear brighter or a red colour, and colder objects may appear darker or a blue colour.

Infrared Cameras can be used alongside other means of surveying to gather data on the building allowing surveyors to spot issues that are arising early on. However, there are some drawbacks to these cameras, they are usually costly to buy, due to their complexity. They have a limited range as they are not usually meant for long distance imagery. Glass and water cannot be penetrated by the infrared sensors (Proctor, 2023), sometimes leading to inaccurate readings. Finally, "fog and rain can severely limit the range of a thermal imaging system" (FLIR, 2020).



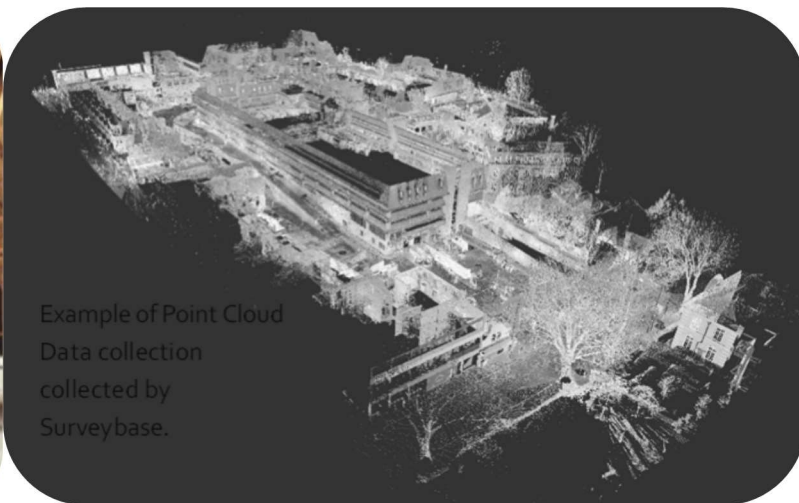
(Building Inspection | Teledyne FLIR, n.d.) (Whale, 2021)

Laser scanners, or Light Detection and Ranging (LiDAR).

Lidar technology is an ideal way to examine a building or structure. Gathering information about the ground and structures, used to create a digital twin of the building. LiDAR being similar to radar, but using laser instead of radio waves, as stated in the article from "FARO" was originally "introduced in the 1960's" (Engineering, 2024) to survey large quantities of area, however, have since substantially technologically advanced, the original principles remain the same.

LiDAR is a ranging device, which measures the distance to a target extremely accurately. They can send out millions of pulses of light per second, and it can accurately calculate the distance once receiving the light back using velocity of light (Time of travel x speed of light) (LiDAR: YellowScan, 2024). This multitude of points are then stored in what is called Point Cloud Data, this is the term used to refer to the data points collected for a given geographical area, terrain, building, or space. A LiDAR point cloud dataset is created when an area is laser scanned using LiDAR, or light detection and ranging. The dataset contains the X, Y and Z coordinate of every visible detail of the project site" Grps (2024).

Using this, an extremely accurate 3D model can be created, that then gets converted into the BIM models. LiDAR can be used stationary, on the move, and even in the dark. There are many ways to utilise these sensors, for example, they can be mounted to an ariel vehicle, a ground vehicle, simply used on a tripod(stationery) or used as a handheld device inside of buildings.

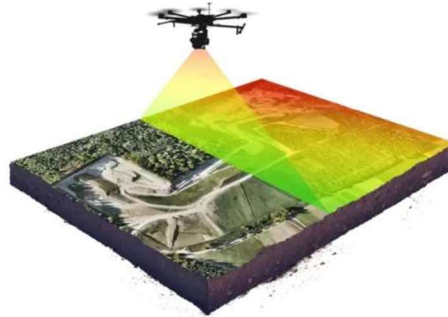


(Leica BLK360 Imaging Laser Scanner | Sunbelt Sales, n.d.) (Surveybase, 2024)

It is also important to add that the laser can be used in combination with other surveying techniques and tools such as drones or navigation and positioning systems. Navigation and positioning systems are essential for determining the absolute position and orientation of the sensor. Global Navigation Satellite Systems (GNSS) can provide precision

geographical coordinates of the LiDAR sensor (latitude, longitude, height) (LiDAR: YellowScan, 2024 B). When combined and used in conjunction, an accurate 3d model can be produced, that has been mapped showing the correct location that the survey has been carried out on the building.

Although laser scanners are extremely capable, there are still some drawbacks to this method. A much higher cost of equipment and maintenance than most other methods. Finally, "LiDAR can be vulnerable to interference from external light sources "Mak (2023), causing discrepancies in the 3d model.



On-site assessments.

Now that the equipment has been selected for a survey of the building. The survey can be carried out once some brief assessments on site are conducted. -

- Look around the building to see if there are any major issues or obstacles that may have a negative impact on the building, for example (in extreme cases) localized ground failure such as a landslide.
- Look for common patterns of issues on surrounding buildings or structure, this could be a weak point.
- Look for a safe access route to get to the building, for example, poor roads or no vehicular access.
- Look for any indication that it is a low-lying flood area, such as marshy ground, or near a waterway.



Once the pre-survey assessments have been conducted, next, the survey can be conducted evaluating the condition. This is split into three parts, external elevations, internal, and surrounding land.

- External Overview. - Focusing on the main elements that make up the structure, this is where structural issues will become evident, working from the top down to ground level recording any defects found.
- Interior inspection. - Focusing on each internal room, going in a clockwise direction as to remain consistent. Recording any defects found, this could include a measured survey if the original plans are unable to be attained.
- Surrounding Land inspection. - Focusing on the geological make-up of the surrounding area. Looking for problems such as drainage issues or subsidence.

For all these steps we would use our drone, thermal imaging camera and our LiDAR scanner to record our findings.

Considerations on site.

A consideration when surveying a building, that may be functional, is the occupants or even pets may become aggravated at the presence of a surveyor whilst trying to accurately survey the building.

As the surveyor, they would need to ensure that they have done everything to avoid any conflicts, make sure to notify in advance of attendance, if the occupants seem particularly stressed or uncooperative about this, suggest rescheduling or adjusting the survey to a less disruptive time. Explain the process clearly and respect privacy. Secondly, if there are any pets, politely ask for separation when conducting the survey, whilst ensuring the correct PPE is worn.

Overall, by ensuring good communication, remaining professional, and preparation, any potential challenges can be addressed before they arise and ensure the survey runs as smoothly as possible. Information to be seen in the guidance from RICS (Royal Institution of Chartered Surveyors (RICS) et al., 2018).

What is produced with the gathered information?

Once all the information has been gathered, next ,evaluate the findings through a building survey report, this will be a detailed comprehensive report on the construction and condition of the various building elements, an outline of repair options, for example, “structural concerns such as severe roof defects, compromised chimney stacks, and significant damp penetration to safety hazards like the large hole in the garage floor” Surveyors (2024) and in some cases, detailed risks to the property and occupants and finally advice for legal advisors. The client will be able to attain a clear understanding of important issues, this is especially important down to the legal duty as surveyors. Following this, the data will be incorporated into the BIM model.



Conclusion.

In conclusion, this planning for a building survey has shown that the advancements in surveying technology have greatly improved accuracy, safety and speed compared to traditional methods proving that once again technology has no limit to its advancements. The use of the modern surveying methods such as drones, LiDAR, Thermal Imaging and Global Navigation Satellite Systems (GNSS) have substantially improved the surveyor's role allowing them to gather precise, conclusive data that has reduced risks and time on site.

The use of 3D models to depict buildings allowing planning of repairs efficiently, future proofing the way the building will be maintained resulting in long term benefits for all those who choose to utilize a modern technology building survey, allowing for the longevity of buildings and setting a much higher overall standard across the construction industry.

References-

- British Geological Survey (2022) BGS Geology FAQ - British Geological Survey. <https://www.bgs.ac.uk/datasets/bgs-geology/bgs-geology-themes-faq/>.
- Building Inspection | Teledyne FLIR (n.d a). [Accessed on <https://www.flir.co.uk/instruments/building-diagnostics/building-inspection/>.]
- Building Inspection | Teledyne FLIR (n.d b). [Accessed on <https://www.flir.co.uk/instruments/building-diagnostics/building-inspection/>.]
- Can Thermal Imaging See Through Fog and Rain? (2020a). [Accessed on <https://www.flir.co.uk/discover/rd-science/can-thermal-imaging-see-through-fog-and-rain/>.]
- Can Thermal Imaging See Through Fog and Rain? (2020b). [Accessed on <https://www.flir.co.uk/discover/rd-science/can-thermal-imaging-see-through-fog-and-rain/>.]
- Construo - The Construction Business Network (no date). [Accessed on <https://construo.io/tags/ordnance-survey/>.]
- Derby Measured Survey (2023) 3D BIM models in REVIT | Derby Measured Survey. [Accessed on <https://www.derbymeasuredsurvey.co.uk/services/as-built-3d-bim-models/>.]
- Drone Surveying Software | Mapping Software | Autodesk (no date). [Accessed on <https://www.autodesk.com/uk/industry/land-development/drone-surveying/>.]
- Drones | Civil Aviation Authority (2024a). [Accessed on <https://www.caa.co.uk/drones/>.]
- Engineering, O. (2024a) What is a Thermal Imaging Camera? [Accessed on <https://www.omega.com/en-us/resources/thermal-imagers#:~:text=How%20Do%20Thermal%20Imagers%20Work,and%20interpret%20thermal%20data%20effectively.>]
- Engineering, O. (2024b) What is a Thermal Imaging Camera? [Accessed on <https://www.omega.com/en-us/resources/thermal-imagers#:~:text=How%20Do%20Thermal%20Imagers%20Work,and%20interpret%20thermal%20data%20effectively.>]
- FLIR E5 Pro Thermal Imaging Camera with WiFi, -20 → +400 °C, 160 x 120pixel Detector Resolution | RS (no date). [Accessed on <https://uk.rs-online.com/web/p/thermal-imaging-cameras/2732555>.]
- Flooding: how nature's wetlands can protect us (no date). [Accessed on <https://features.wwt.org.uk/flooding/index.html>.]
- Fluke (no date) What is Thermal Imaging? How a Thermal Image is Captured. [Accessed on https://www.fluke.com/en-us/learn/blog/thermal-imaging/how-infrared-cameras-work?srsId=AfmBOoxWJfWZjQypv_8bIAROWtMDW2nVET5fiyTI-OtDVvOuwvpof.]
- Georgieva, R. (2024) Technical Publications | CIOB Academy. [Accessed on <https://www.ciobacademy.org/publications/>.]
- Grps (2024) What is a Point Cloud? [Accessed on <https://www.gp-radar.com/article/what-is-a-point-cloud.>]
- Historic England (no date) A Short History of the Historic England Archive | Historic England. [Accessed on <https://historicengland.org.uk/images-books/archive/history/>.]
- Lawrence and Taylor Chartered Surveyors (2020) Structural (Crack) Survey - Lawrence & Taylor Chartered Surveyors. [Accessed on <https://lawrenceandtaylor.co.uk/structural-crack-survey/>.]
- Leica BLK360 Imaging Laser Scanner | Sunbelt Sales (no date a). [Accessed on https://www.sunbeltsales.co.uk/leica-blk360-imaging-laser-scanner-3?utm_term=&utm_source=google&utm_medium=cpc&campaign_id=21441925662&ad_group_id=162794627405&ad_id=705178379258&keyword_id=pla-2350530645084&gad_source=1&gclid=CjoKCOiAr7C6BhDRARIsAOUKifgHAYC_wA-kJMQFHgpTmP6HkOV6eCE3utPrFa5BZyMgVFkEN3XLYdYaAvxhEALw_wcB.]

- Leica BLK360 Imaging Laser Scanner | Sunbelt Sales (no date b). [Accessed on <https://www.sunbeltsales.co.uk/leica-blk360-imaging-laser-scanner-3/>.]
- LiDAR: What Is It and How Does It Work? | YellowScan (2024a). [Accessed on <https://www.yellowscan.com/knowledge/how-does-lidar-work/>.]
- LiDAR: What Is It and How Does It Work? | YellowScan (2024b). [Accessed on <https://www.yellowscan.com/knowledge/how-does-lidar-work/>.]
- Mak, H. (2023) Lidar vs Radar: Differences, Advantages and Disadvantages. [Accessed on <https://globalgpsystems.com/lidar/lidar-vs-radar-differences-advantages-and-disadvantages/>.]
- Mira (2022) Sistem Drone LiDAR: 5 Penggunaan UAV yang dilengkapi LiDAR. [Accessed on <https://halorobotics.com/drone-lidar-5-penggunaan-uav-lidar/>.]
- Poor housing and refugee homelessness highlighted in new reports - University of Huddersfield (no date). [Accessed on <https://www.hud.ac.uk/news/2024/february/phil-brown-report-housing-homelessness/>.]
- Proctor, J. (2023) 'What you need to know about thermal Imaging cameras | RS,' Everything You Need to Know About Thermal Imaging Cameras, 5 January. [Accessed on https://uk.rs-online.com/web/content/discovery/ideas-and-advice/thermal-imaging-cameras-guide?srsId=AfmBOopPRp8_TzJhdlbRYwZJgoJMNngXhrY6hUxPicNfCc_JhugXskcg (Accessed: December 1, 2024).]
- Propelleradmin and Propelleradmin (2024) How Lidar Drone Surveying Works. [Accessed on <https://www.propelleraero.com/blog/how-lidar-drone-surveying-works/>.]
- RCAHMW | About Us | Our Recording Work (no date). [Accessed on <https://rcahmw.gov.uk/about-us/our-recording-work/>.]
- RICS Home Surveys (no date a). [Accessed on <https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/home-surveys/>.]
- RICS Home Surveys (no date b). [Accessed on <https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/home-surveys/>.]
- Royal Institution of Chartered Surveyors (RICS) et al. (2018) Surveying safely: health and safety principles for property professionals. 2nd edition, RICS guidance note. 2nd edition. Edited by S. Crouch et al. Royal Institution of Chartered Surveyors (RICS). [Accessed on https://www.rics.org/content/dam/ricsglobal/documents/standards/November_2018_Surveying_Safely_Health_And_Safety_Principles_For_Property_Professionals_2nd_Edition.pdf.]
- Surveybase (2024a) Laser scanning in London, Cheltenham & Oxford. [Accessed on <https://www.surveybase.co.uk/services/laser-scanning-survey/>.]
- Surveyors, P.K. (2024a) 'Understanding the Significance of a Level 3 Building Survey: A Case Study by a RICS Surveyor,' Peer King Surveyors, 7 April. [Accessed on <https://www.peerkingssurveyors.com/post/understanding-the-significance-of-a-level-3-building-survey-a-case-study-by-a-rics-surveyor/>.]
- Surveyors, P.K. (2024b) 'Understanding the Significance of a Level 3 Building Survey: A Case Study by a RICS Surveyor,' Peer King Surveyors, 7 April. [Accessed on <https://www.peerkingssurveyors.com/post/understanding-the-significance-of-a-level-3-building-survey-a-case-study-by-a-rics-surveyor/>.]
- Types of RICS reports (no date). [Accessed on <https://www.nisurv.co.uk/rics-reports.html>.]
- Whale, J. (2021) Infrared Differential Bioscanner use with Electronic Gem Therapy. [Accessed on <https://whalemedical.com/infrared-thermal-camera-imaging/>.]
- What is a LiDAR drone and are they useful? (no date). [Accessed on <https://www.faro.com/en/Resource-Library/Article/What-is-a-LiDAR-drone>.]