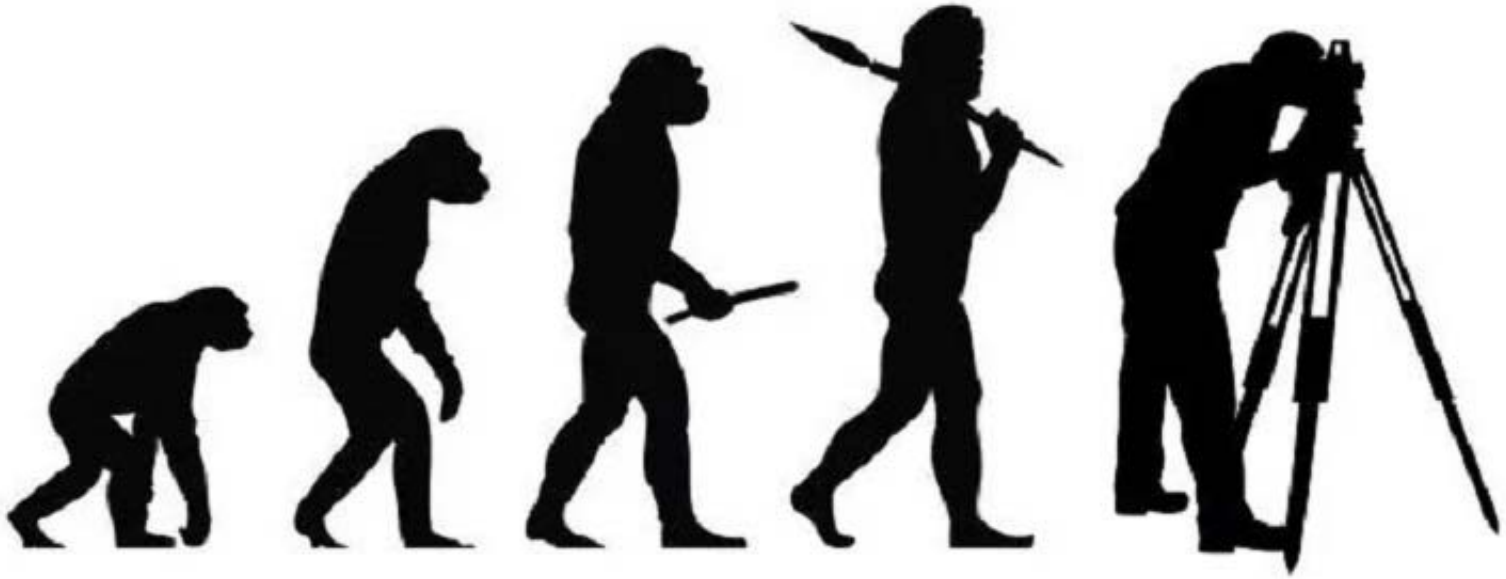
ABCA 4002
DIGITAL SURVEYING: LEVEL 4

Lecture 3: Digital Surveying

Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David



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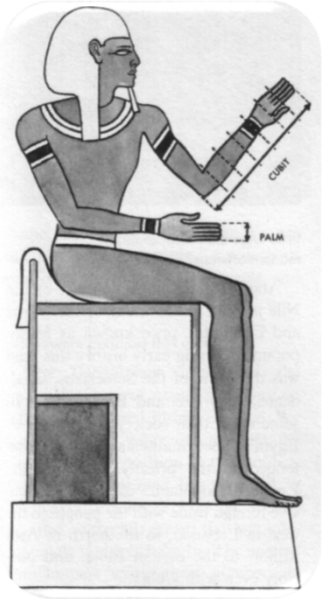
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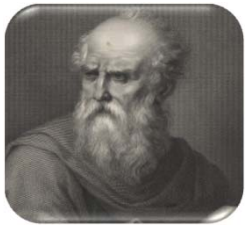

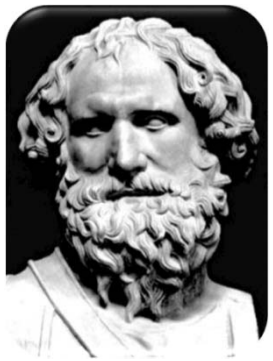

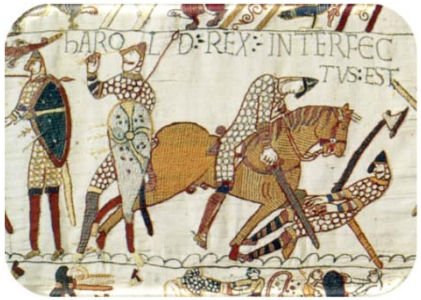
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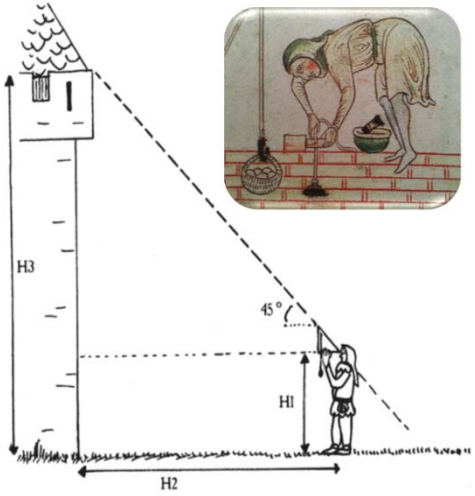
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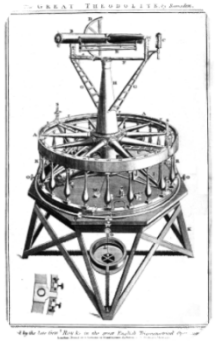

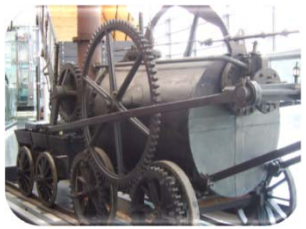

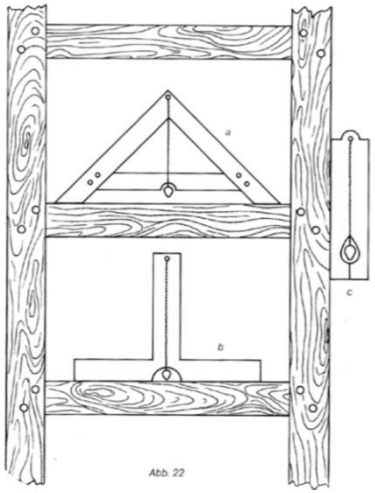
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Modern Era – Surveying Today

Surveying Today - What do we use surveying for?

- Mapping the earth above and below the sea.
- Prepare navigational maps (land, air, sea).
- Establish boundaries of public and private lands.
- Develop data bases for natural resource management.
- Development of engineering data for:
    - Bridge construction.
    - Roads.
    - Buildings.
    - Land development.

Surveying Today - What are the Five Main Areas on Surveyors Work?

- Research, analysis, and decision making.
- Field work {Data acquisition}.
- Computing {Data processing}.
- Mapping {Data representation}.
- Stake-out / Setting out

Surveying Today - What are the two Major Methods of Surveying?

DIFFERNCE BETWEEN GEODETIC AND PLANE SURVEYING

Plane Surveying

- Earth surface is considered as a plane surface.
- The curvature of the earth is ignored.
- The line joining any two stations is considered as a straight line.
- The triangle formed by any three points is considered as a plane.
- The angles of the triangle are considered to be plane angles.
- Carried out for a small area < 250km2 .

Geodetic Surveying

- Earth surface is considered as a curved surface.
- The curvature of the earth is taken into account.
- The line joining any two stations is considered as a curved line.
- The triangle formed by any three points is considered as spherical.
- The angles of the triangle are considered to be spherical.
- Carried out for a large area >250km2 .

CADASTRAL SURVEYS are usually closed surveys which are undertaken in urban and rural locations for the purpose of determining and defining property lines and boundaries, corners, and areas. These surveys are also made to fix the boundaries of municipalities, towns, and provincial jurisdictions.

CITY SURVEYS are surveys of the areas in and near a city for the purpose of planning expansions or improvements, locating property lines, fixing reference monuments, determining the physical features and configuration of the land, and preparing maps.

CONSTRUCTION SURVEYS these are surveys which are undertaken at a construction site to provide data regarding grades, reference lines, dimensions, ground configuration, and the location and elevation of structures which are of concern to engineers, architects, and builders.

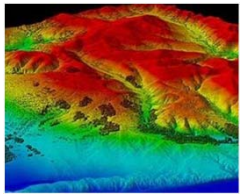
FORESTRY SURVEYS a type of survey executed in connection with forest management and mensuration, and the production and conservation of forest lands.

HYDROGRAPHIC SURVEYS refer to surveying streams, lakes, reservoirs, harbour's, oceans, and other bodies of water. These surveys are made to map shore lines, chart the shape of areas underlying water surfaces, and measure the flows of the stream. They are of general importance in connection with navigation, development of water supply and resources, flood control, irrigation, production of hydro-electric power, sub aqueous constructions, and recreation

INDUSTRIAL SURVEY sometimes known as optical tooling. It refers to the use of surveying techniques in ship building, construction and assembly of aircraft, layout and installation of heavy and complex machinery, and in other industries where very accurate dimensional layouts are required.

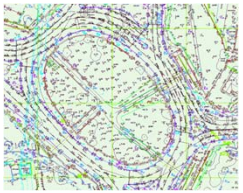
MINE SURVEYS are surveys which are performed to determine the position of all underground excavations and surface mine structures, to fix surfaces boundaries of mining claims, determine geological formations, to calculate excavated volumes, and establish lines and grades for other related mining work.

PHOTOGRAMMETRIC SURVEYS a type of survey which makes use of photographs taken with specially designed cameras either from airplanes or ground stations. Measurements are obtained from the photographs which are used in conjunction with limited ground surveys.



ROUTE SURVEYS involves the determination of alignment, grades, earthwork quantities, location of natural and artificial objects in connection with the planning, design, and construction of highways, railroads, pipelines, canals, transmission lines, and other linear projects.

TOPOGRAPHIC SURVEYS are those surveys made for determining the shape of the ground, and the location and elevation of natural and artificial features upon it. The features shown include such natural objects as hills, mountains, rivers, lakes, relief of the ground surface, etc.; and works , such as roads, building, ports, towns, municipalities, and bridges.



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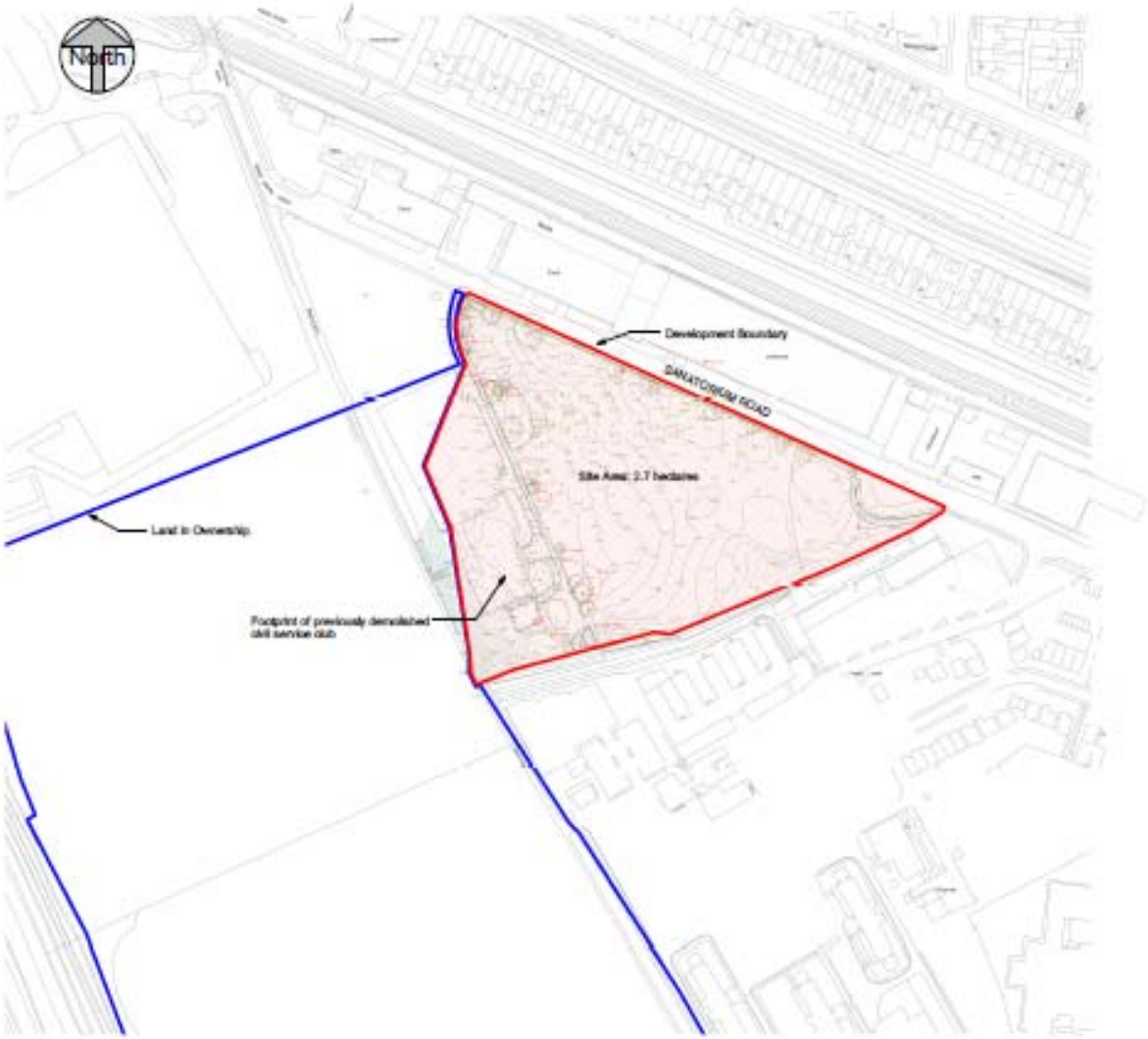


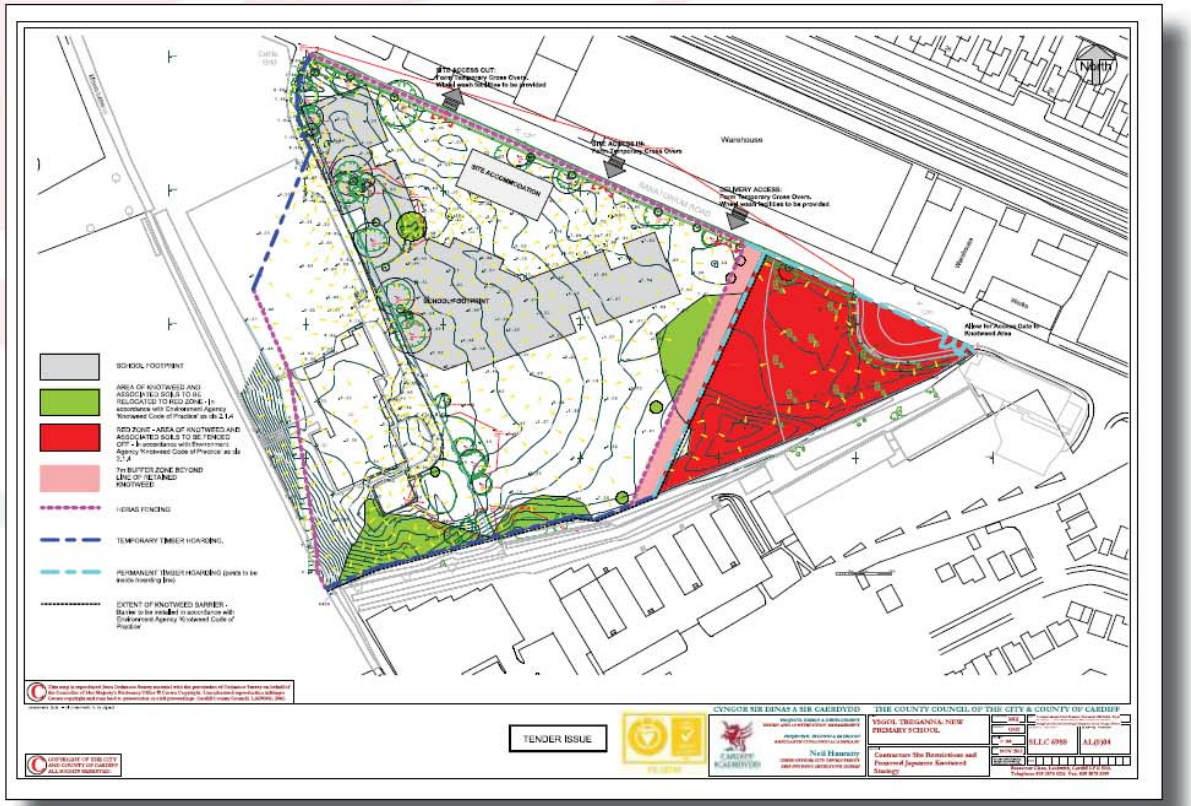
Site Location Plan

Aerial View

0 - GA Floor Plan

Capping layer of 600mm clean soils to any soft landscaping.

Volume of JK mitigation works estimated at 6000m³

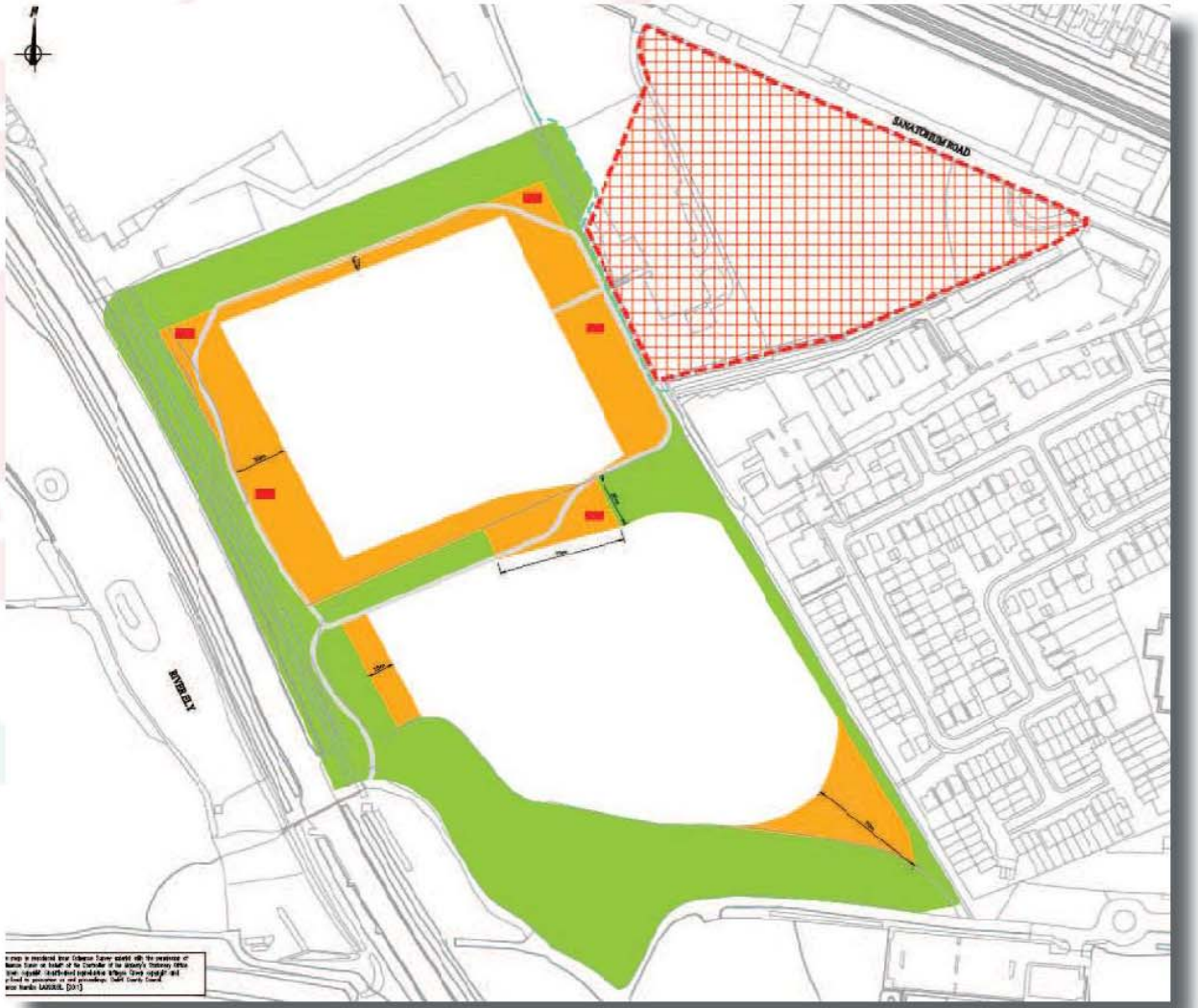


1. Excavate a pit to a depth of 50cm and a minimum of 2m across.

2. Loosely fill pit with piled up rocks, logs, dead wood and other suitable clean fill material. Small amounts of soil can be loosely filled between layers during construction.

3. The hibernaculum should be filled to just above ground level, then capped with a layer (50-100 mm thick) of turf or moss. If neither is available, topsoil may be used. Leave gaps in the capping material at ground level to allow reptile access.

4. The addition of a geotextile membrane may be used to prevent erosion of the capping layer into the cavities beneath. This would be particularly important where the capping layer is composed of topsoil or other loose material.



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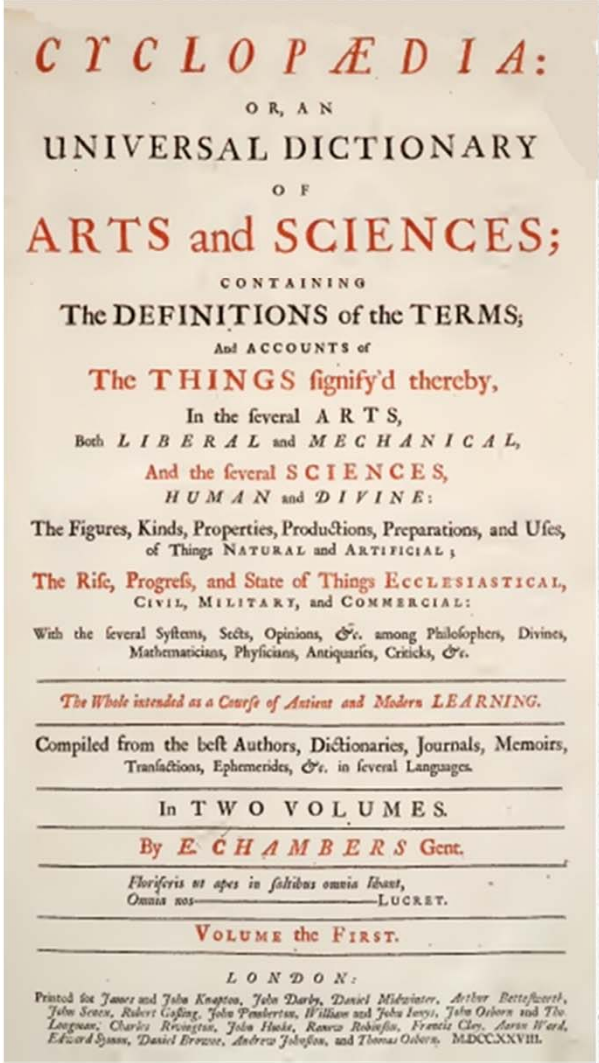
Equipment and Tools for Surveying



CYCLOPÆDIA:

OR, AN

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CONTAINING

The DEFINITIONS of the TERMS;

And ACCOUNTS of

The THINGS signify'd thereby,

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Floriferis ut apes in saltibus omnia libant,
Omnia nos———————LUCRET.

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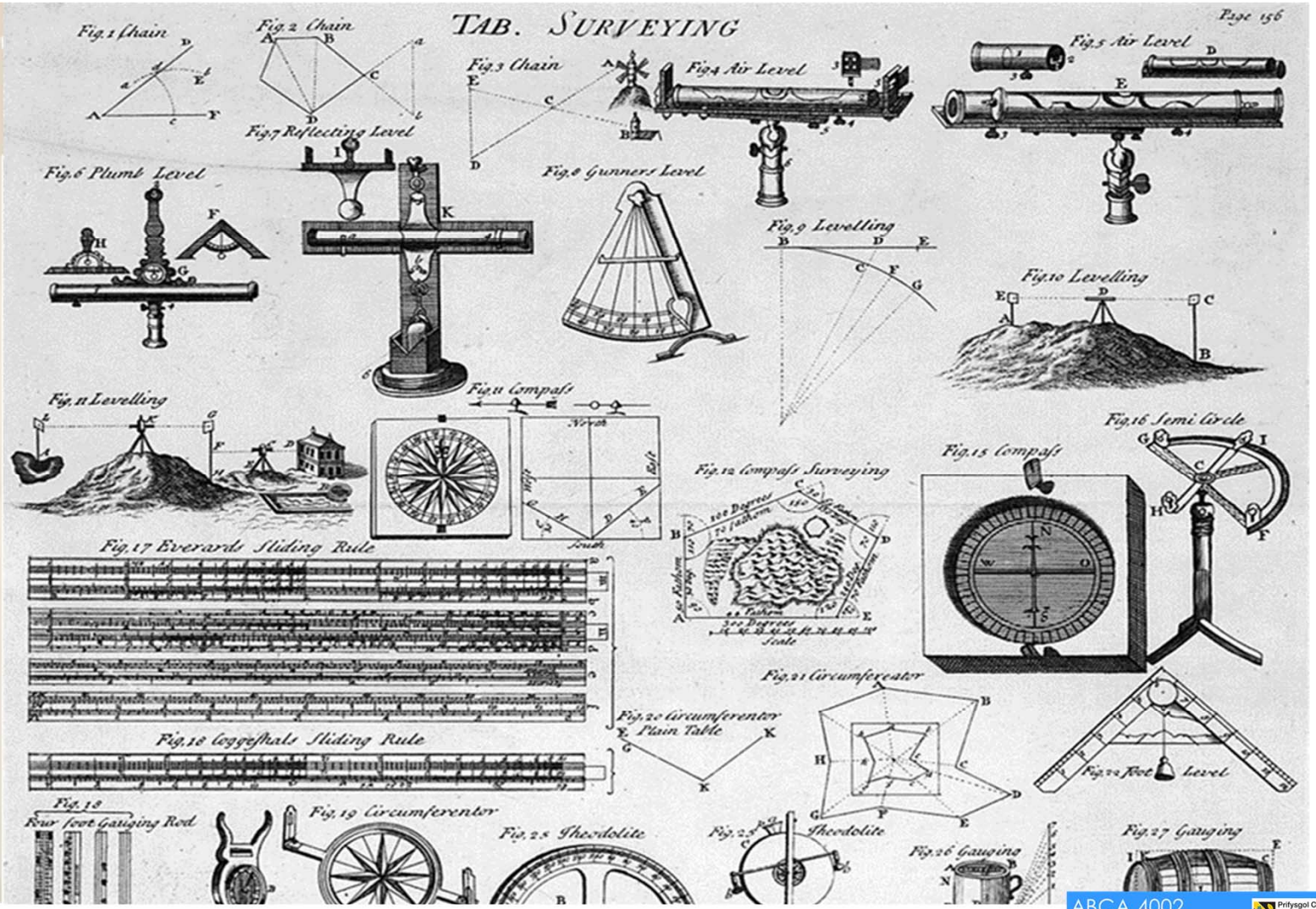
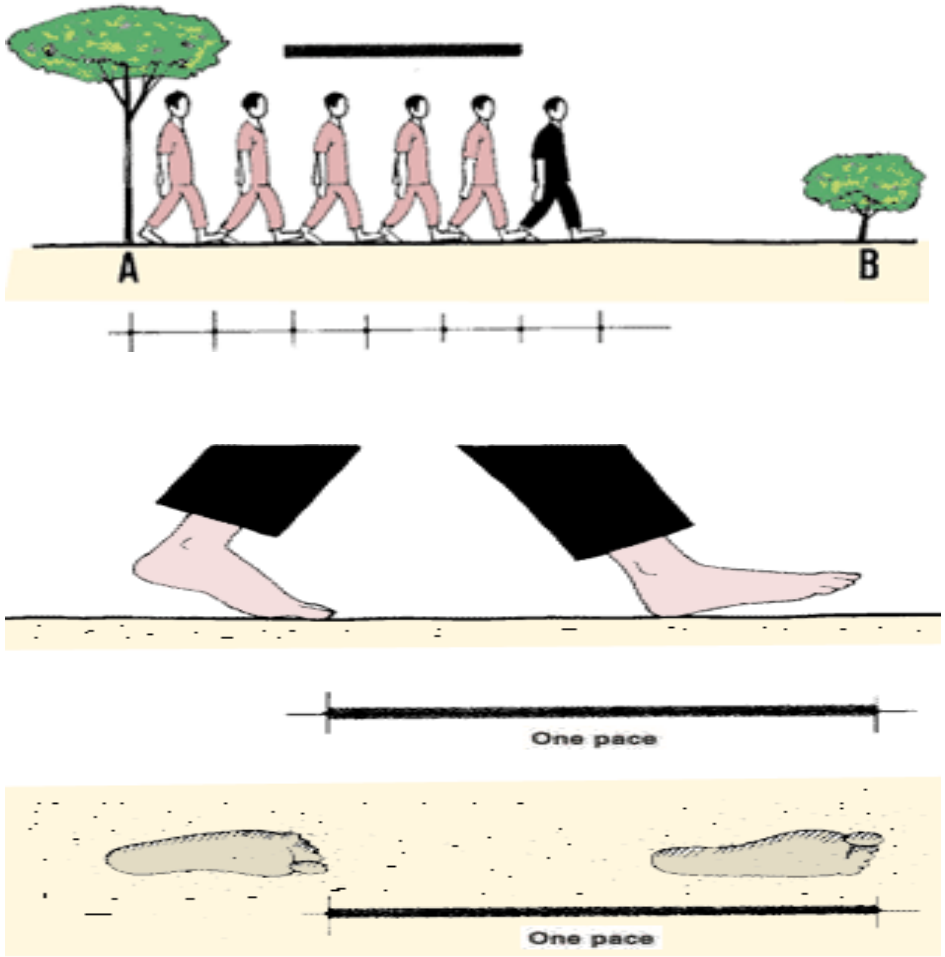


General: The Basics

General: Pacing

Pacing: The ability to pace distance is very useful
A person can determine their pace by counting the number of paces necessary to walk a distance that has been previously measured. The natural pace of each individual normally varies from 700 – 950mm.

- A pace is defined as one step
- A stride is consider two steps



Finding your Own Pace Factor.

To measure the average length of your **normal pace** (the pace factor, or **PF**):

- take 100 normal steps on horizontal ground, starting with the toes of your back foot from a well-marked point, A, and walking along a straight line.

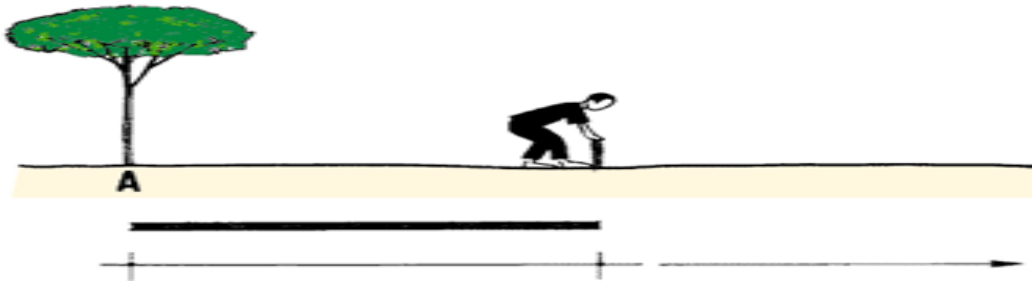
- Mark the end of your last step with peg B, at the toes of your front foot.

Measure the distance AB (in metres) with, for example, a tape and calculate your pace factor PF (in metres) as follows:

Pacing Factor (PF) = Measured distance / Number of pace

Distance measured with a tape = 76m

Number of pace = 100 paces



Example

If for 100 paces, you measure a distance of 76 m, then your pace factor is calculated like this:

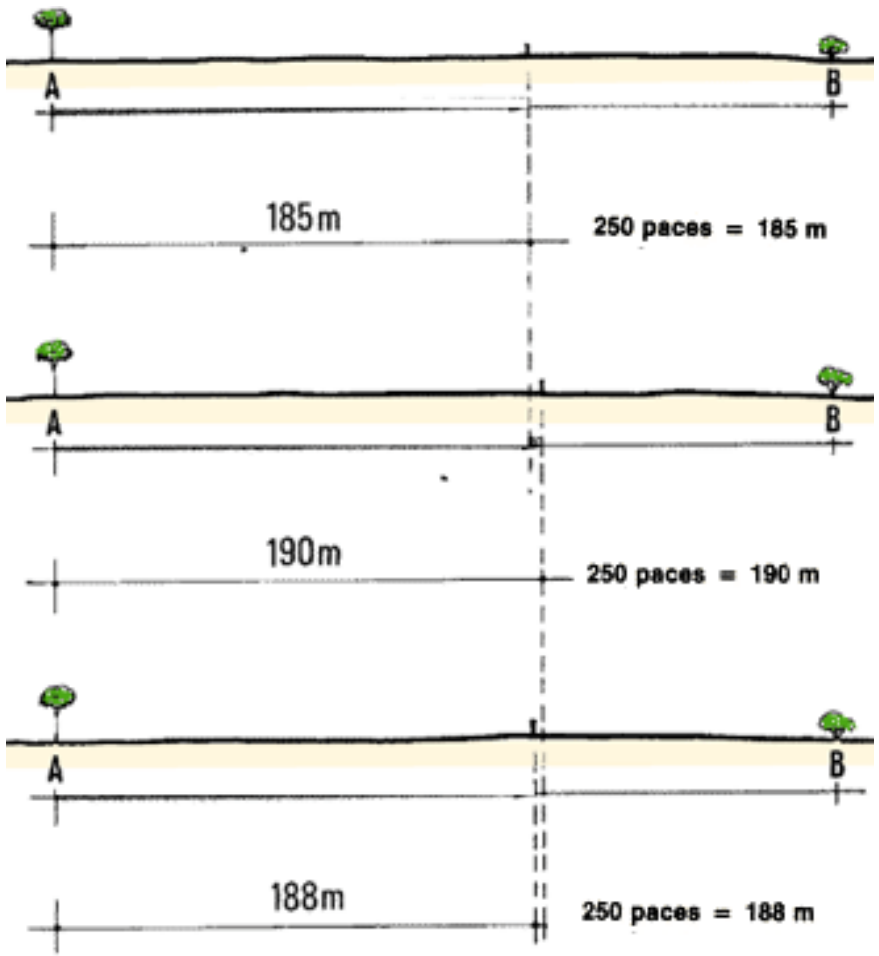
PF = 76 m ÷ 100 = 0.76 m

- walk over a **longer distance** (at least 250 paces)
- **repeat** the measurements at least three times and calculate **the average PF**.

Example:

For 250 paces, you measure successively
185 m, 190 m and 188 m;
in total, for 3 x 250 = 750 paces, you have walked 185 + 190 + 188 m = 563 m;

Therefore your average pace factor, PF = 563 m ÷ 750 = 0.75 m.



Distance (m) = N x PF,

N = Number of Steps,

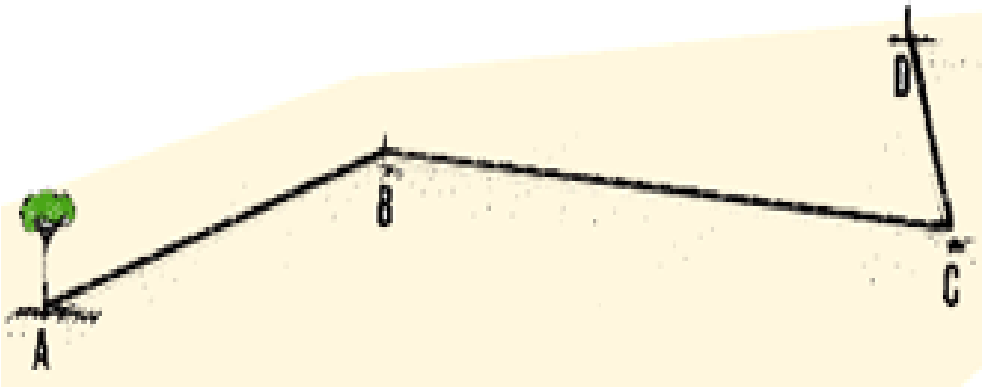
PF = Pace Factor

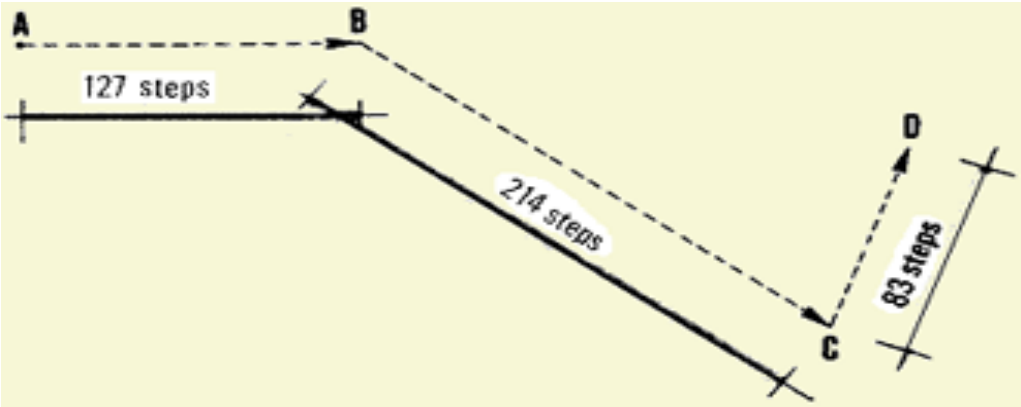
Example

To measure ABCD,
pace distances
AB = 127 steps;
BC = 214 steps; and
CD = 83 steps.
ABCD = 127 + 214 + 83 = 424 steps.

If PF = 0.75 m,

ABCD = 424 x 0.75 m = 318 m





Your pace factor will vary, depending on **the type of terrain** you are measuring.

<u>Remember</u>:

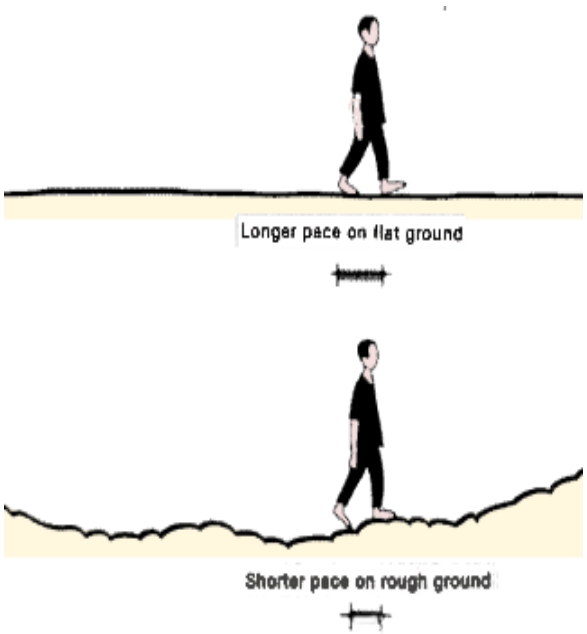
➢Pace will be shorter in tall vegetation than in short vegetation;

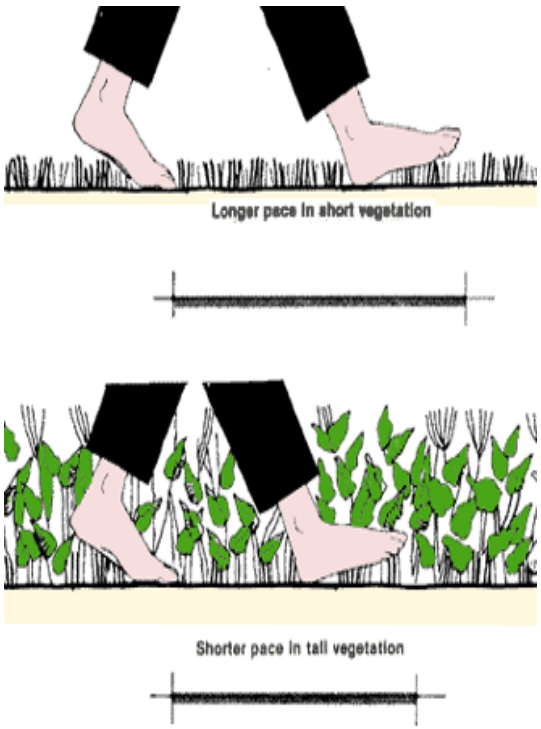
➢Pace will be shorter walking uphill than walking downhill;

➢Pace will be shorter walking on sloping ground than on flat ground;

➢Pace will be shorter walking on soft ground than on hard ground.

➢To get the best results, you should first make your paces as nearly the same length as possible. To do this, walk over known distances, both on level ground and on uneven or sloping ground. Adjust your pace so that it is as regular as possible.





Building Surveying: Linear Measurement

Surveying tapes are available in lengths up to 100m, but a 30m tape is the most common length in use. Two types of tapes are commonly used:

Steel Tapes

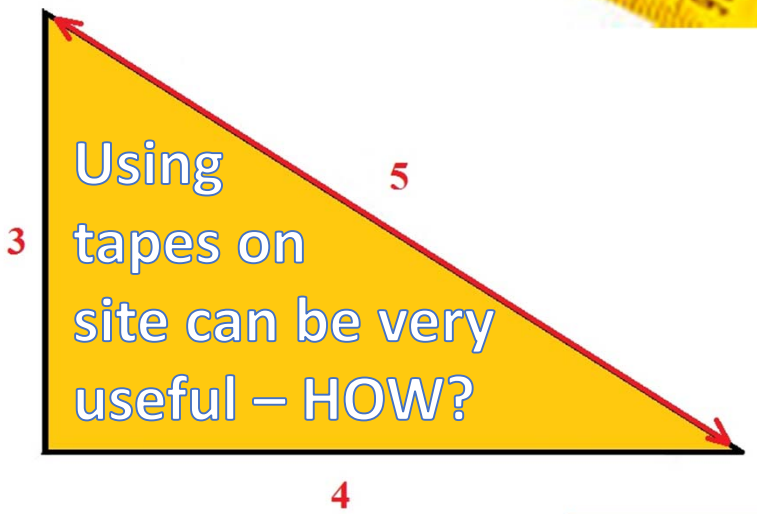
- All steel tapes are manufactured so that they measure their normal length at a specific temperature and under a certain pull, which is generally 20°C and 50N.
- With care it is possible to take measurements using a steel tape with an accuracy of 1 in 10,000 (or 3mm for a 30m distance)

Fibreglass Tapes

- Fibreglass tapes are manufactured from fibreglass strands embedded in PVC.
- Compared to steel tapes they are lighter, more flexible and less likely to break.
- They are also rust free.
- They stretch more when pulled
- The accuracy of a fibreglass tape is lower at 1 in 1000 (i.e. a precision of 30mm in a 30m length).

Building Surveying: Linear Measurement

- The tape is not the standard length
- Poor alignment of the tape
- Tape not horizontal
- Tape twisted or not straight.
- Human error of observations
- Variations in temperature
- Variations in tension
- Tape Sag.



Building Surveying: Other Linear Measurement

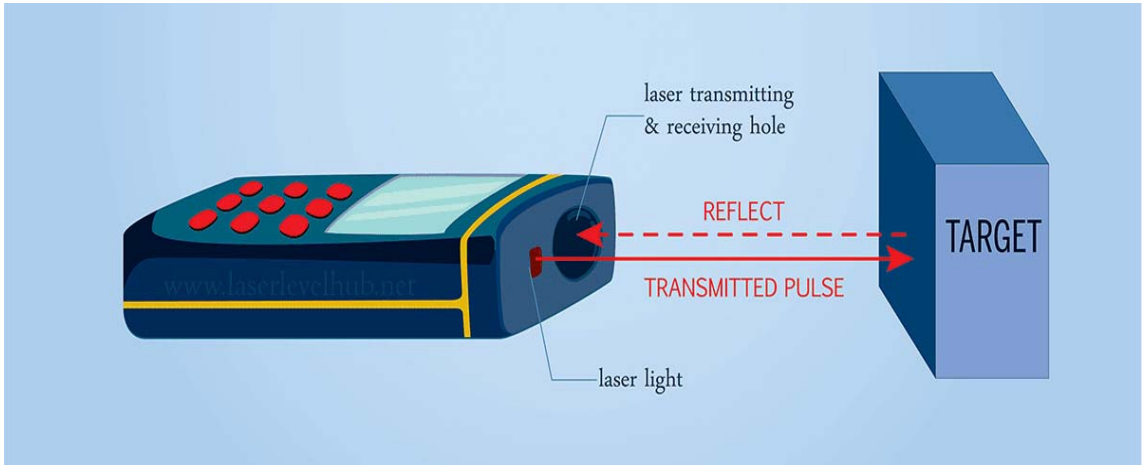
Measuring Wheels and Rods can be used to supplement other equipment.

Building Surveying: Linear Measurement

Disto / Laser measuring

Typically used in building surveys. Hand held disto equipment use laser beam. Modern versions can calculate room areas, volumes and angled slopes.

- Accuracy = ±3mm; Range = 200m; Single Operator; useful when
- not possible to use inaccessible heights/points etc
- Errors: requires baseline calibration; errors due to weather
- Safety: Lasers must NOT be pointed in the eye



Building Surveying: Other Measurement

In Building Surveying you will also be looking at other factors especially when assessing existing buildings.

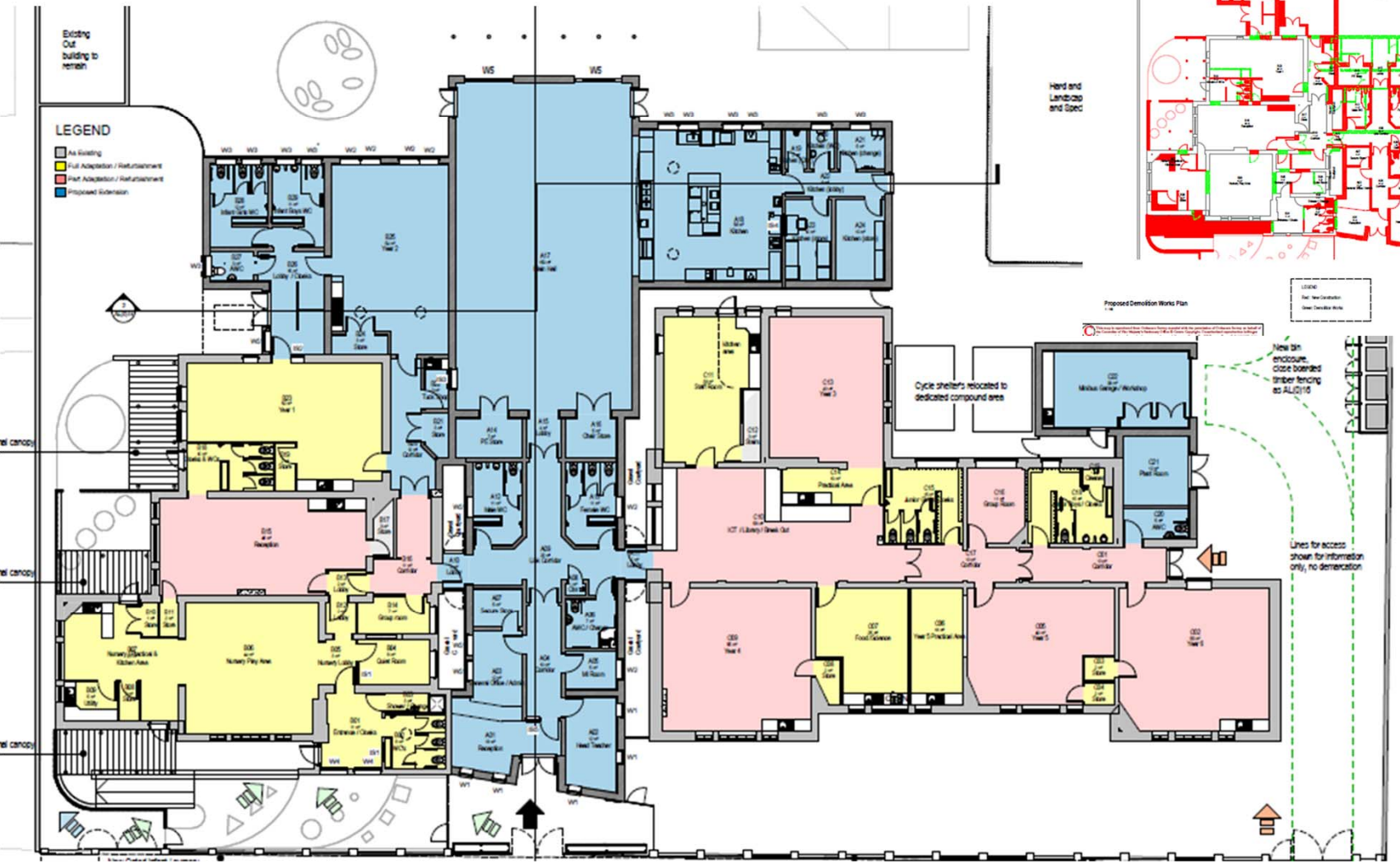
Thermal Camera

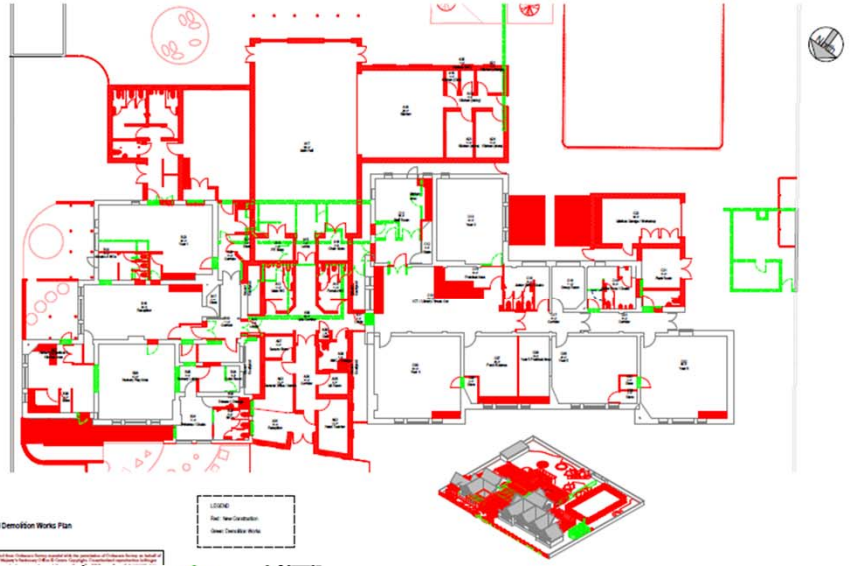
Thermal bridging / heat loss detecting areas of poor detailing, damage or construction defects.

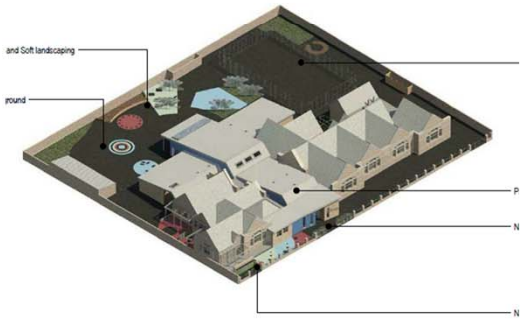
Moisture Meter / Protimeter

Areas of damp / water ingress detecting both moisture (damp) and humidity levels.

Millbank Primary School







Aerial View of Proposed Scheme

Land Surveying: Measurement

Automatic Levelling

<u>Building Level/Dumpy Level</u>

Requires Tripod, Levelling staff, changing plate and Level.

Two methods of levelling ‘Rise and Fall’ and ‘Height of Collimation’ Methods.

Land Surveying: Measurement

Digital Laser Levels

Requires: Tripod, levelling staff with integrated sensor or bar coded staff, change plate and laser level.

Laser levels can be limited when there are lots of obstructions, such as scaffolding and railing.

Where precise levelling or monitoring work is required laser level can use an INVAR bar coded staff.

Land Surveying: Measurement

Theodolites

Requires: Tripod, plumb bob / ranging rod tape and theodolite.

Theodolites are uses for measuring horizontal and vertical angles. Measurements required on both faces of the theodolites to determine instrument errors.

Theodolites can be used underground and are used in mining operations.

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Land Surveying: Measurement

Total Stations

Requires: Tripod, detail pole, prism and Total Station.
Total stations can be used to measure distances and angles with the use of the prism and details pole.

Offers two modes of measurement, with infra red and Red laser mode. Total stations enable measurements to be taken where access is restricted such as, railways, motorway white lines. Can also be used for measurement of elevations.

Total stations have built in recording ability where measurements and angles can be downloaded and digitally transferred through industry software.

Land Surveying: Measurement

Laser Scanners

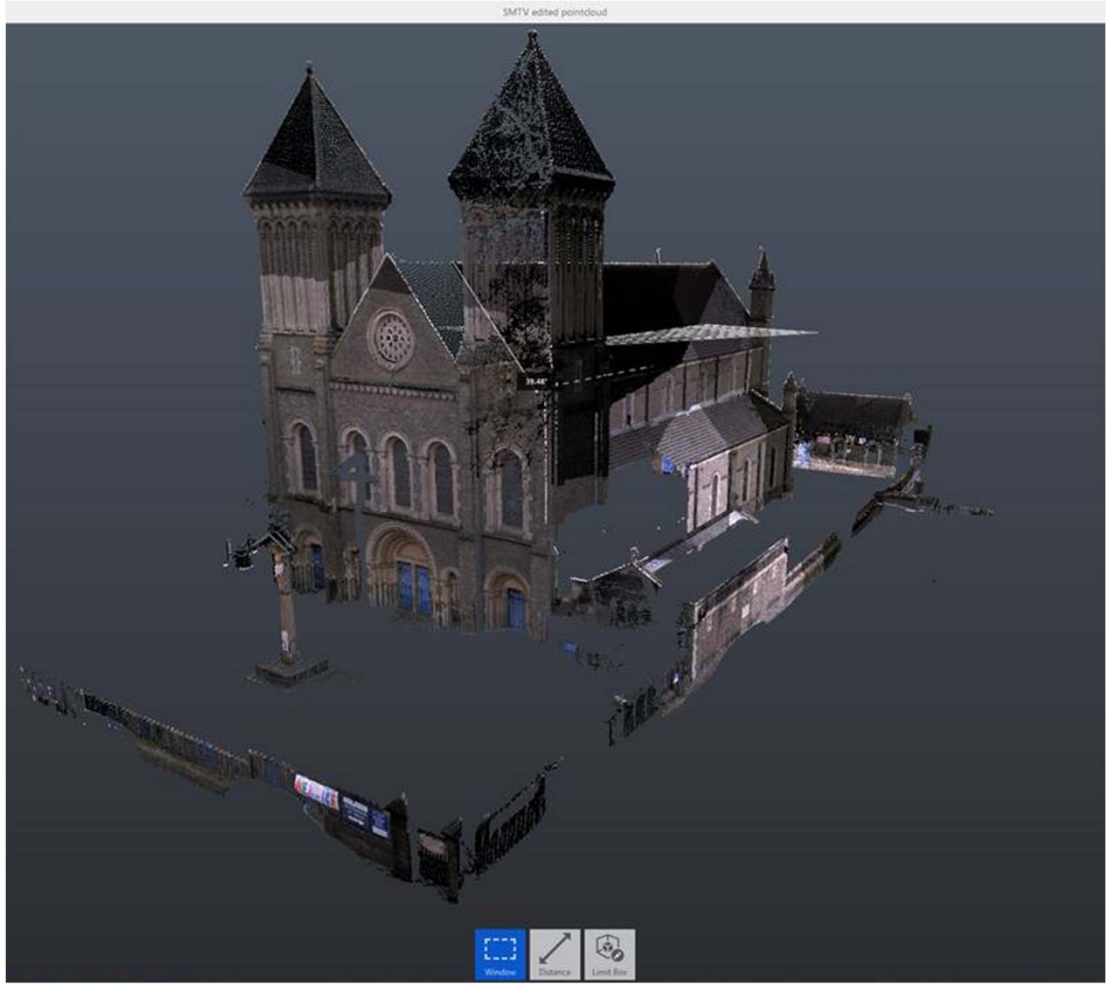
Requires: Tripod, detail pole, prism, reflected target and scanner.

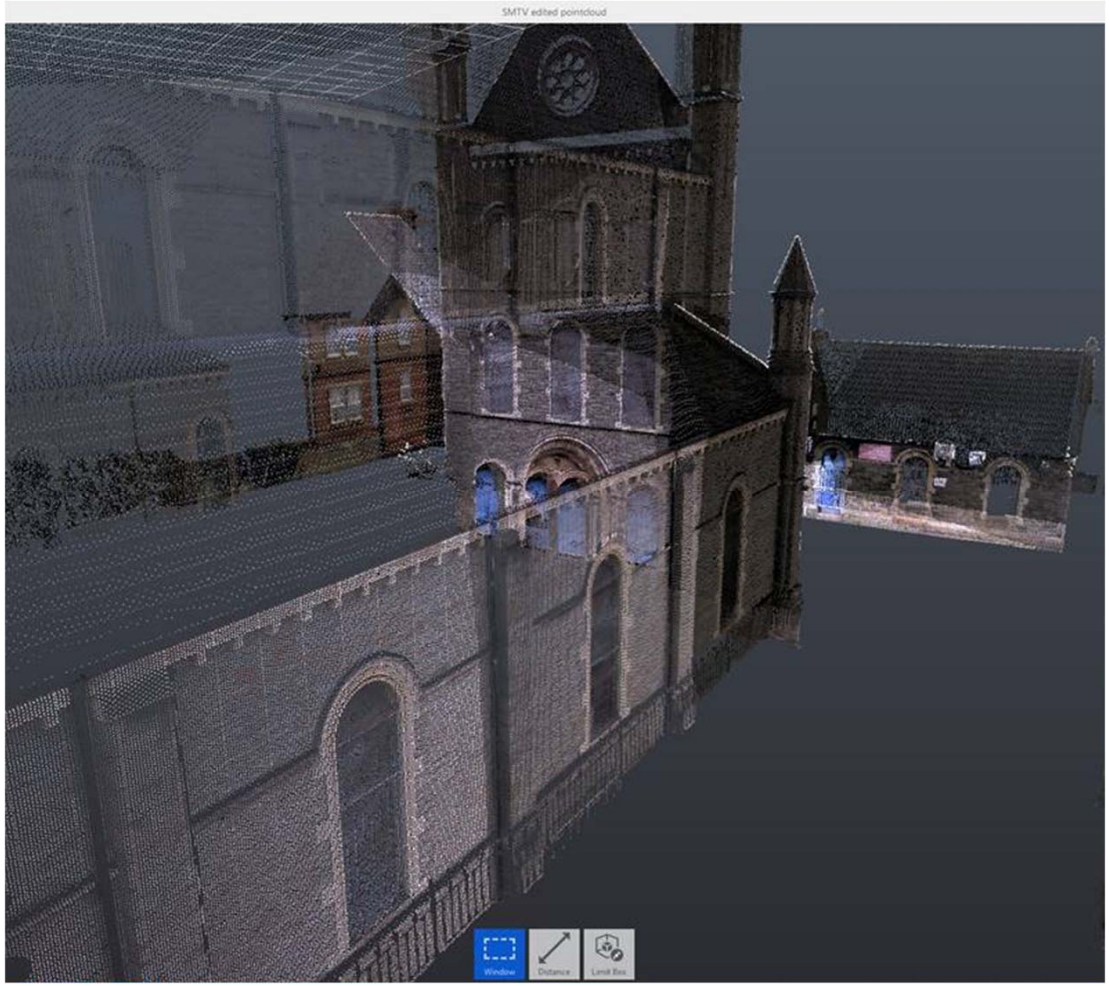
Laser scanners undertake highly accurate detailed surveys, through to production of basic point cloud and rendered photographic imagery.

Typically used for historic buildings and in areas where access is restricted, for example complex pipework installations.

Data can be downloaded and digitally transferred for use in industry software.

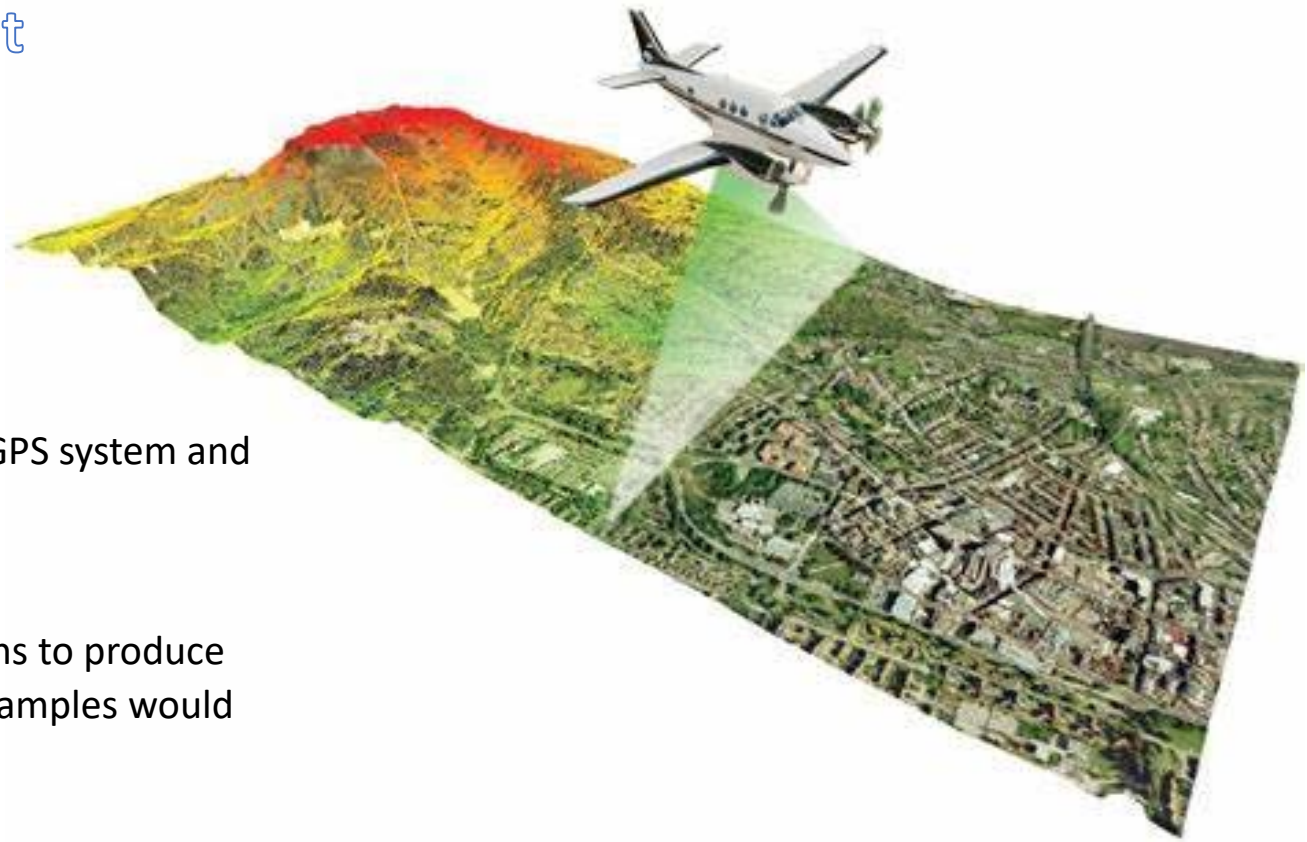
St Mary's Church – Grade II listed.





Land Surveying: Measurement

Airborne Laser Scanner



LIDAR (Light Detection and Ranging)

Laser scanners mounted on aircraft utilising a GPS system and inertial navigations system.

LIDAR process scans the ground with laser beans to produce and level survey of large open areas. Typical examples would be NWR.

Land Surveying: Measurement

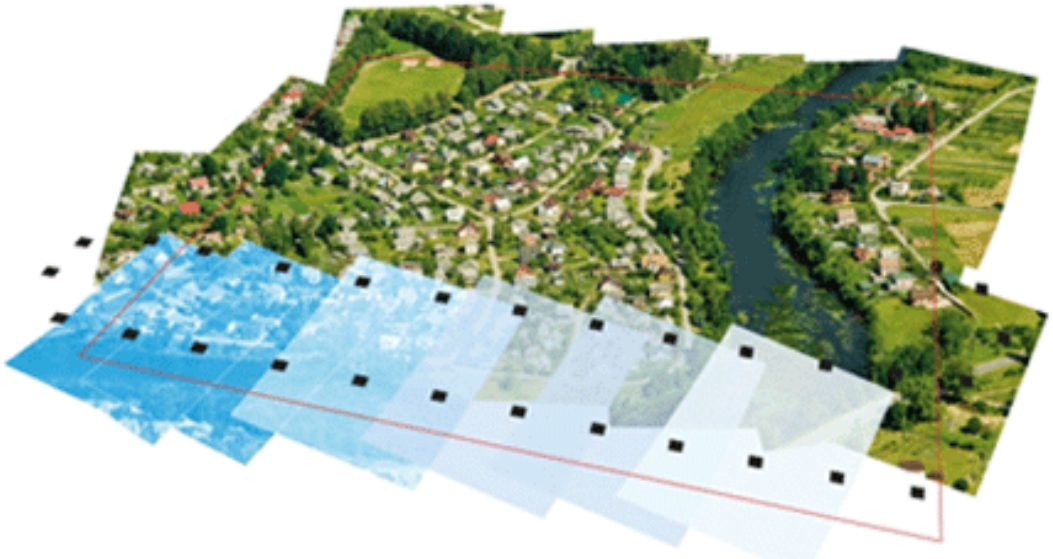
Photogrammetry

Aircraft mounted photographic system, with GPS and inertial navigation system.

Photogrammetry requires ground control and ground markers produced by a conventional surveying.
Fixed patterns of flight are used to produce overlapping photographs.

Stereoscopic images are produced from the photography to produce a 3D image of the site.

LIDAR has been preferred in recent time to photogrammetry, however with the rise of the use of Drone technology photogrammetry is now becoming a more favourable and affordable option.



Land Surveying: Measurement

GNNS System

Commonly referred to a GPS.
Comprises of: GPS Base station, GPS Rover, Data logger / pad, Tripod and detail pole.

The principle of system is the utilisation of measurement taken from GNSS (global navigation Satellite System) to measure the distance to the satellites to triangulate and calculate your position.

GPS - US satellite system
GLONASS – Russian Satellite system
Gallileo – European Satellite system
BeiDou – Chinese Satellite system.

To create accurate data, the Base Station will need to be left in position for at least 4 hours.