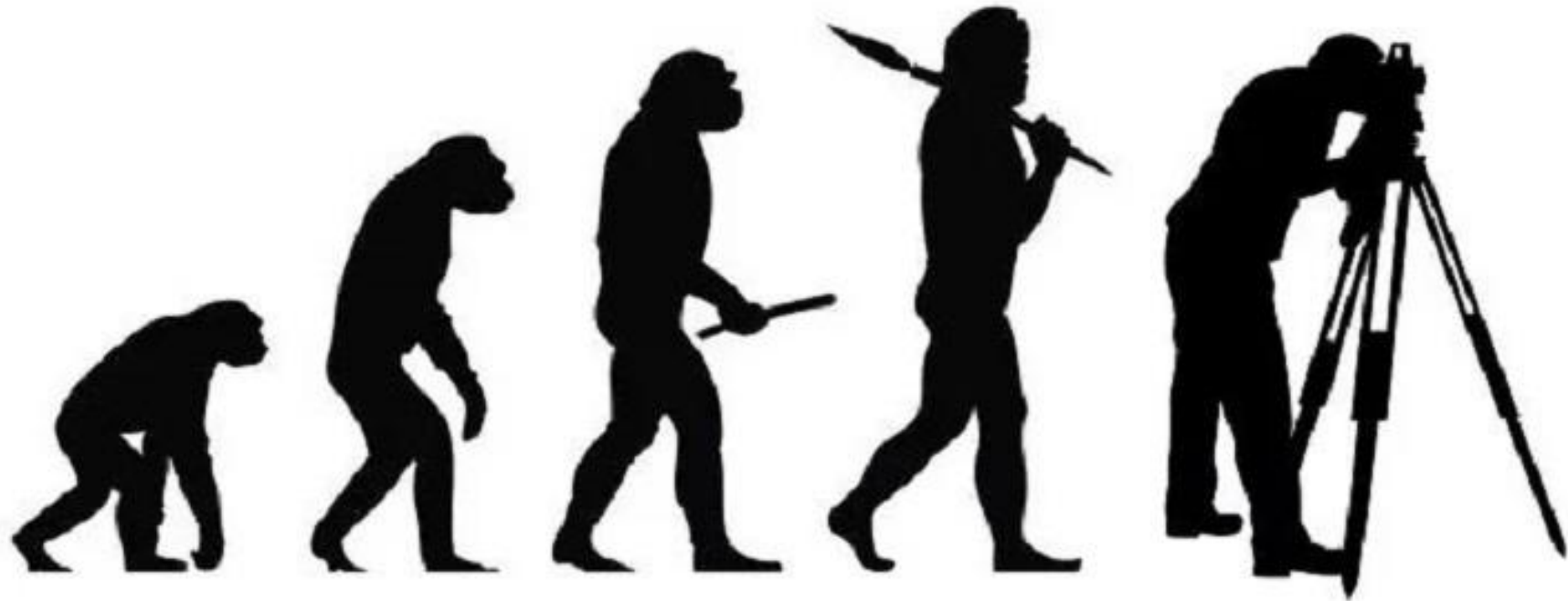


Lecture 5: Digital Surveying



<https://www.satpalda.com/blogs/evolution-in-surveying-techniques>

How will it be assessed?

Module Credit 20

30% Scheduled Learning and 70% Independent Learning

Assessment Component 1		
Mode of Assessment	Word Limit	Weighting
Practical and written report	2000 Words	50%

Assessment Component 2		
Mode of Assessment	Word Limit	Weighting
Essay	2000 Words	50%



Assessment 2

Submission
deadline:

7th May 2021

Return date of provisional marks &
written feedback: 18th June 2021

Essay (2000 words)

There are two parts to be considered for the essay and these are to be approached in equal weighting.

Part 1

Outline a **brief history of surveying**, describing different measurement and surveying techniques from antiquity to the modern era.

Part 2

Briefly describe the application of digital surveying technologies in **surveying listed buildings** giving examples of appropriate tools to be used and the information to be collected from the survey.

The essay can incorporate the use of diagrams and figures to illustrate the text.

A list of references is required and all referencing is to be clearly indicated throughout the essay.

Assessment 2

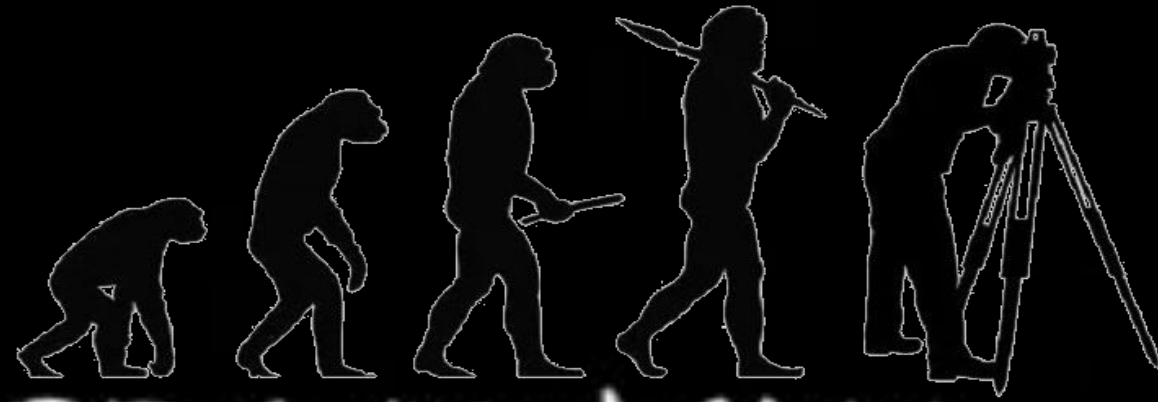
Submission
deadline:

7th May 2021

Return date of provisional marks &
written feedback:

18th June 2021

- *Use appropriate sources and compile make sure to reference any material.*
- *Demonstrate your understanding of the methods and tools of surveying over time.*
- *Show how the surveying tools are used on site. Give real life examples.*
- *Demonstrate through your examples, process of building surveying and be sure to indicate limitations where appropriate.*
- *The essay should be presented in a professional manner with all work clearly labelled and referenced.*



PREVIOUSLY . . .

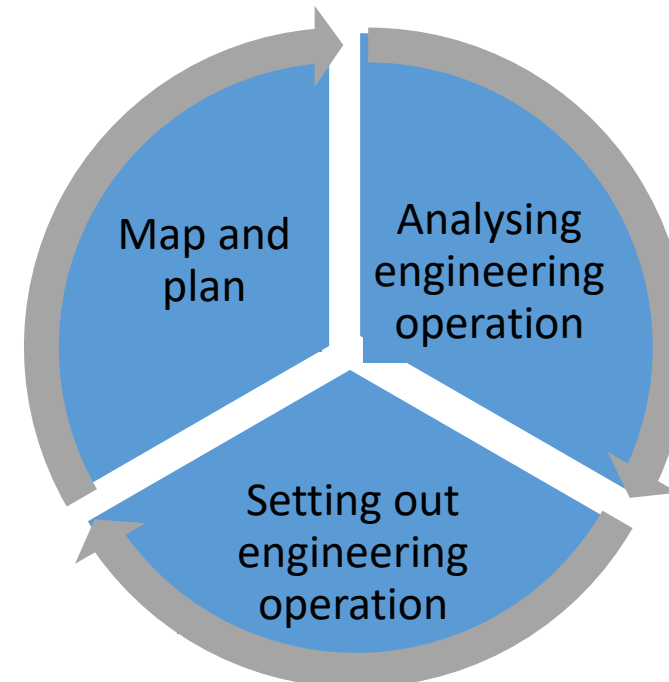
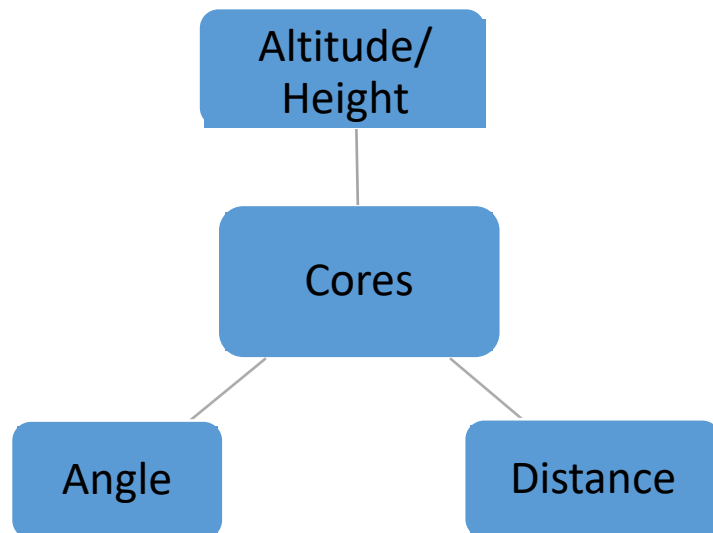


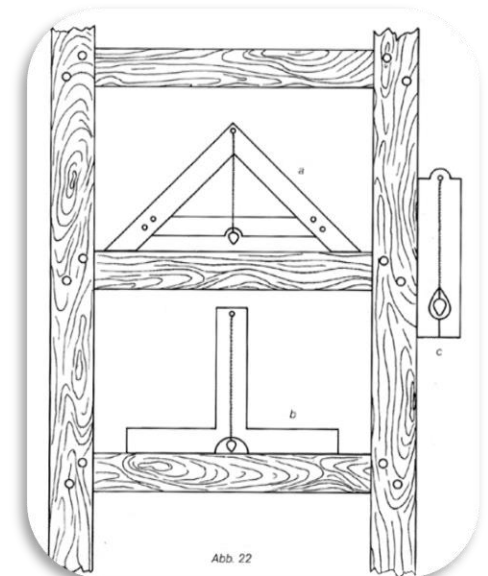
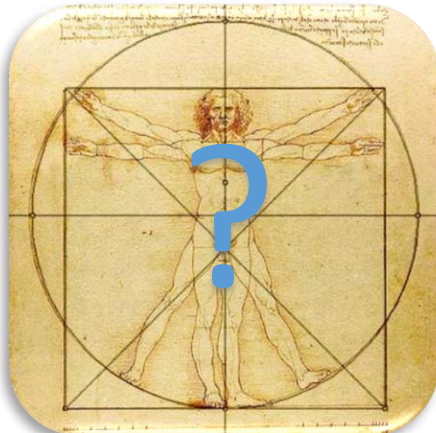
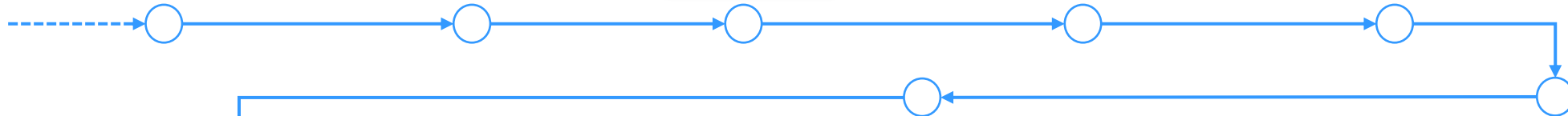
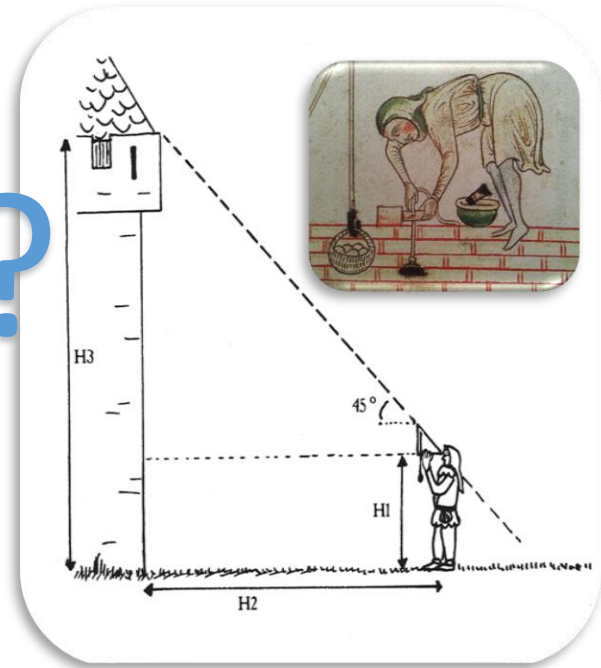
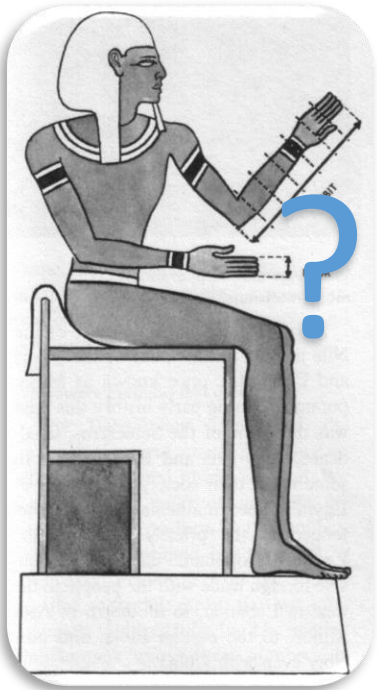
noun

1. the study or practice of measuring altitudes, angles, and distances on the land surface so that they can be accurately plotted on a map
2. the setting out on the ground of the positions of proposed construction or engineering works

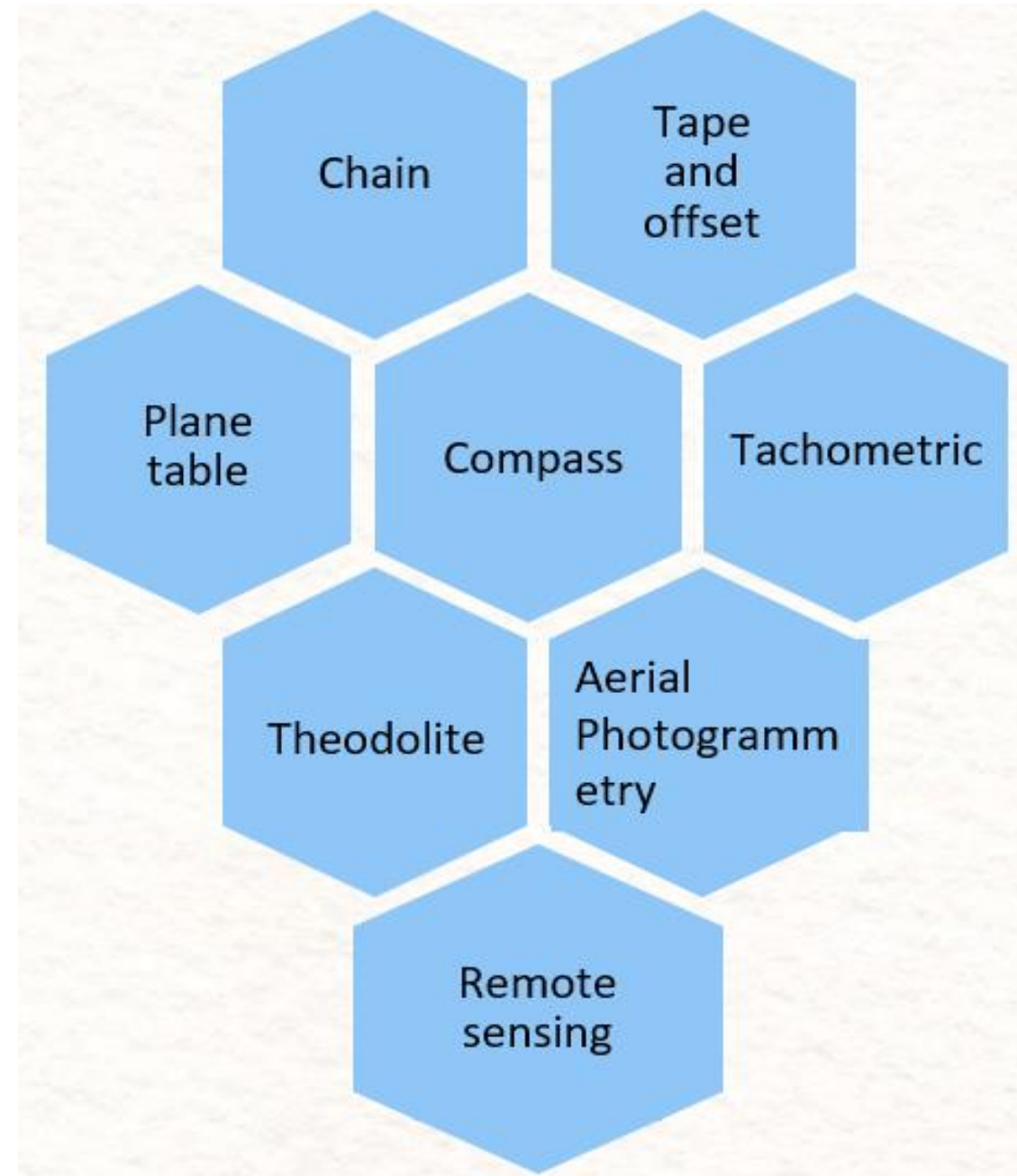
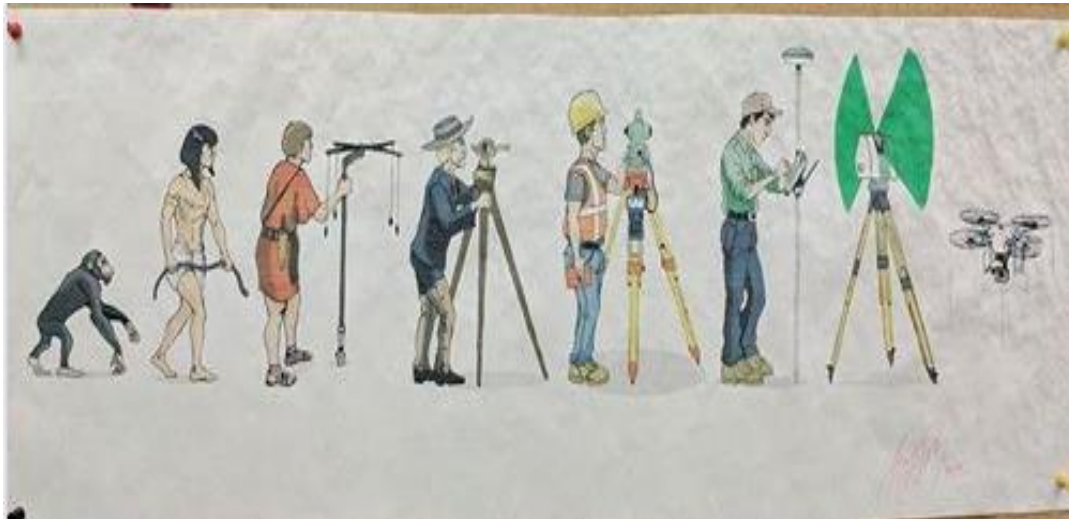


Collins English Dictionary. Copyright © HarperCollins Publishers





Evolution of Surveys



surveying in British

(sɜːˈveɪɪŋ 🔊)

Word Frequency 🔴 🔴 🔴 🔴 🔴

noun

1. the study or practice of measuring altitudes, angles, and distances on the land surface so that they can be accurately plotted on a map
2. the setting out on the ground of the positions of proposed construction or engineering works

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Measurement and Recording

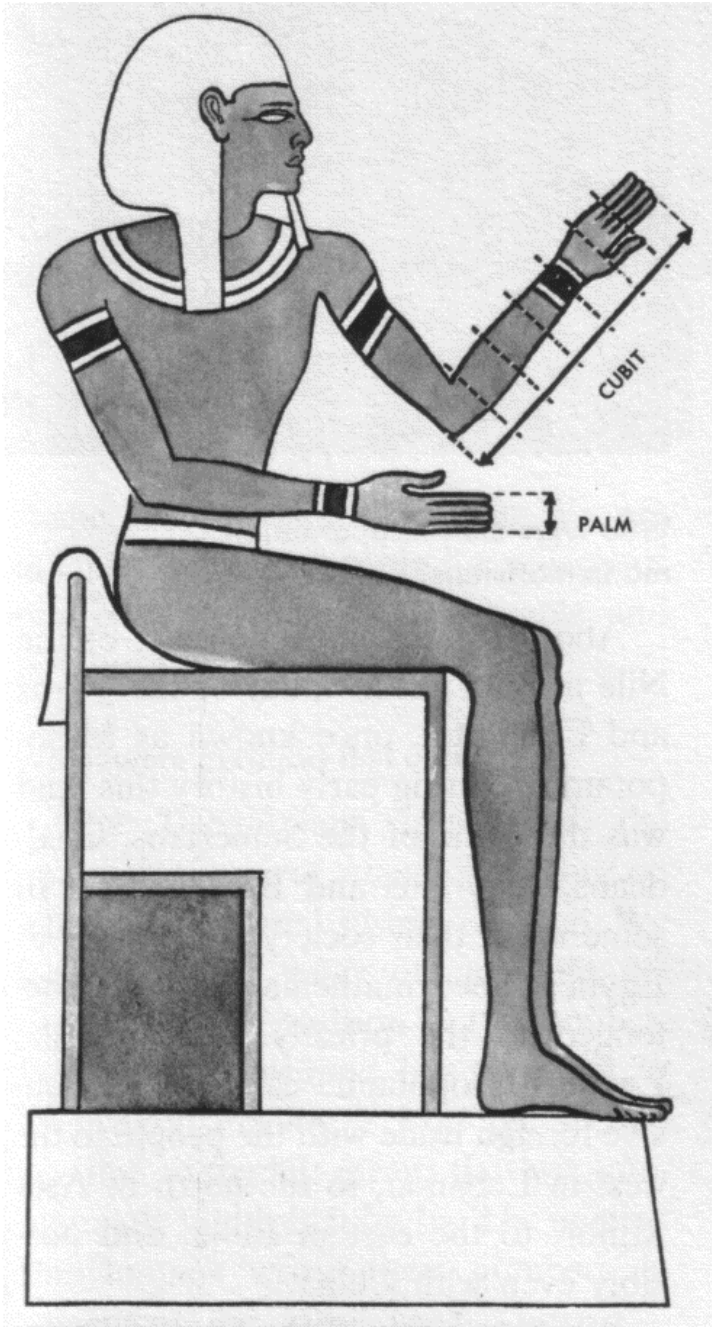


Mathematics and Writing

Ancient History or Antiquity



Pyramids of Giza, Egypt
Great Pyramid
Constructed 2560BC
By Pharaoh Khufu
440 cubits side base
280 cubits high



<http://2.bp.blogspot.com/-T2TknoeVZRE/T-IgAMIQ-vI/AAAAAAAAALo/OMk9SuTZmNA/s1600/cubit.gif>



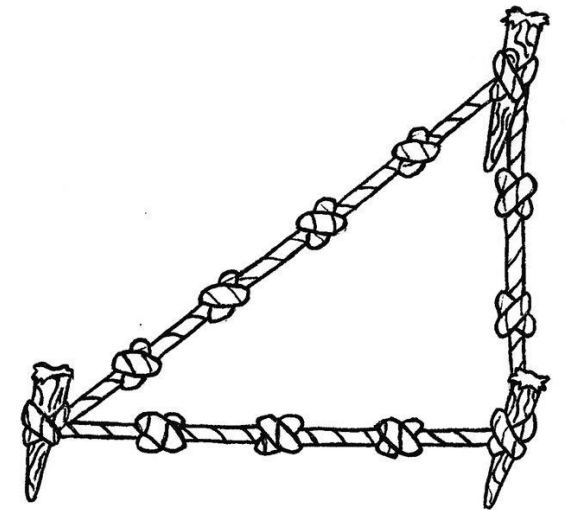
http://www.yallatours.com/blog/deir_el_medina/louvre-cubit.jpg



<https://4815162342execute.wordpress.com/lost-themes/hieroglyphs/>

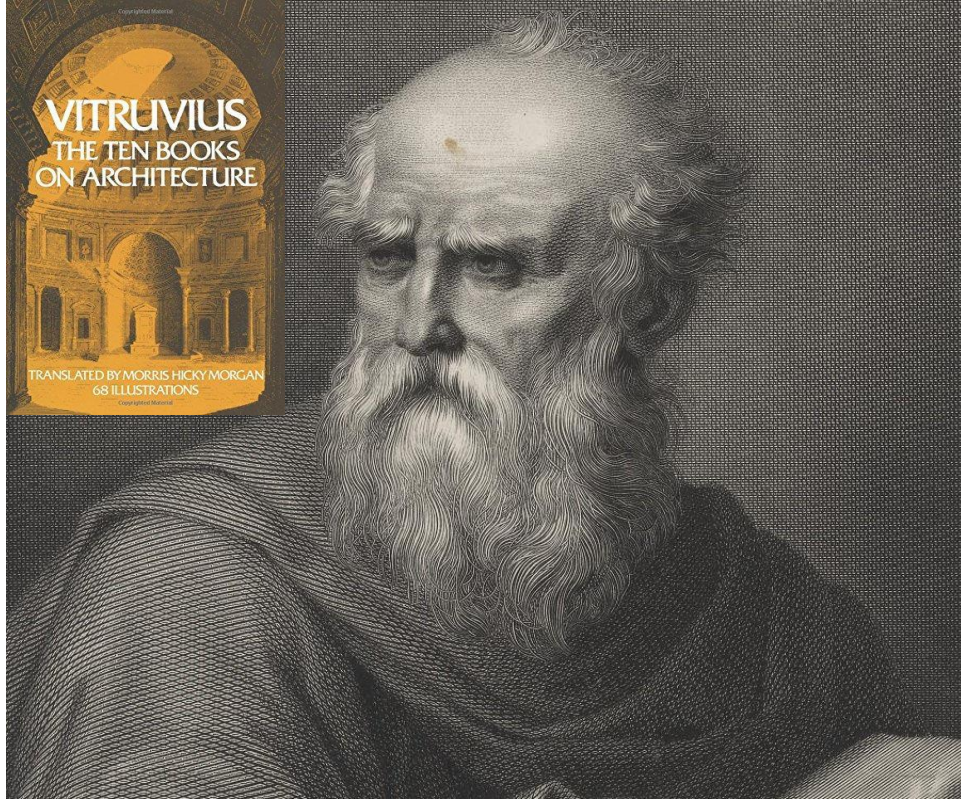


<http://www.taneter.org/Menna%20Surveying.jpg>



Ancient Egypt

Vitruvius born 80-70 BCE



<https://www.thefamouspeople.com/profiles/vitruvius-34320.php>

Vitruvius asserts in his book *De architectura* (the ten books of architecture) that a structure must exhibit the three qualities of *firmitatis*, *utilitatis*, *venustatis* – that is, stability, utility, beauty.

Odometer:

<http://www.hellenicaworld.com/Greece/Technology/en/Measurements.html>



The odometer of Vitruvius was based on chariot wheels of 4 feet (1.2 m) diameter turning 400 times in one Roman **mile** (about 1400 m). For each revolution a pin on the axle engaged a 400 tooth cogwheel thus turning it one complete revolution per mile. This engaged another gear with holes along the circumference, where pebbles (*calculus*) were located, that were to drop one by one into a box. The distance travelled would thus be given simply by counting the number of pebbles.

Sleeswyk, André Wegener "Vitruvius' Odometer", *Scientific American* 245.4 (October, 1981), pp. 188–200

Early Roman Period

The Groma



<https://www.satpalda.com/blogs/evolution-in-surveying-techniques>

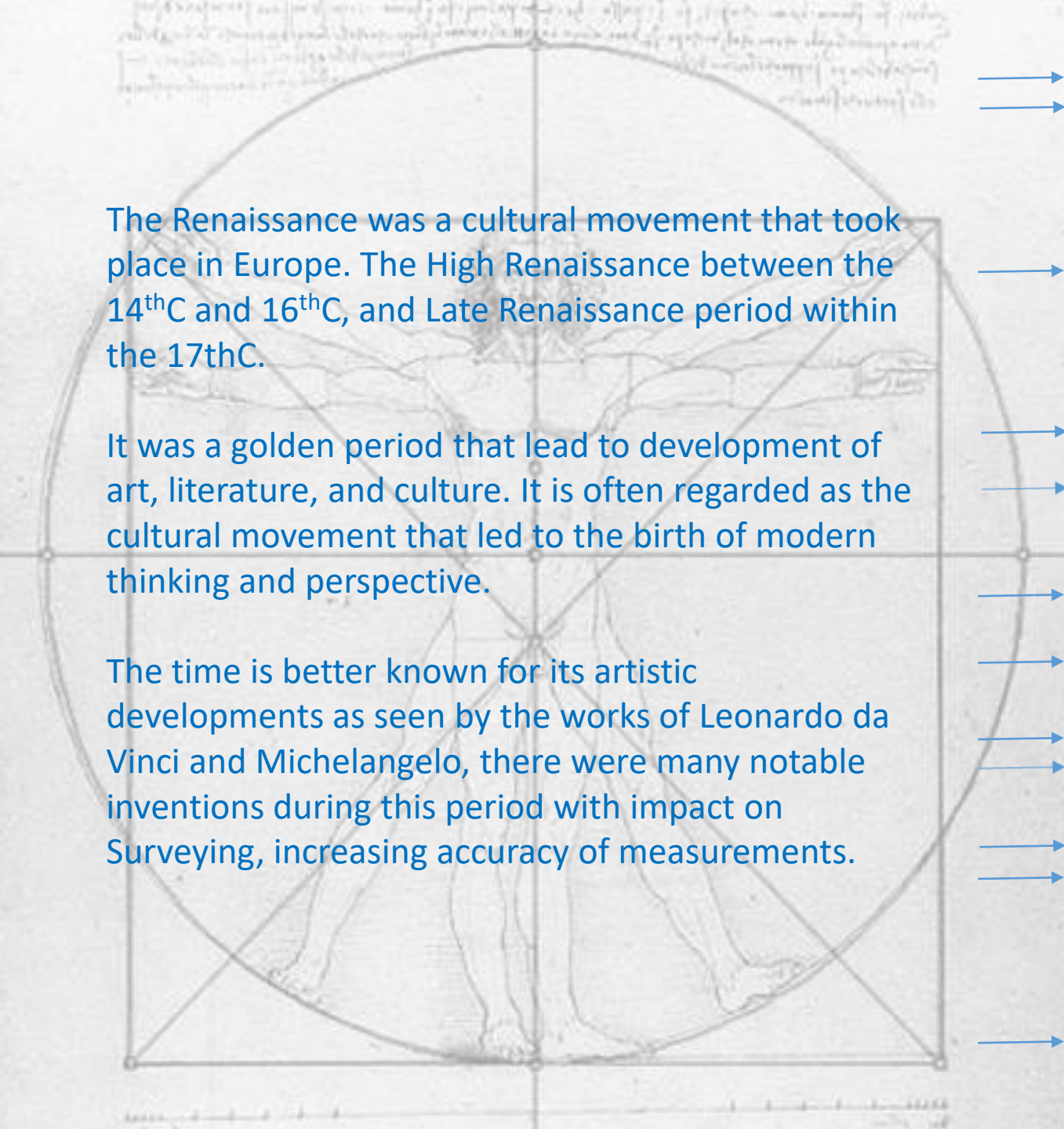
<https://youtu.be/-pIUTs2XD50>



<https://www.worldatlas.com/articles/5-important-cities-of-the-roman-empire.html>

Other surveying equipment used by the Roman included:
Dioptra, Libella and Chorobates.

Roman Empire

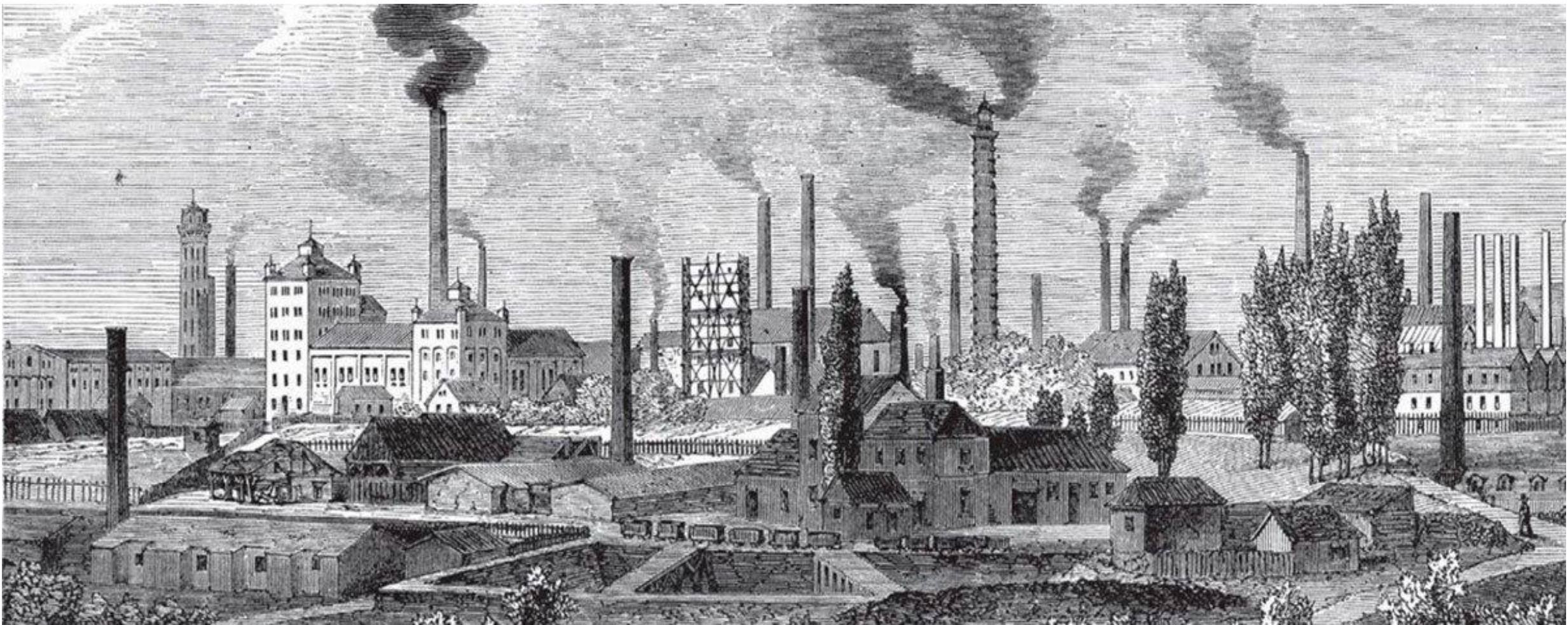


The Renaissance was a cultural movement that took place in Europe. The High Renaissance between the 14thC and 16thC, and Late Renaissance period within the 17thC.

It was a golden period that led to development of art, literature, and culture. It is often regarded as the cultural movement that led to the birth of modern thinking and perspective.

The time is better known for its artistic developments as seen by the works of Leonardo da Vinci and Michelangelo, there were many notable inventions during this period with impact on Surveying, increasing accuracy of measurements.

- 1300 - The first mechanical clock.
- 1366 - Scales for weighing.
- 1400 - First golf ball was invented
- 1411 - The trigger for the gun. The first piano called the Spinet invented.
- 1420 - Oil painting was invented.
- 1421 - Hoisting gear invented in Florence.
- 1450 - Lenses for near-sighted people invented by Nicholas of Cusa.
- 1456 - Printing press by Gutenberg.
- 1465 - Drypoint engravings invented.
- 1475 - Muzzle loaded rifles invented in Italy.
- 1485 - Leonardo da Vinci designed the first parachute.
- 1487 - Bell chimes.
- 1500 - The first flush toilets were invented.
- 1510 - Pocket watch invented by Peter Henlein.
- 1514 - Nicolaus Copernicus established the fact that the centre of the universe is not the Earth.
- 1579 - Azimuth Instrument 'Theodolite'
- 1589 - Knitting machine invented by William Lee.
- 1590 - Compound microscope invented by Zacharias Janssen.
- 1593 - Galileo Galilei invented the water thermometer.
- 1608 - First refracting telescope was invented by Hans Lippershey.
- 1620 - The first submarine was invented by Cornelis Drebbel.
- 1624 - Slide Rule was invented by William Oughtred.
- 1625 - Method of blood transfusion was invented by Jean Baptiste Denys.
- 1636 - W. Gascoigne invents the micrometer.
- 1642 - Adding Machine invented by Blaise Pascal.
- 1643 - Barometer invented by Torricelli.
- 1650 - The first air pump.
- 1656 - The pendulum clock was invented by Christian Huygens.
- 1661 - Thevenot invented the Bubble Spirit Level .
- 1663 - The first reflecting telescope was constructed by James Gregory.
- 1670 - Champagne was invented by Dom Perignon.
- 1671 - The first calculating machine invented by Gottfried Wilhelm Leibniz.
- 1671 - Sir Isaac Newton publishes his major work, Principia, which contains the three laws of motion and the law of universal gravitation.
- 1679 - Pressure cooker invented by Denis Papin.
- 1698 - Steam pump invented by Thomas Savery.



<https://www.learnodo-newtonic.com/wp-content/uploads/2018/03/Industrial-Revolution-Facts-Featured.jpg>

Industrial Revolution 18thC/ 19thC

ABCA 4002
DIGITAL SURVEYING: LEVEL 4



https://d3d00swyhr67nd.cloudfront.net/w944h944/SW/SW_MTLIB_PCF3.jpg

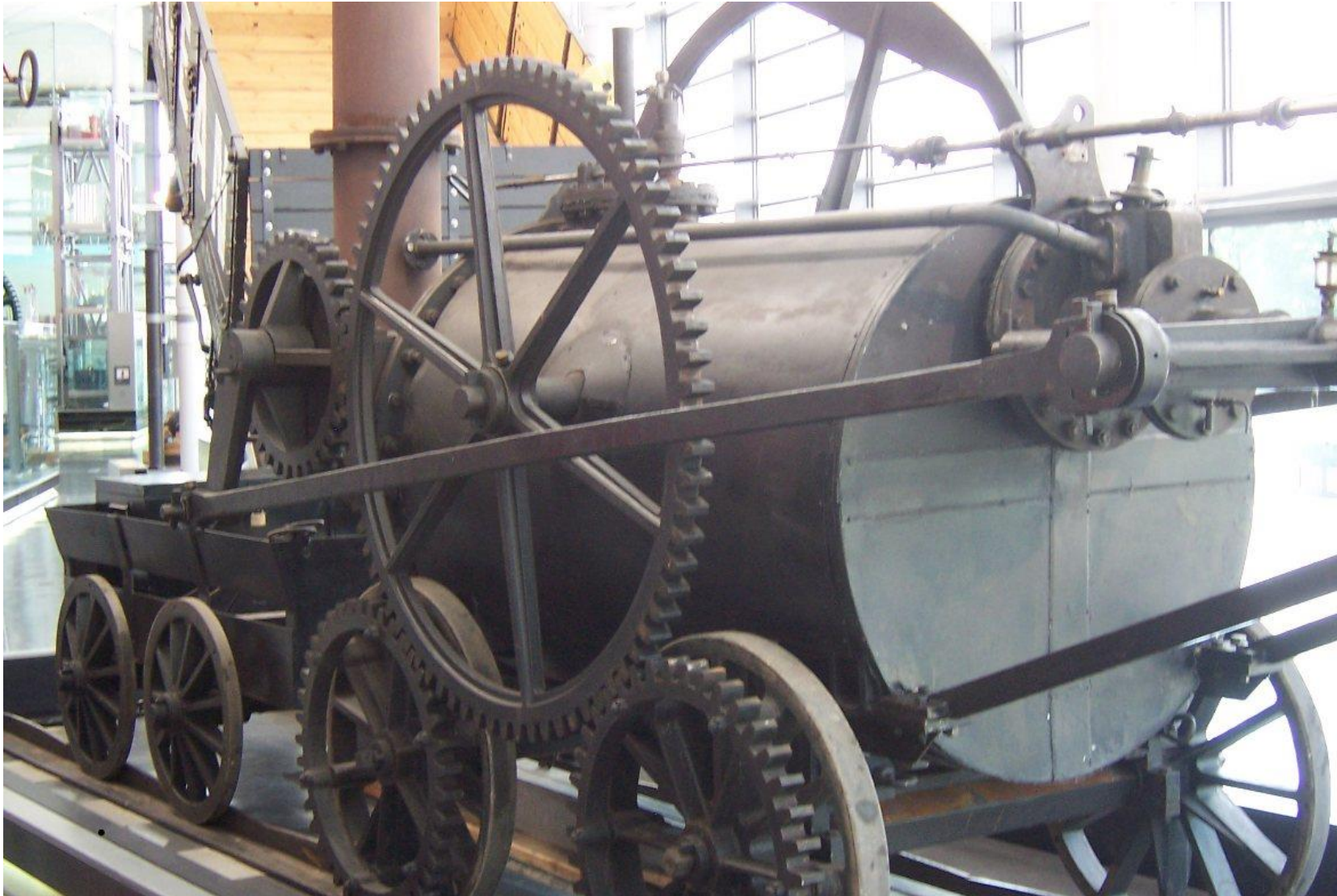
Industrial Revolution 18thC/ 19thC



http://lightmoor.co.uk/BDLbooksample_pics/B9129_samp2.jpg

Industrial Revolution 18thC/ 19thC

ABCA 4002
DIGITAL SURVEYING: LEVEL 4



The world's first locomotive-hauled railway journey took place on 21 February 1804, when Richard Trevithick's unnamed steam locomotive hauled a train along the tramway of the Penydarren Ironworks, in Merthyr Tydfil.

https://en.wikipedia.org/wiki/Richard_Trevithick#/media/File:TrevithicksEngine.jpg

Industrial Revolution 18thC/ 19thC

CYCLOPÆDIA:

OR, AN

UNIVERSAL DICTIONARY

OF

ARTS and SCIENCES;

CONTAINING

The DEFINITIONS of the TERMS;

And ACCOUNTS of

The THINGS signify'd thereby,

In the several ARTS,

Both LIBERAL and MECHANICAL,

And the several SCIENCES,

HUMAN and DIVINE:

The Figures, Kinds, Properties, Productions, Preparations, and Uses,
of Things NATURAL and ARTIFICIAL;

The Rise, Progress, and State of Things ECCLESIASTICAL,
CIVIL, MILITARY, and COMMERCIAL:

With the several Systems, Sects, Opinions, &c. among Philosophers, Divines,
Mathematicians, Physicians, Antiquaries, Critics, &c.

The Whole intended as a Course of Ancient and Modern LEARNING.

Compiled from the best Authors, Dictionaries, Journals, Memoirs,
Transactions, Ephemerides, &c. in several Languages.

In TWO VOLUMES.

By E. CHAMBERS Gent.

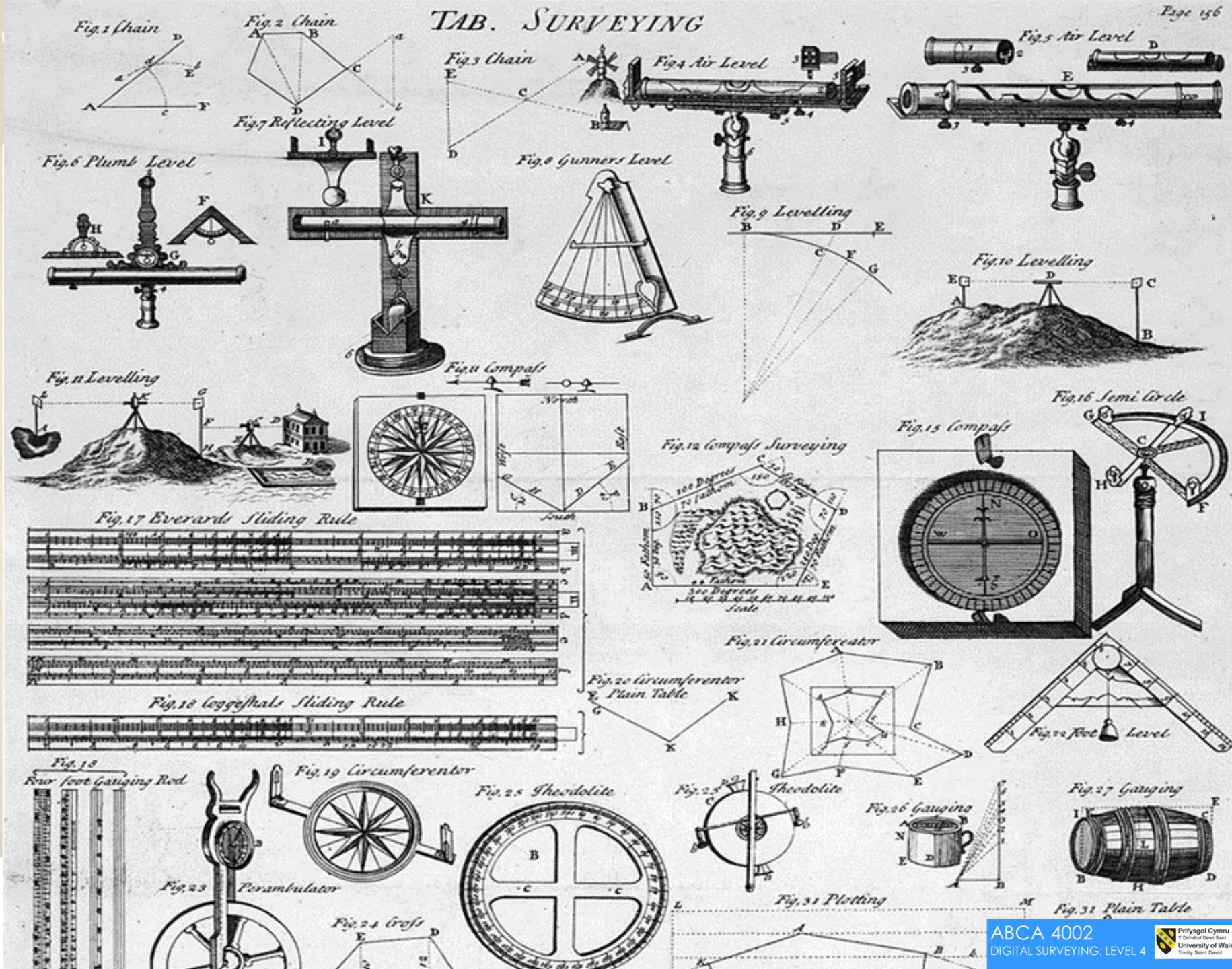
*Floris ut apes in salubris omnia libat,
Omnis nos* ———— LUCRET.

VOLUME the FIRST.

LONDON:

Printed for James and John Knapton, John Darby, Daniel Midwinter, Arthur Bettsworth,
John Senex, Robert Giffing, John Pemberton, William and John Innes, John Orlson and Tho.
Longman; Charles Rivington, John Hulse, Rawson Robinson, Francis Clay, Aaron Ward,
Edward Symon, Daniel Browne, Andrew Johnston, and Thomas Osborn. MDCCLXXVIII.

Chambers Cyclopedia 1728
More accurate instruments were
developed



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

A

Consider the horizontal distances between A – A and B – B
Are they the same ?

A

B

B

SOH CAH TOA

$$\sin \alpha = \frac{a}{c}$$

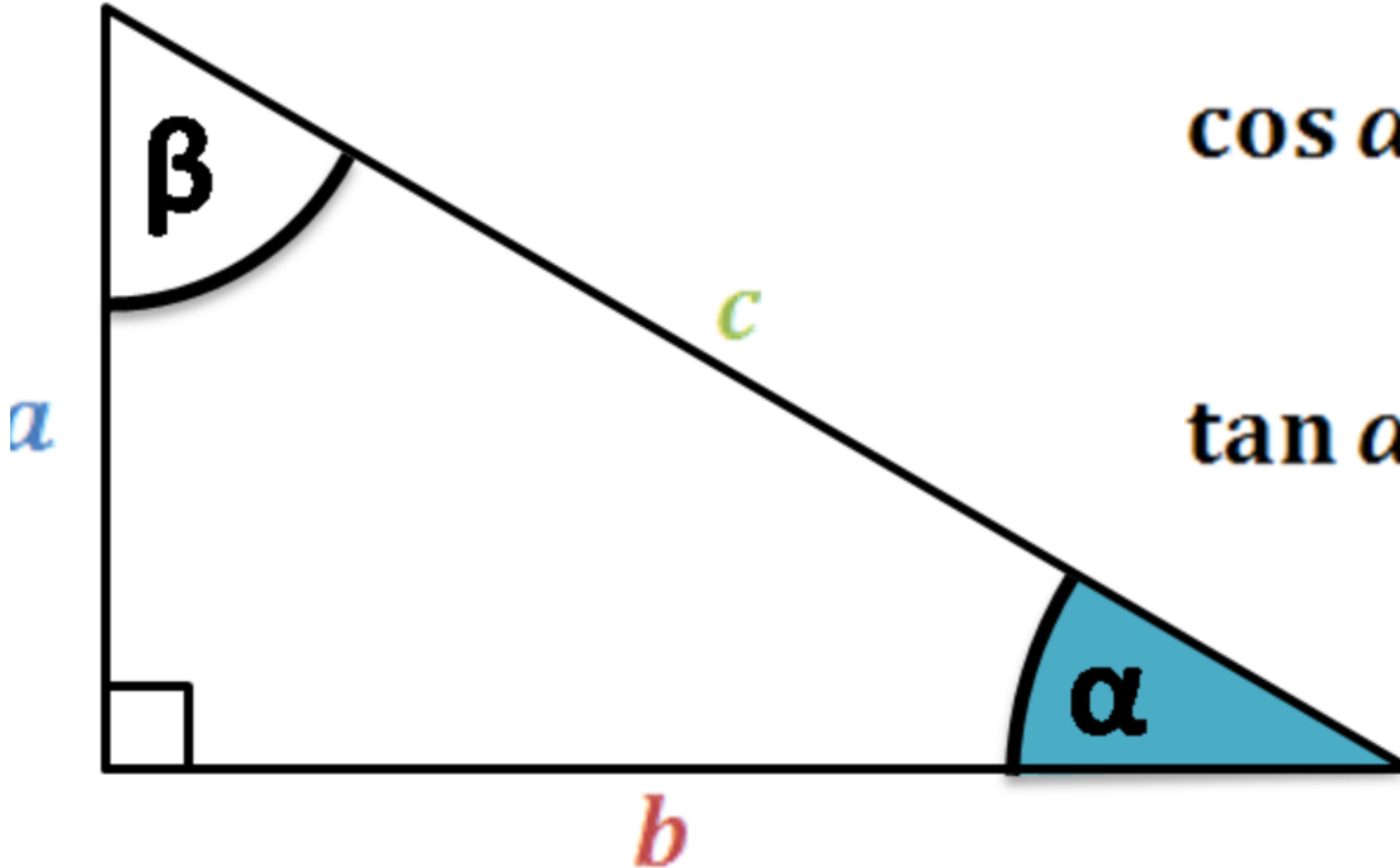
Opposite
Hypotenuse

$$\cos \alpha = \frac{b}{c}$$

Adjacent
Hypotenuse

$$\tan \alpha = \frac{a}{b}$$

Opposite
Adjacent

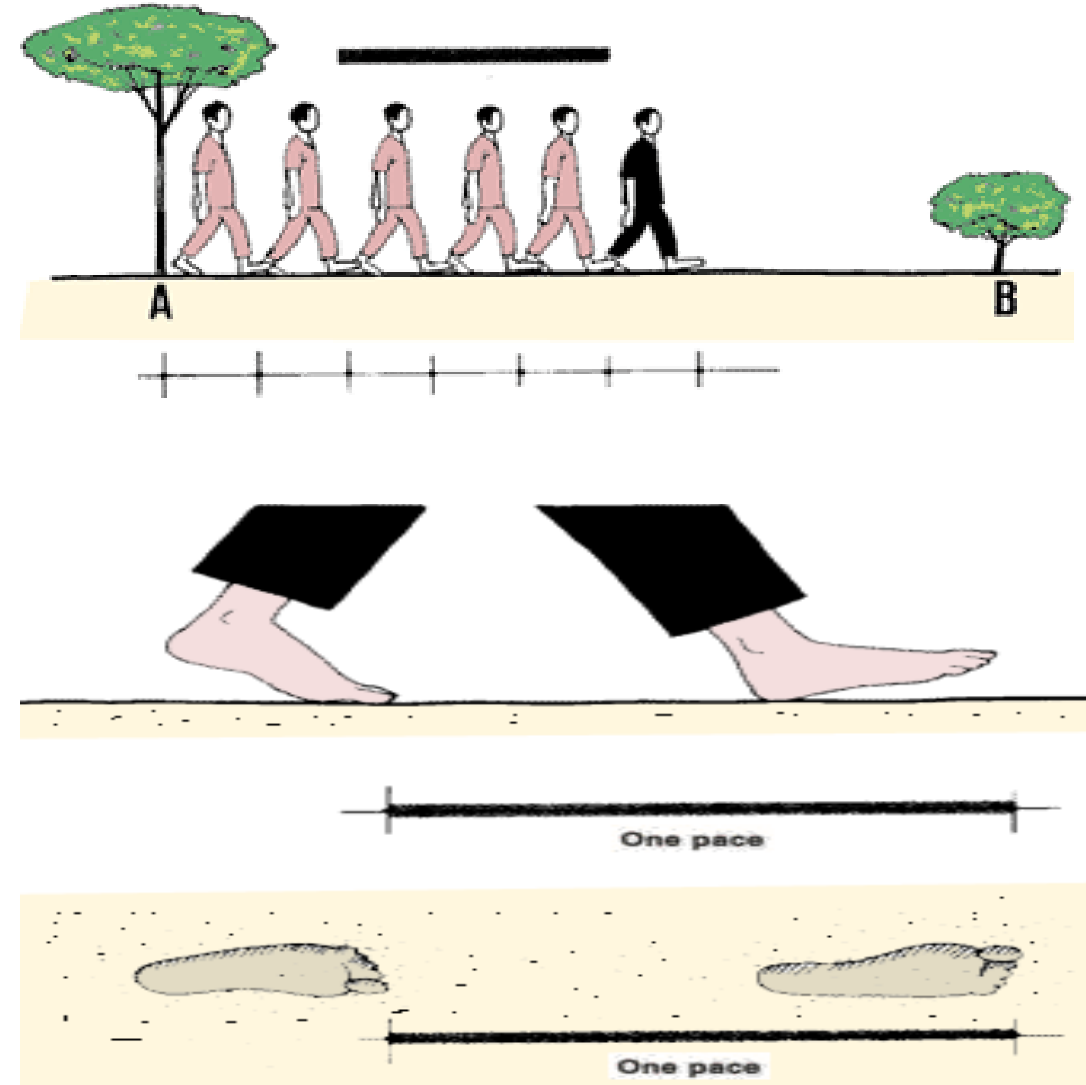


General: Pacing

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



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)

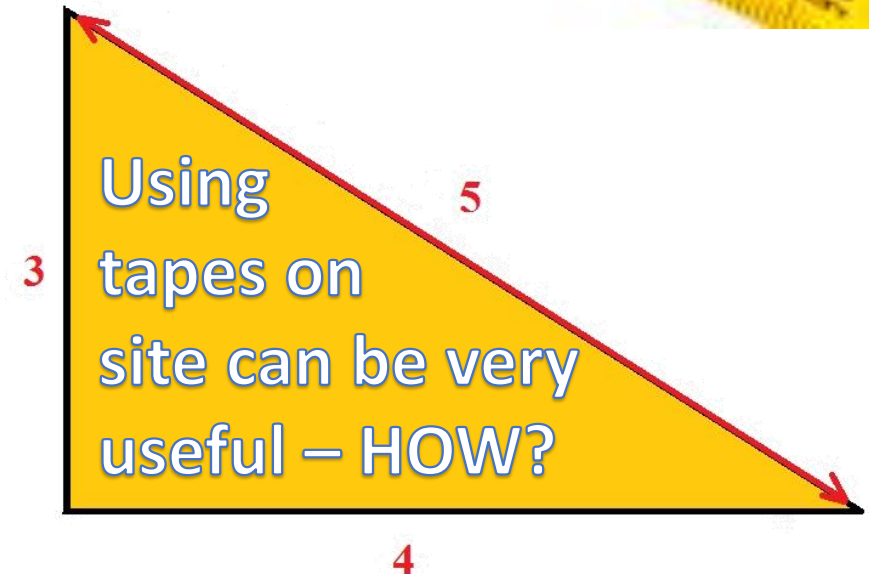
Fibreglass Tapes

- 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



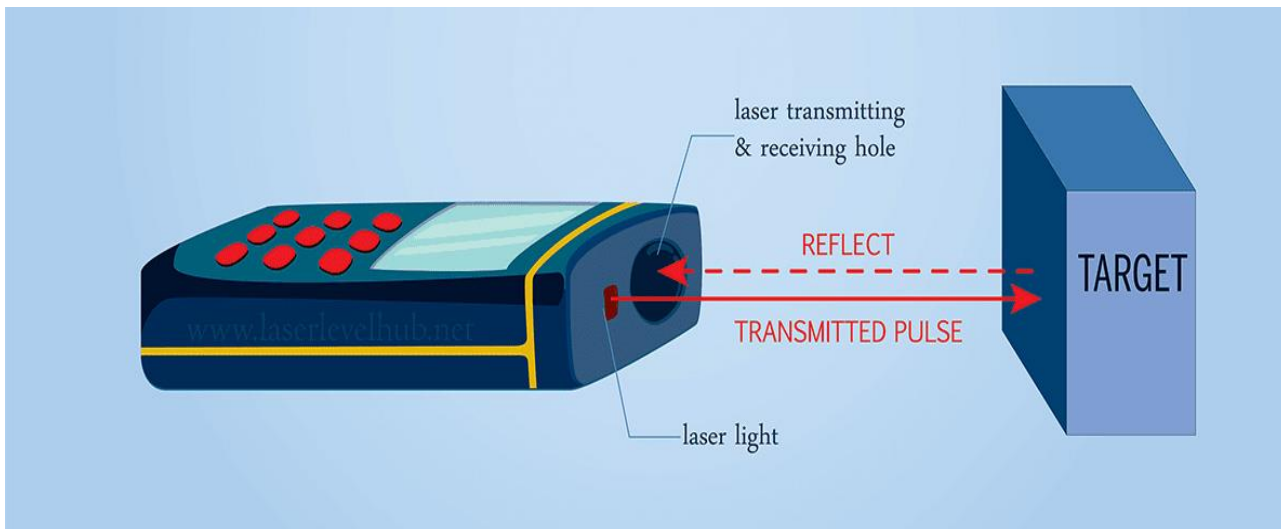
Measuring Wheels and Rods can be used to supplement other equipment.

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 = $\pm 3\text{mm}$; 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.



Land Surveying: Measurement

Automatic Levelling

Building Level/Dumpy Level

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 used 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.



iStockphoto.com/pryzmat

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.

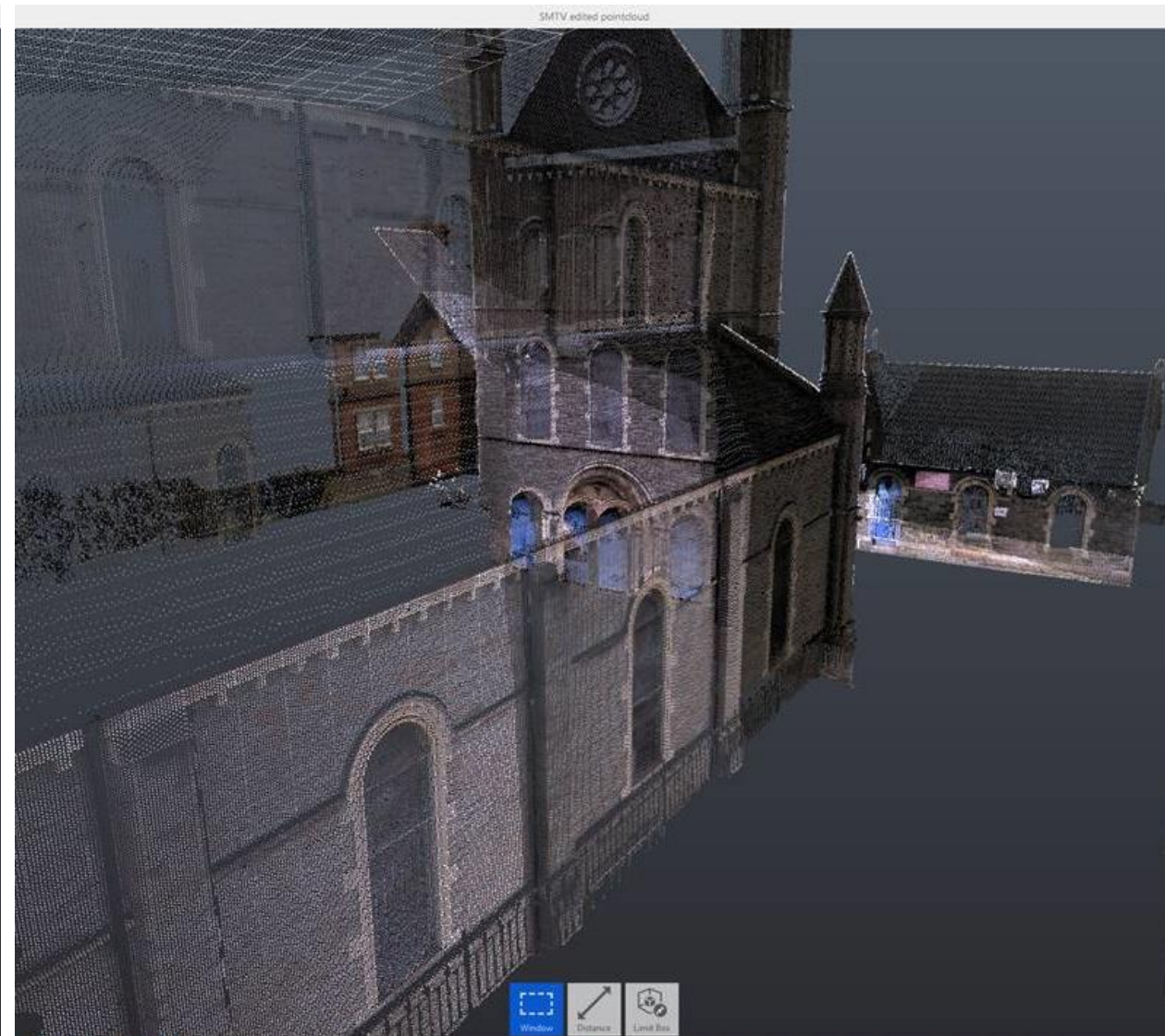
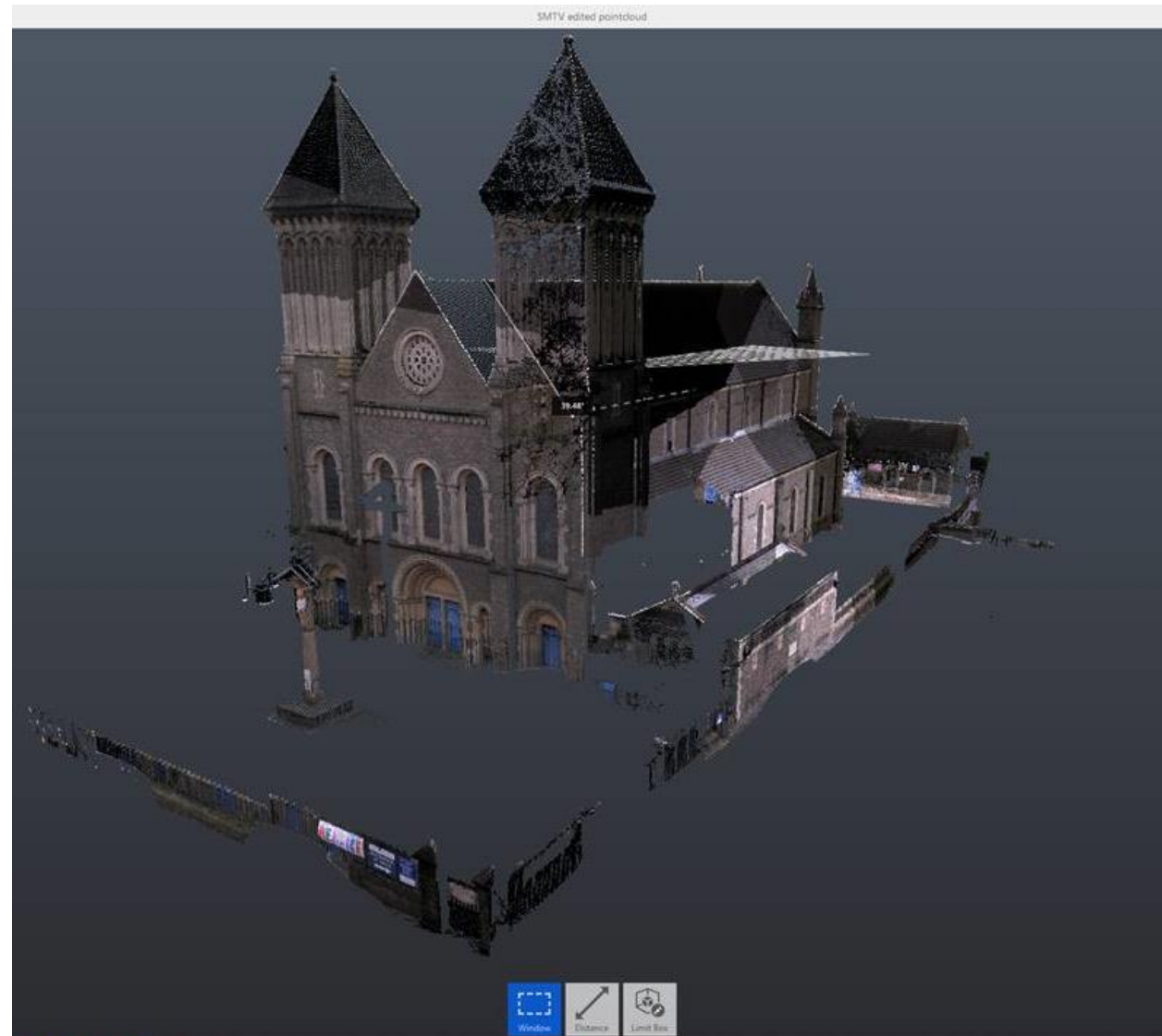
Laser scanners undertake highly accurate detailed surveys, through to production of basic point cloud and rendered photographic imagery.

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.



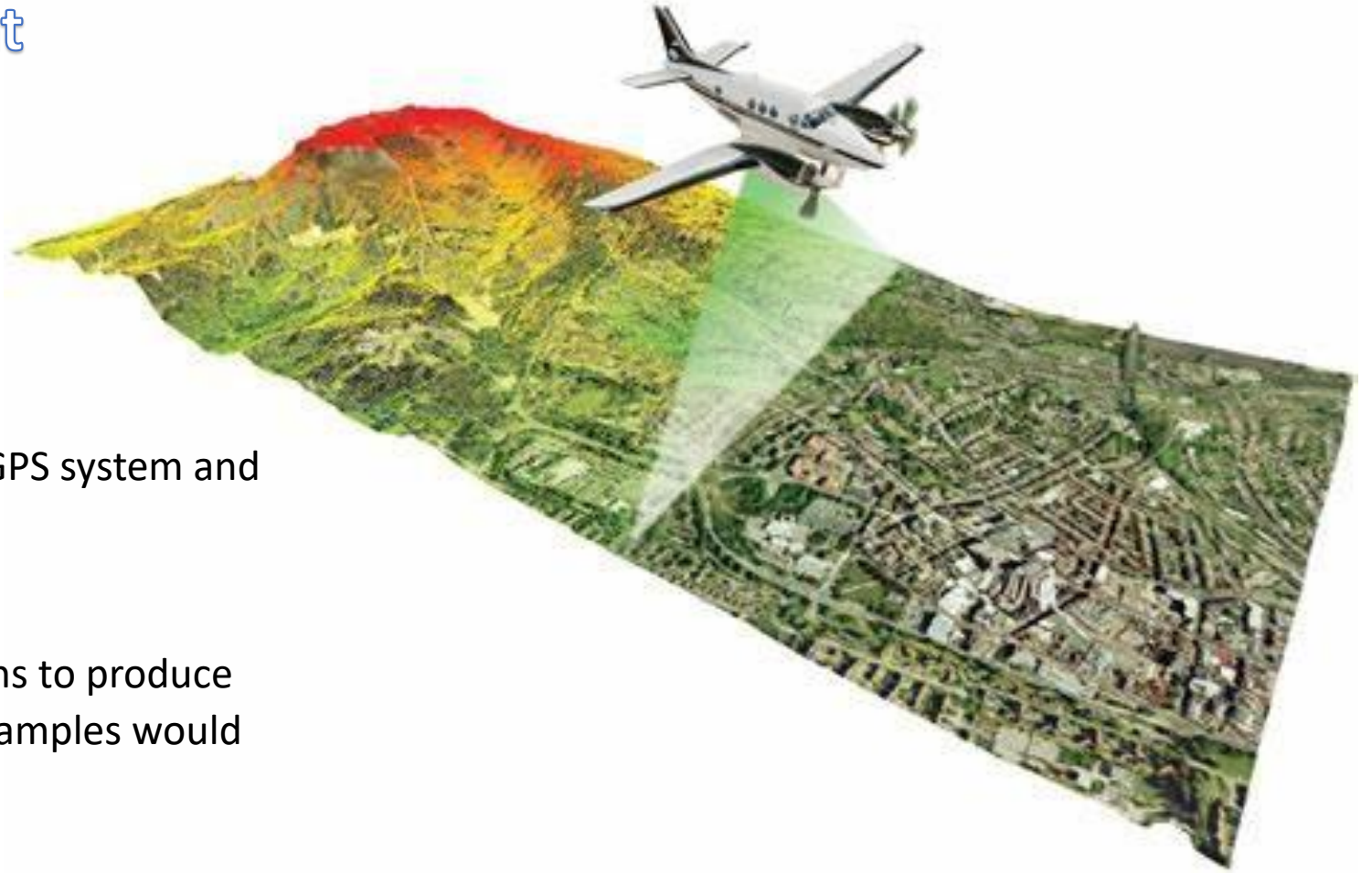
Land Surveying: Measurement

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 beams to produce and level survey of large open areas. Typical examples would be NWR.



Land Surveying: Measurement

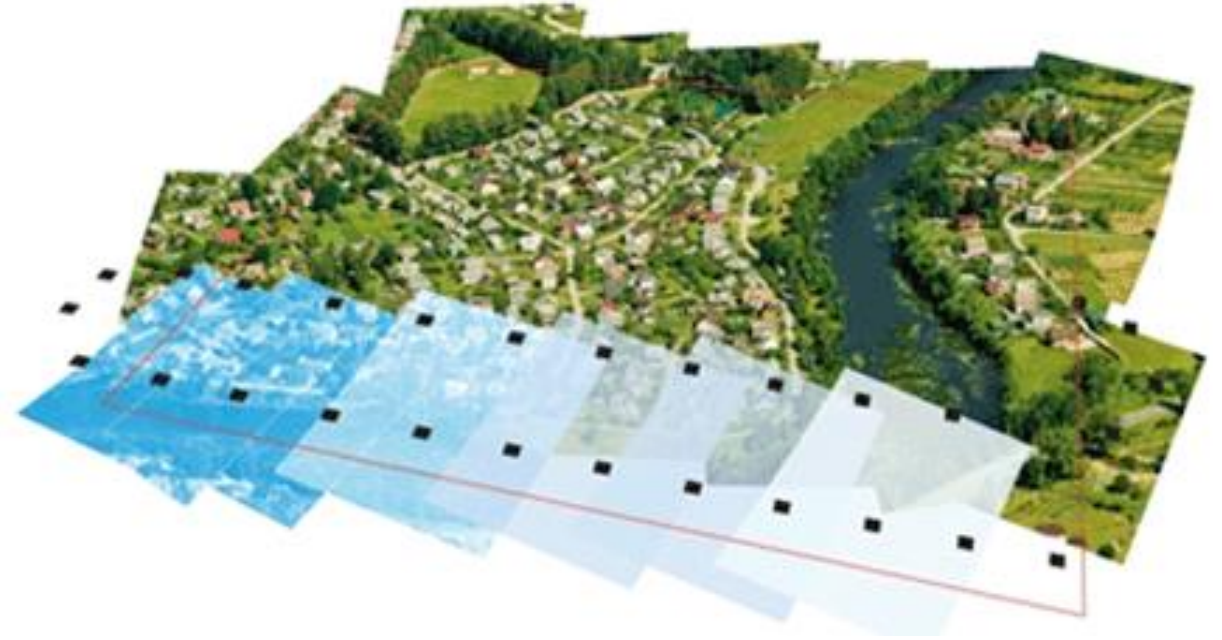
Photogrammetry

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

GNSS System

Commonly referred to as 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

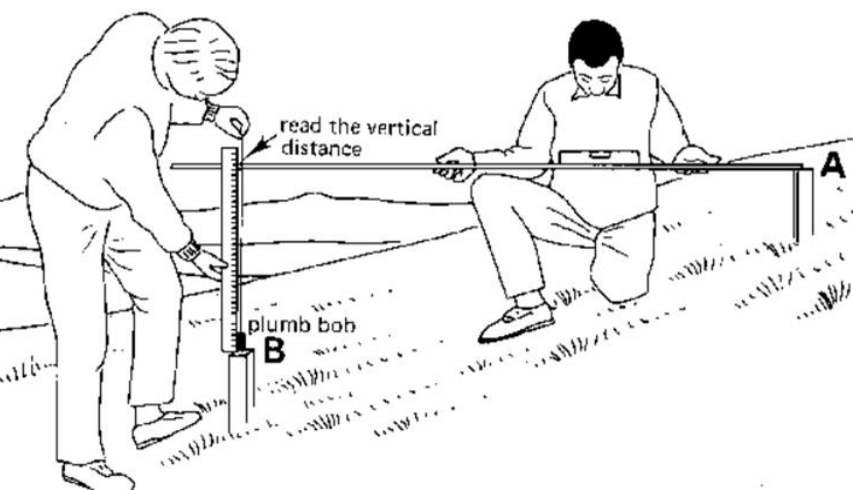
BeiDou – Chinese Satellite system.

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



Classification of Surveying based on Equipment

Traditional



Modern/ Digital



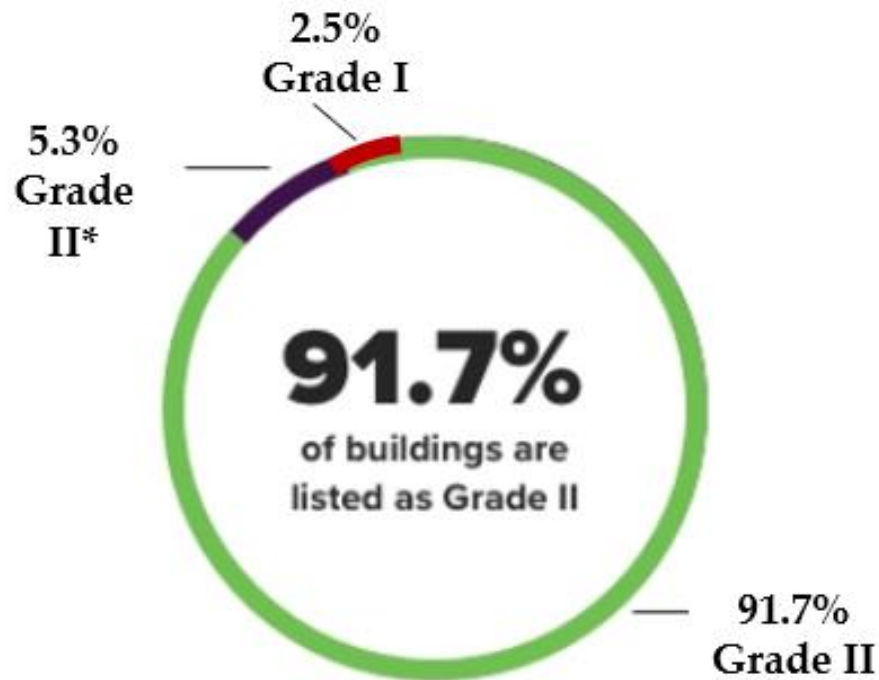


Survey of Listed Building

The Palace Theatre, Swansea

Listed Building Survey

Definition: survey of older buildings, some of which are of such historical or architectural importance that they're listed and therefore maintain a certain level of protection.



Classification (by Historic England)

Reason for building survey

Detailed building plan/elevation

As-existing conditions

Retrofit/renovation plan

Fulfilment of building legislation

Building Surveying: Measurement where Access is Limited



Telescopic inspection camera: mounted at the top of featherweight with telescopic, self locking pole. It is perfect for taking pictures and videos of **roofs, gutters**.



Optical distance measurement: for geometric survey to measure distance to produce building **plan and drawings**.



Protimeter survey master: this will be used to check **wall dampness** within the building.



Digital camera: high quality digital camera will be used to ensure small details are captured for the **technical report**.

Building Surveying - Process

- Planning: Research, analysis, and decision making.
- Field work: Data acquisition, site measurement and observation
- Computing: Data processing and calculation
- Mapping: Data representation, sketches and drawing
- Report

Planning: Available Existing Information

- As built drawings
- Building File / O&M Manuals
- Original Property deeds
- Previous planning applications / building regulation work
- Fire plans
- Asbestos register plans
- OS Data / Historic Maps / Topography



Building surveys; Survey document preliminaries

- Title and address of property
- Client's name, address and contacts
- Survey date and time
- Property status freehold, leasehold or common hold
- Occupancy occupied or vacant. If vacant, source of keys
- **Extent of survey, e.g. full structural services reports**
- Specialists in attendance, e.g. electrician, heating engineer, etc.
- Age of property (approx. if very dated or no records)
- Disposition of rooms, i.e. number of bedrooms, etc.
- Floor plans and elevations if available
- Elevation (flooding potential) and orientation (solar effect)
- Estate/garden area and disposition if appropriate
- Means of access roads, pedestrian only, rights of way
- Drainage Positions



SCOPE

Data / Information from the Survey

History

- History and development of the building (desk study)

Construction

- Original construction principle of the building (As-built survey)

Condition

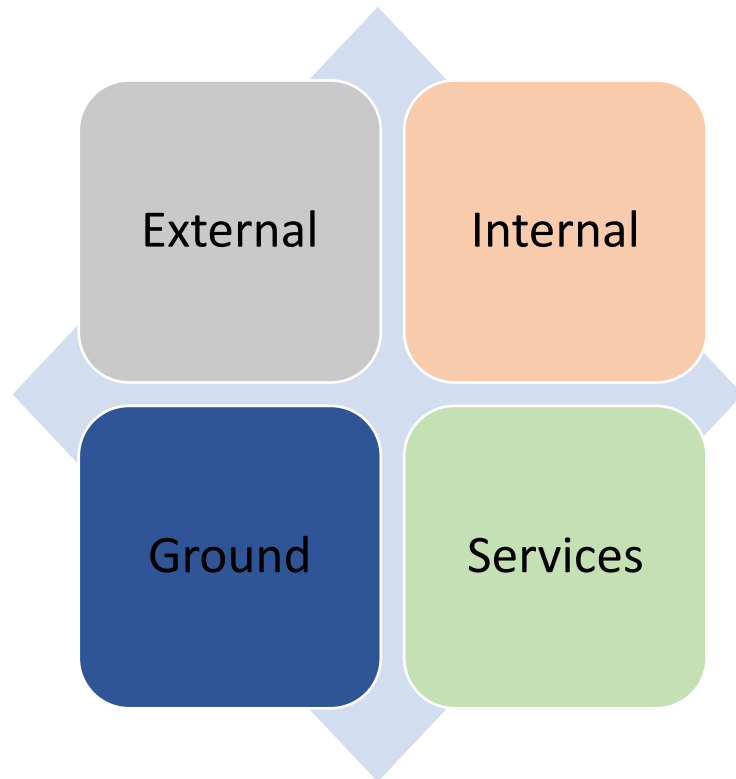
- As- existing condition of the building (**Initial Assessment/survey**)

Defect / Strength

- Major and minor defects and what they could mean (**Full Assessment**)

Initial Assessment

Q1) Assess the condition of the main building elements (roof, wall, ceiling, stair, pipes etc) as good, fair, poor, very bad or not inspected.



Good	Structurally sound; weathertight; no significant repairs needed.
Fair	Structurally sound; in need of minor repair; showing signs of a lack of general maintenance.
Poor	Defects that need repairing or replacing but are not considered to be either serious or urgent. The property must be maintained.
Very bad	Defects that are serious and/or need to be repaired, replaced or investigated urgently.
Not inspected	Not inspected (further investigation required)

Initial Assessment (contd)

Q2) Overall condition: Taking into consideration the evidence collected, assess the condition of the building as a whole as good, fair, or poor.

Good (1)	Satisfactory Repair: Considered to be in an acceptable state of repair and condition taking into account the age of the property. No repair is required.
Fair (2)	Maintenance Required: Considered by the surveyor to be in a generally acceptable condition but requires some routine maintenance and repair which is considered normal for a property of this age and character.
Poor (3)	Urgent Repair or Further Investigation Needed: Defects or shortcomings that are an actual or developing threat to the fabric of the building or to personal safety. Repair or further investigation is required immediately.

Full Assessment

A Full assessment / building survey looks at certain aspects of a building and gives details of its condition and any potential concerns. (Usually carried out by building retrofit expert to know the strength of the building).



Technical Survey Report

Definition: This is a process of presenting the survey data collected to non-specialist audiences in an **A**ccurate, **B**rief and **C**lear format (i.e. easily understandable form).

Importance of technical survey report :

- ❖ provide detailed advice on the condition of the building
- ❖ describe the identifiable risk of potential or hidden defects
- ❖ make recommendations for any further special inspection
- ❖ help you make a reasoned and informed decision when purchasing or planning for repairs, maintenance or upgrading of the property
- ❖ where practicable, provide an estimate of costs for identified repairs

Structure of Survey Report

Section	Details
Title page	Must include the title of the report, property address, name of the owner/client and date of inspection. It is also desirable to put the photograph of the property
Summary	A summary of the whole report including the brief overall assessment, important features, and the overall condition rating of the building
Contents	Numbers and lists of all sections, subsection headings and appendixes with page numbers
Introduction/ Instruction	This section will contains the scope of the assessment carried out on the building. The report should be prepared in accordance with the signed terms and conditions of engagement
Body	Divided into numbered and headed sections. These sections separate the different main ideas in a logical order constructional principles & structural risks, exterior, interior, services and grounds.
Conclusions	A short, logical summing up of the theme(s) developed in the main text
Appendices	Any further material which is essential for full understanding of the report (e.g. drawings, photos, general advice, house illustration, glossary of building terms, general maintenance notes and guidance

Further Reading Materials

- Adrian Tagg (2018). *Technical due diligence and building surveying for commercial property*, 1st Edition, Taylor & Francis, London UK.
- Bannister, A. (1999). *Solving Problems in Surveying*. 2nd Ed. Harlow: Pearson Education Ltd.
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