Faculty of Geomatics
Sabaragamuwa University of Sri Lanka

Department of Surveying & Geodesy

FC 11218 Basics in Land Surveying

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Synopsis

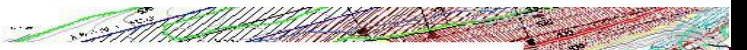
This course introduces students to fundamental aspects of Land Surveying.

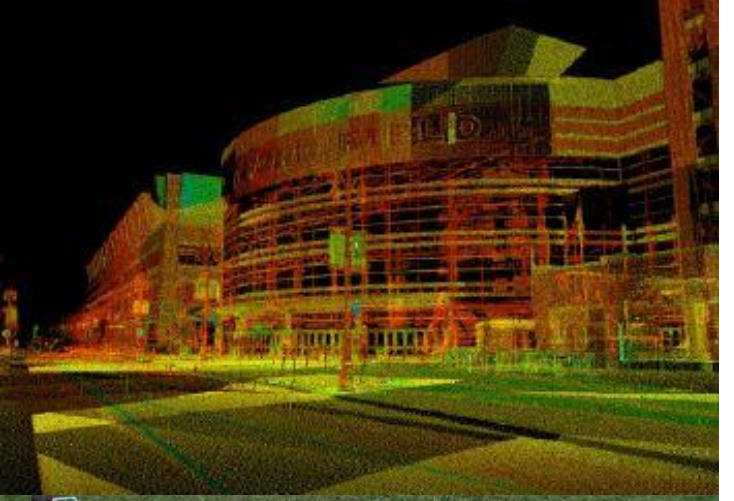
The principle of surveying, definitions, introduction to conventional surveying and mapping techniques will be provided.

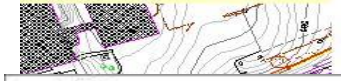
Ground Rules

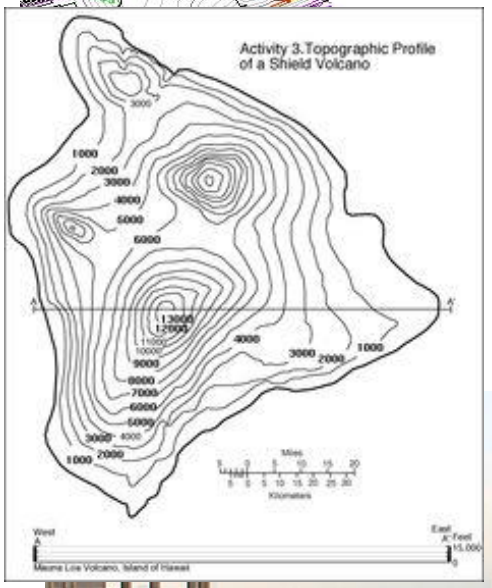
Credit Rating	**:** 2 credits (30 lecture hours)	
Time	**:** Monday – 1000 – 1200 hours	
	: Tuesday – 1100 – 1200 hours	
References	**: Additional reference is advised**	
Evaluation Policy	**:** Final Examination	50%
	Continuous Assessments	50%
	(Assignments/Quizzes)	

Land Surveying

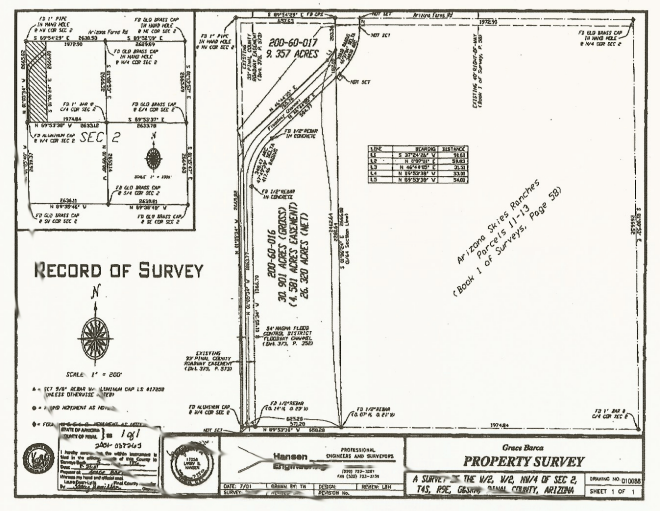


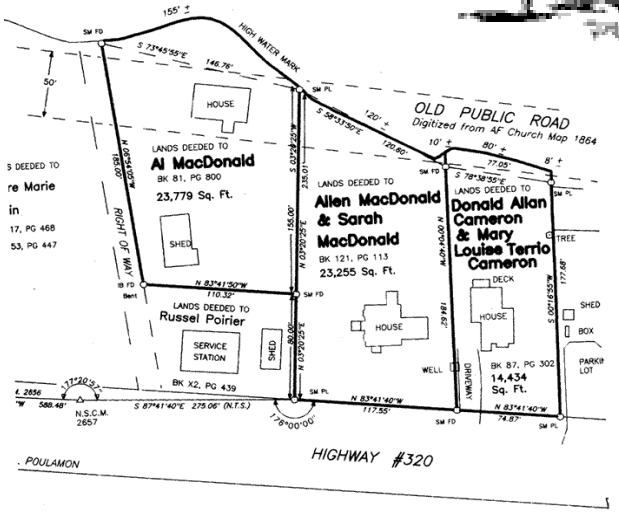






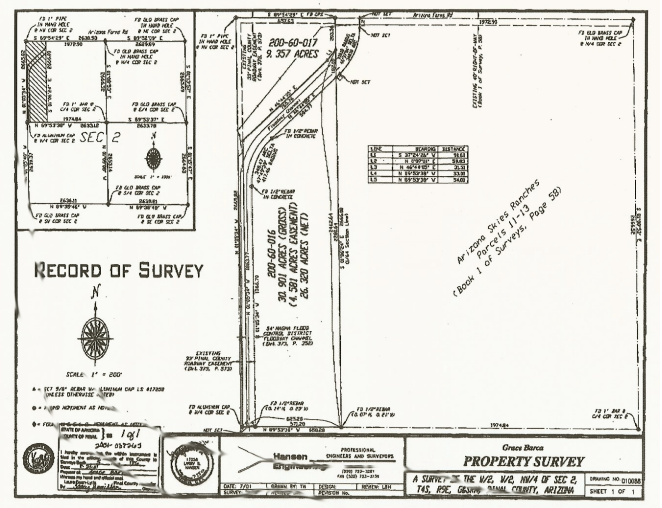
What IS Surveying?

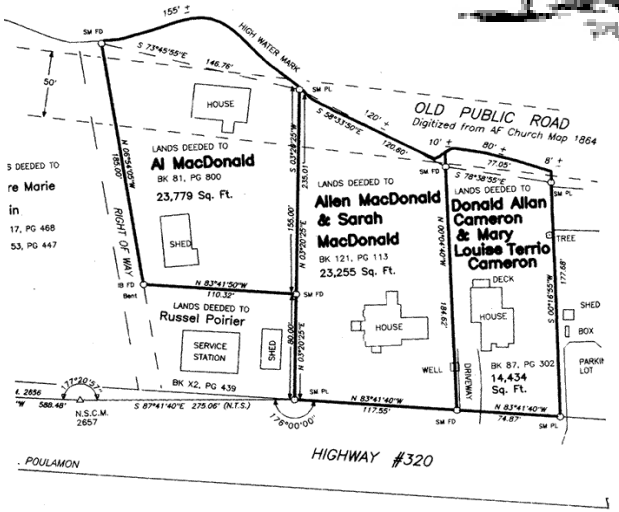




What IS Surveying?

The art of making **measurements** of the **relative positions** of natural and man-made features on the earth's surface, and the **presentation** of this information either graphically or numerically





Since When?

- https://www.youtube.com/watch?v=9sPwFu_fn5w

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- Used for 6,000 years based on historical records

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- The Egyptians first used it to accurately divide land into plots for the purpose of taxation
- Greeks developed the science of geometry and were using it for precise land division
- Greeks developed the first piece of surveying equipment (Diopter), and standardized procedures for conducting surveys

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- 1787 – Jesse Ramsden – theodolite instrument – tool used to measure angles in vertical and horizontal planes

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- 1600 – triangulation – various changes in land mapping and surveying techniques, and was used for mapping entire countries
- Early 1800 – Industrial Revolution – more advanced surveying instruments were developed – Surveyors assisted in construction of canals, roads, railways, etc.

Today …

To map the earth above and below the sea

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Prepare navigational maps (land, air, sea)

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Develop data bases for natural resource management

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Develop data bases for natural resource management

Development of engineering data

Principal of Surveying

“Working from WHOLE to PART”

Principal of Surveying

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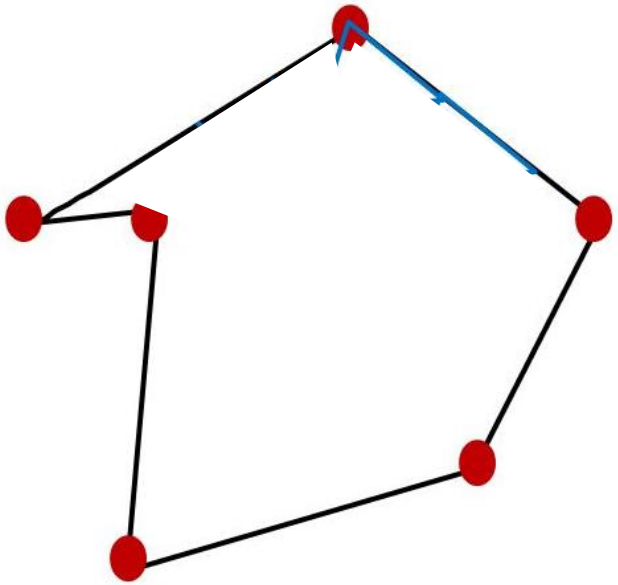
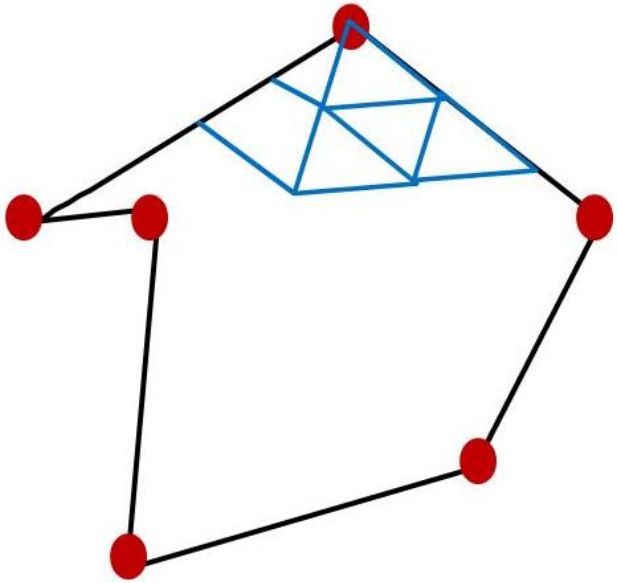


Step 1 – establish a system of (major) control points – fixed with a fairly high standard of accuracy

Principal of Surveying

“Working from WHOLE to PART”



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Step 2 – between them, minor control points – lesser accuracy – detail collection

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- Idea – **prevent** accumulation of errors

Principal of Surveying

"Working from WHOLE to PART"

Step 1 – establish a system of (major) control points – fixed with a fairly high standard of accuracy

Step 2 – between them, minor control points – lesser accuracy – detail collection

- Idea – **prevent** accumulation of errors
- **ALWAYS** from high accuracy – low accuracy

How is this Achieved?

Relative positions (2D case):

Requirement – find two points and measure the distance between them

Hence, a coordinate system can be created

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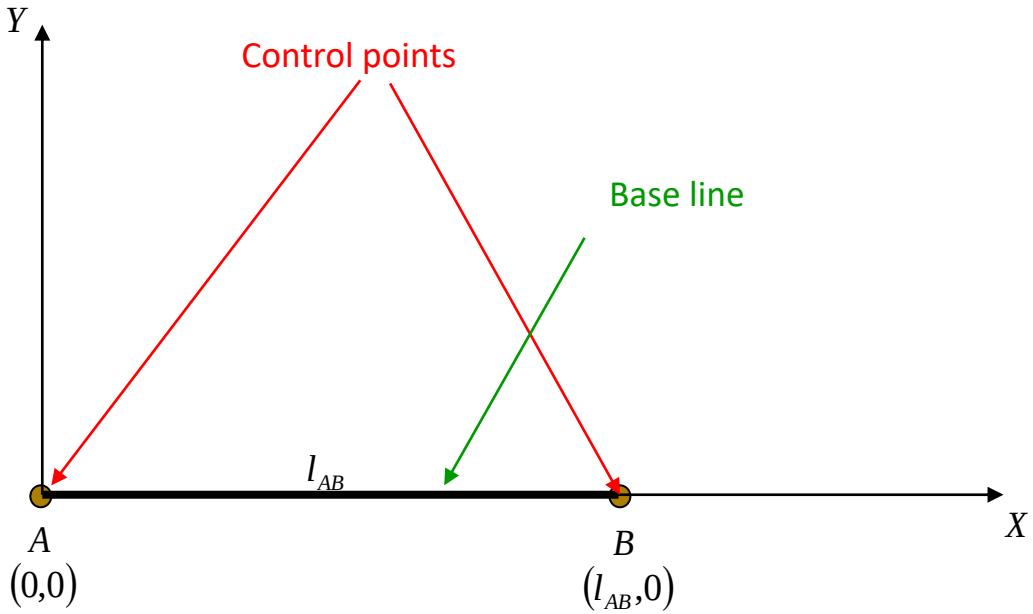

How is this Achieved?

Let's determine the position of a third, unknown point (C)

Two unknowns $-X_C, Y_C$

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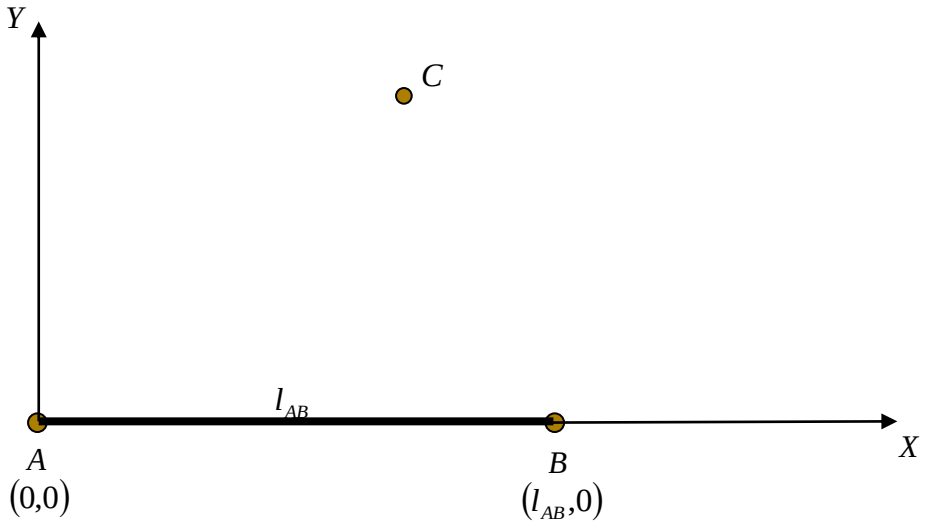

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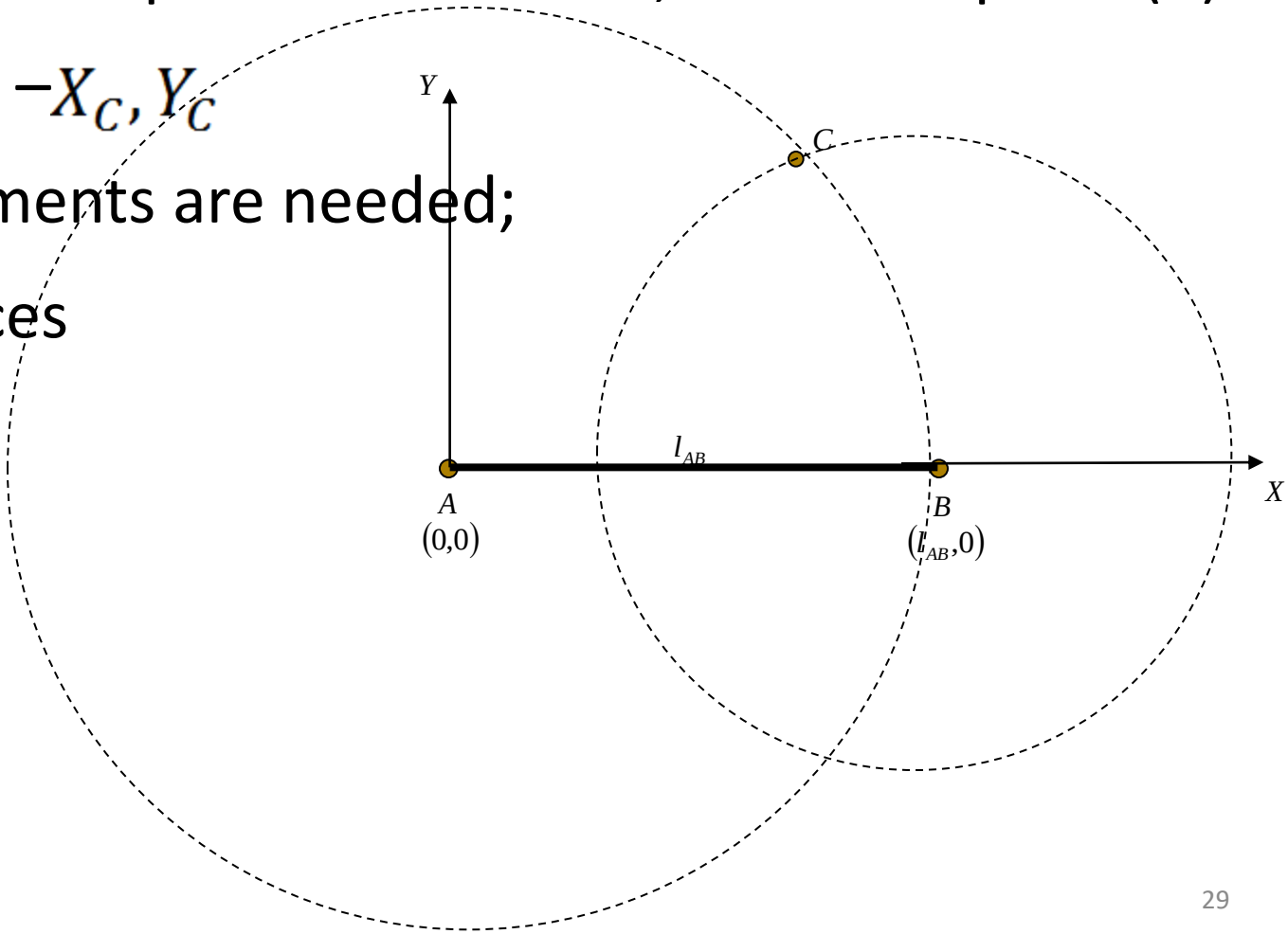

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Let's determine the position of a third, unknown point (C)

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TWO measurements are needed;

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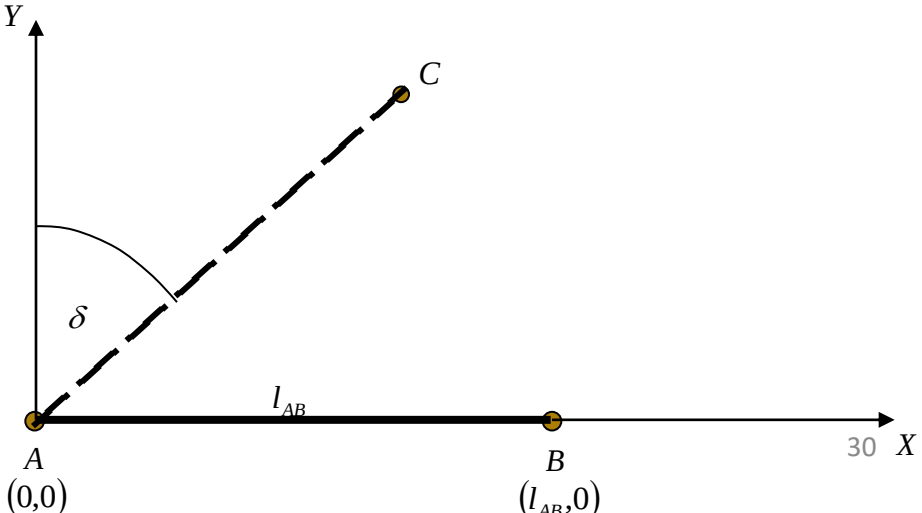
(ii) one distance and one angle



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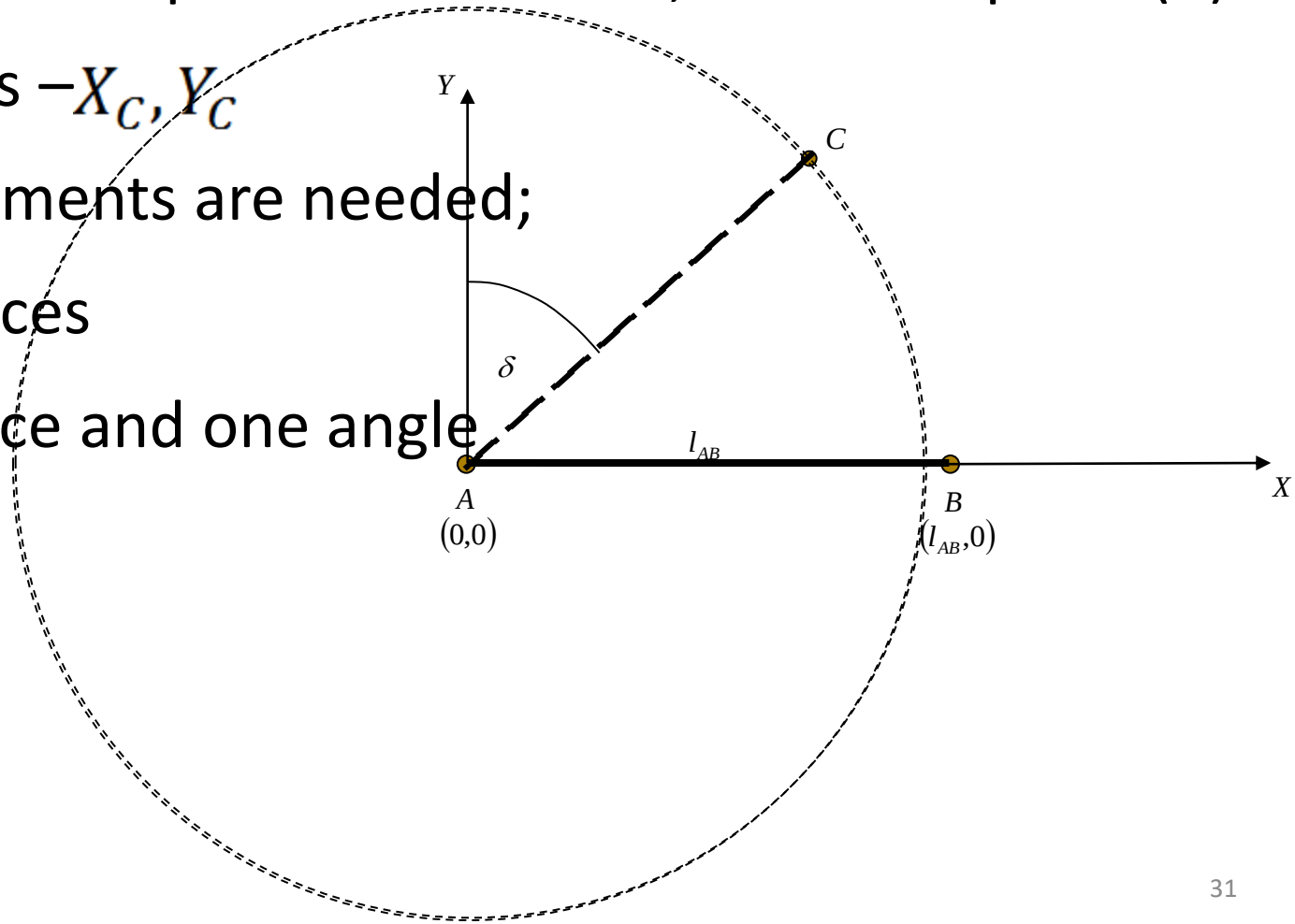

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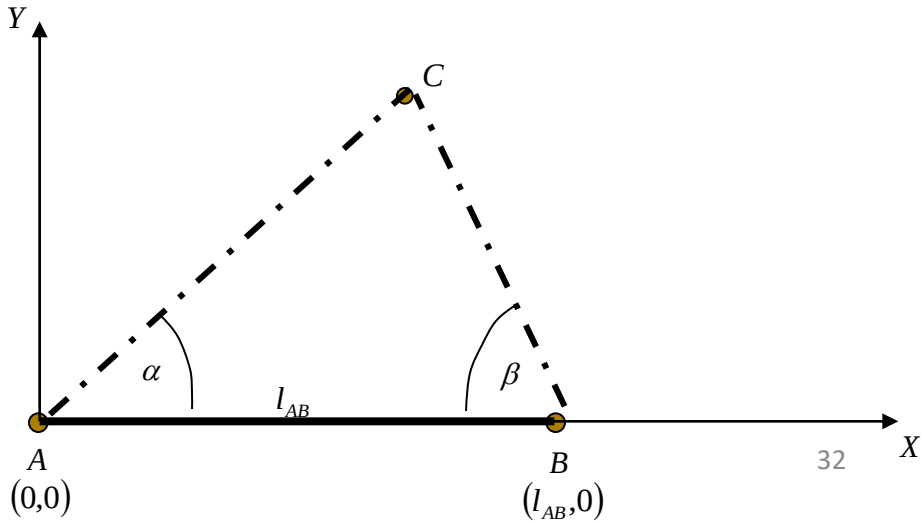
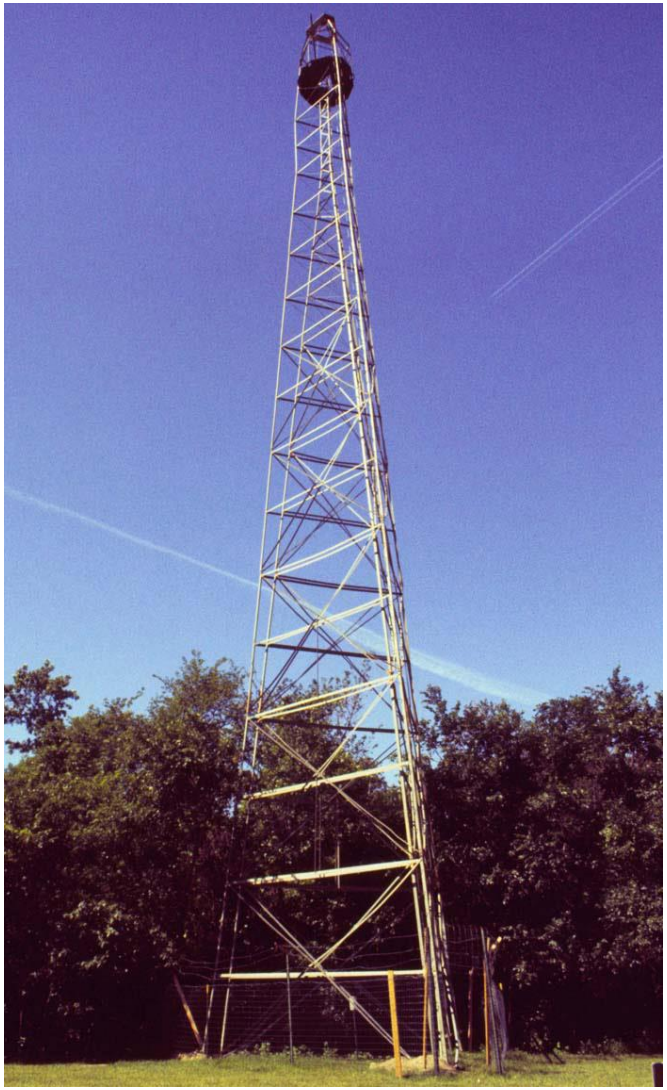


Control Points/Benchmarks



Classification (Division) of Surveying

Plane Surveying

According to the space involved:

Note: The two radii can be assumed to be parallel, when the (A,B) is small

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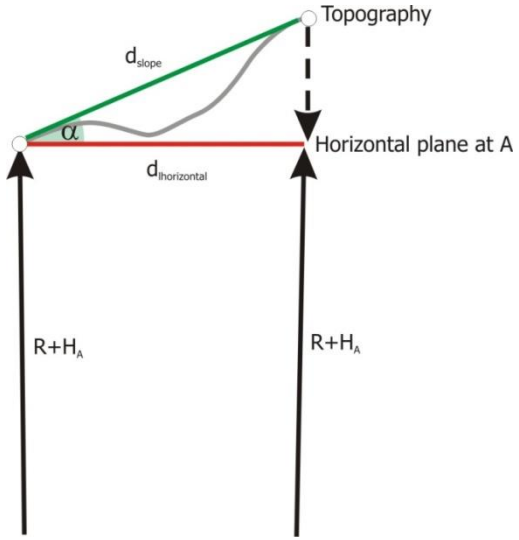
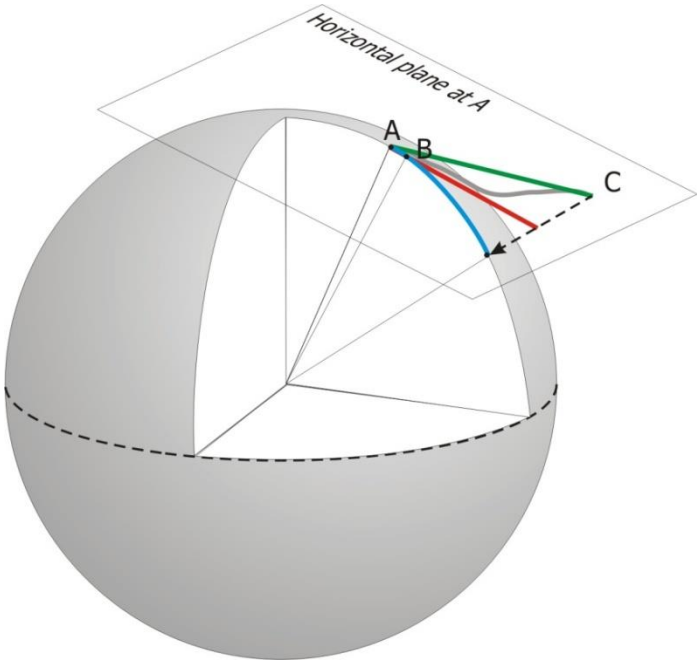


According to the space involved:

- Relatively small areas



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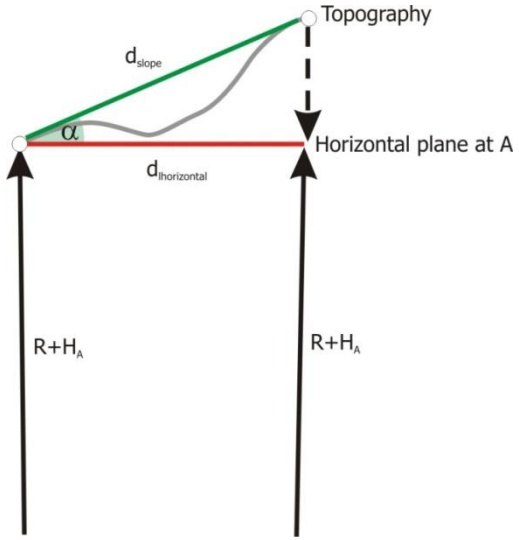
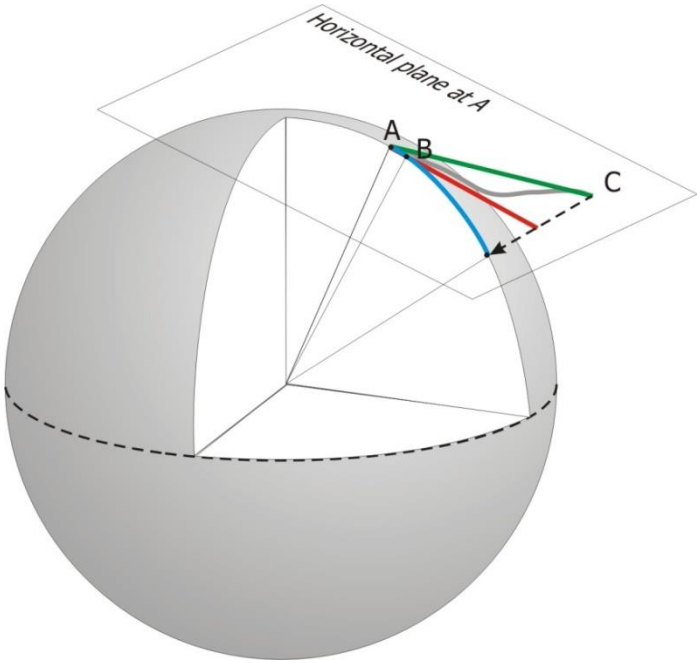


According to the space involved:

- Relatively small areas
- Surface of earth can be assumed to be flat



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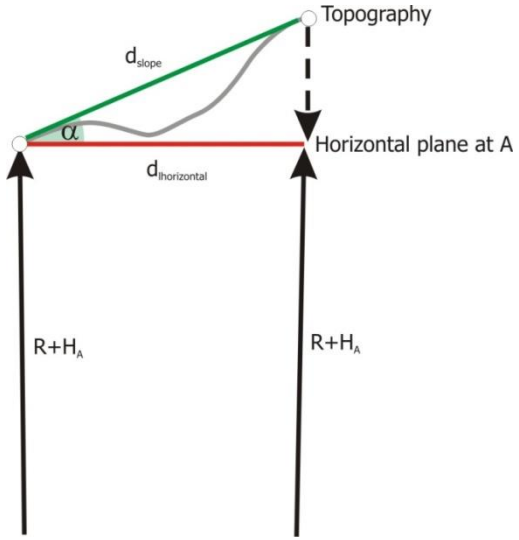
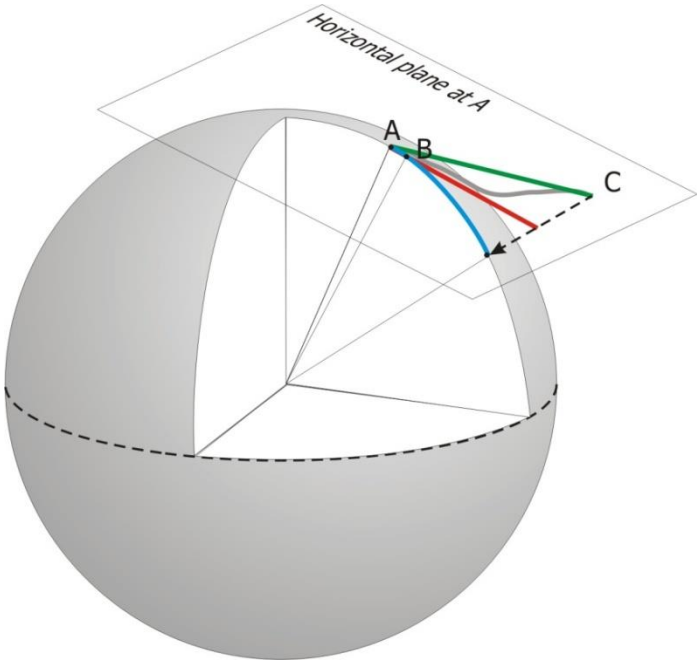


According to the space involved:

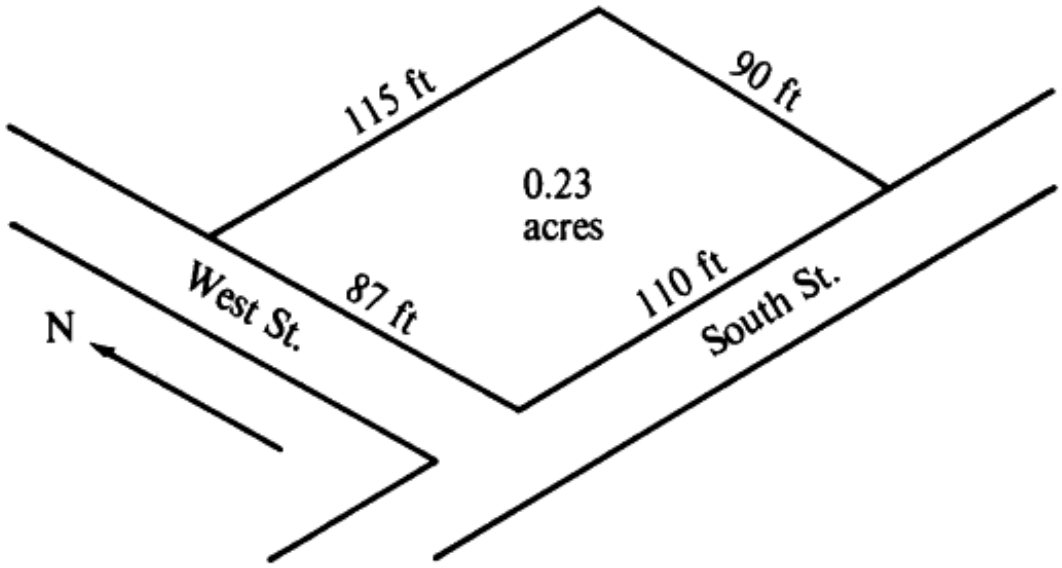
- Relatively small areas
- Surface of earth can be assumed to be flat
- Measurements plotted represent a horizontal projection of the actual field measurements



Classification (Division) of Surveying

Plane Surveying

- Surveys up to 256 km^2 (16km by 16km) – <u>error</u> due to earth's curvature is <u>not</u> serious (deviation ~1 cm)



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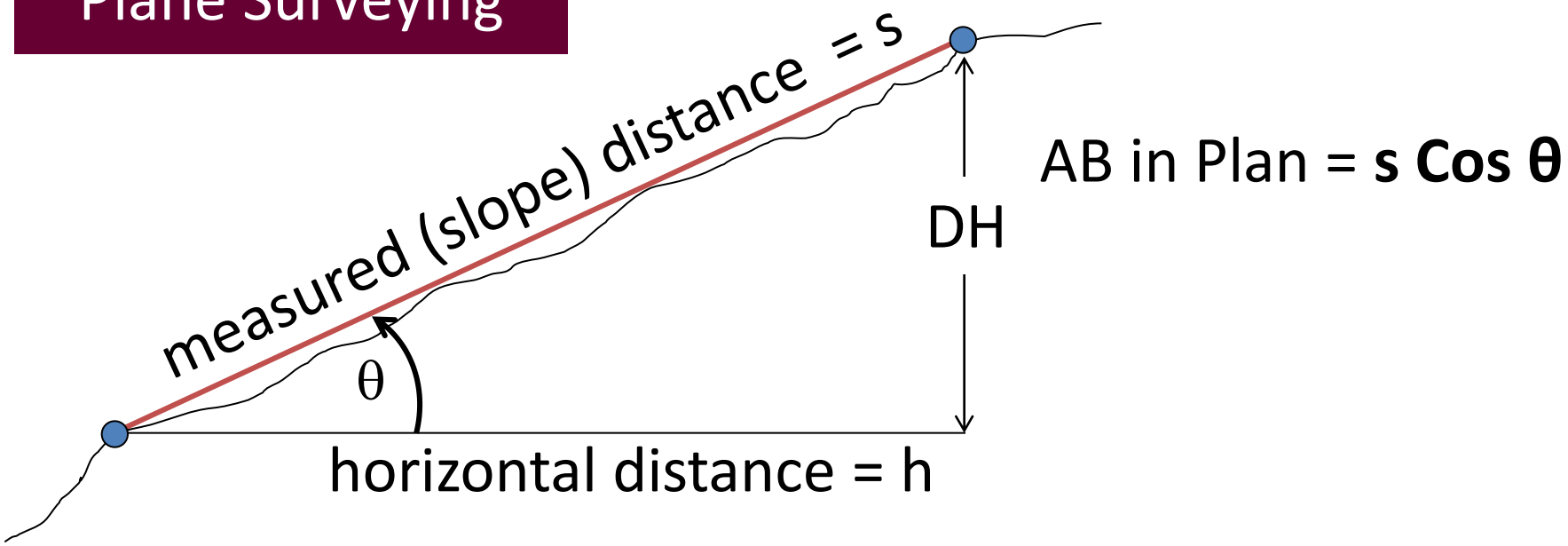

To calculate the *horizontal* distance :

$$\mathbf{h = s\ Cos\ \theta} \quad \text{or} \quad \mathbf{h = (s^2 - DH^2)^{1/2}}$$

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Geodetic Surveying

According to the space involved

Classification (Division) of Surve

Geodetic Surveying

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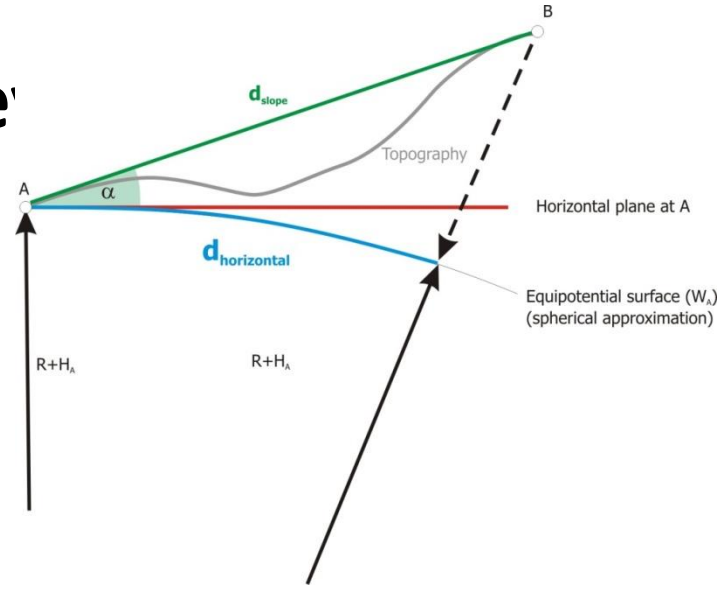
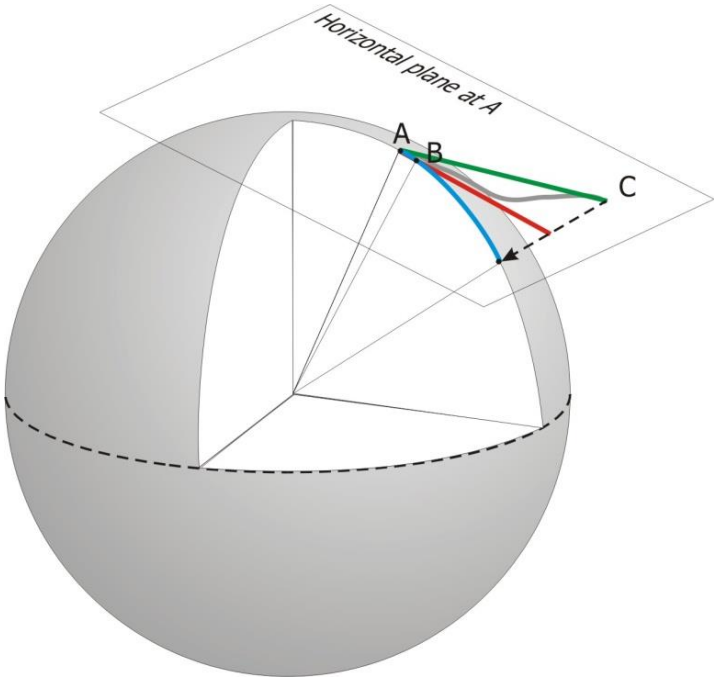
- Large areas





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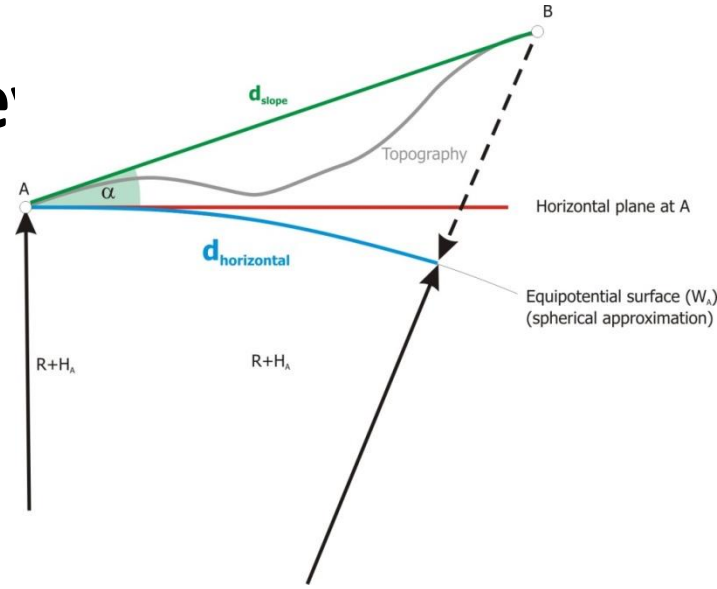
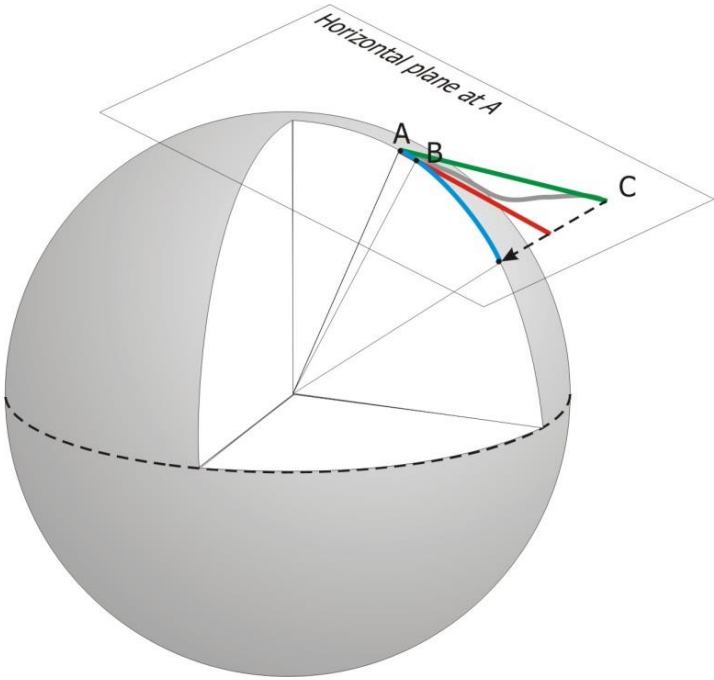
According to the space involved:

- Large areas
- Surface of the Earth <u>can not</u> be assumed to be flat



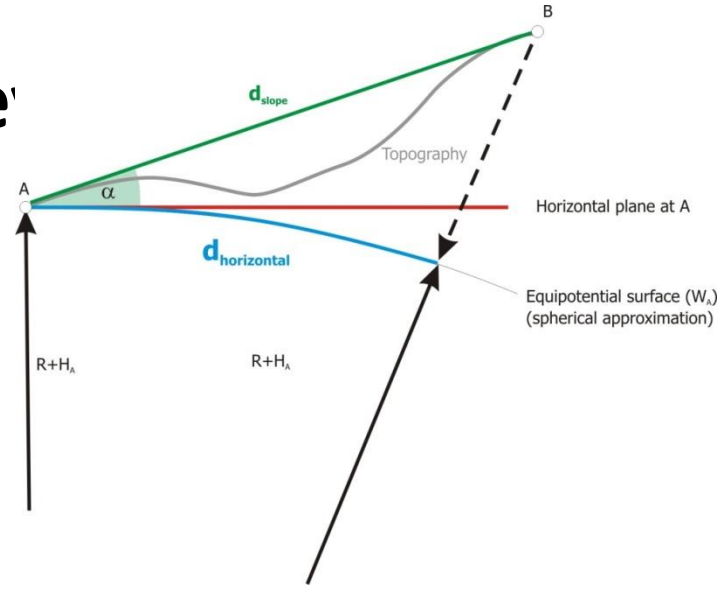


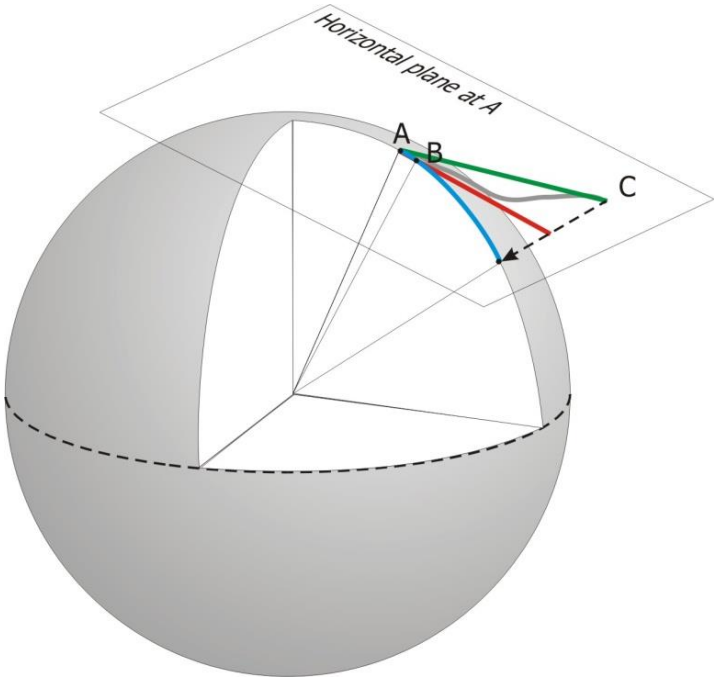
Classification (Division) of Surve

Geodetic Surveying

According to the space involved:

- Large areas
- Surface of the Earth <u>can not</u> be assumed to be flat
- The curvature of the Earth is taken into account

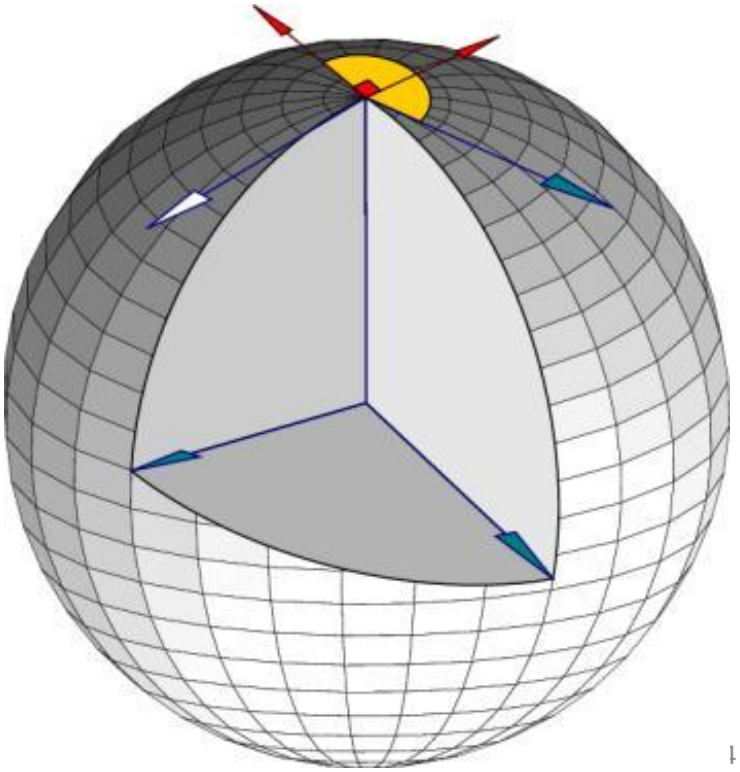




Classification (Division) of Surveying

Geodetic Surveying

- Higher degree of accuracy in linear as well as angular observation is necessary



Classification (Division) of Surveying

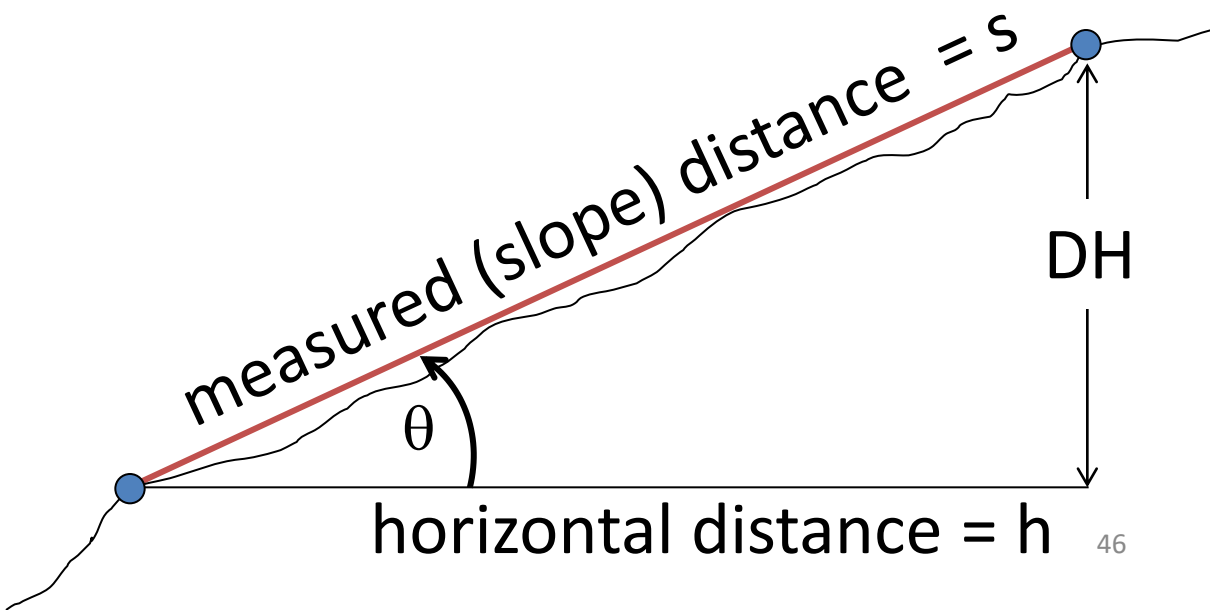
Geodetic Surveying

- Higher degree of accuracy in linear as well as angular observation is necessary
- Mostly used for
  - Establishing control networks
  - Determining the size and shape of the Earth
  - Determining the gravity field of the Earth

Classification (Division) of Surveying

Geodetic Surveying

- Calculation of the projected plane distances – curvature correction is applied to the measured distances



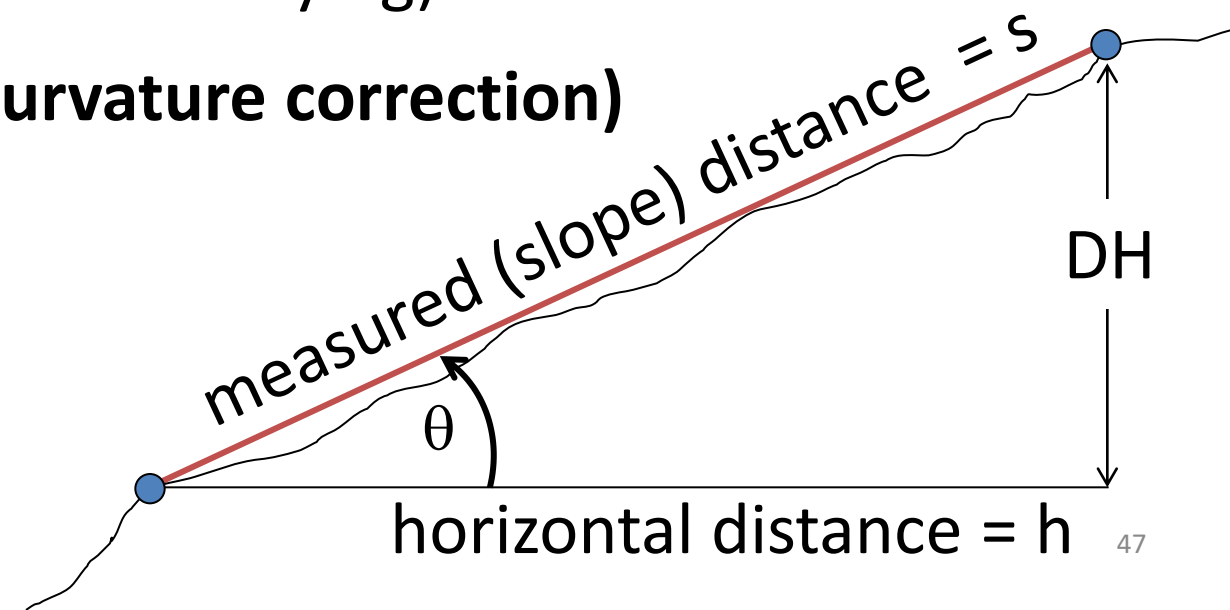
Classification (Division) of Surveying

Geodetic Surveying

- Calculation of the projected plane distances – curvature correction is applied to the measured distances

If AB is an arc (in geodetic surveying)

h = s cos θ + (earth's curvature correction)



Classification – According to Applications

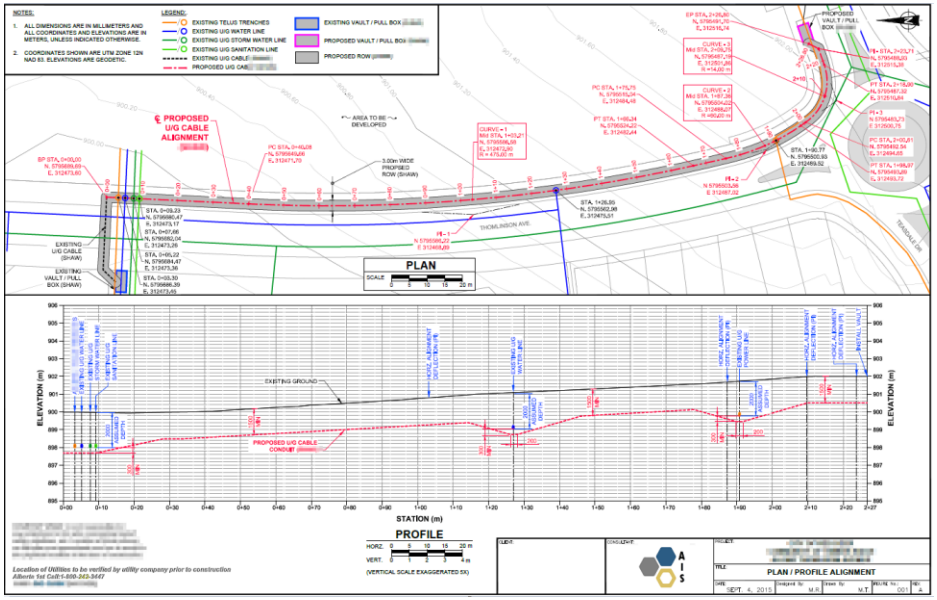
- Topographic Surveys

  e.g. configuration of terrain (hills, rivers, forests, valleys), location of objects (natural, man-made)

Classification – According to Applications

- Engineering Surveys

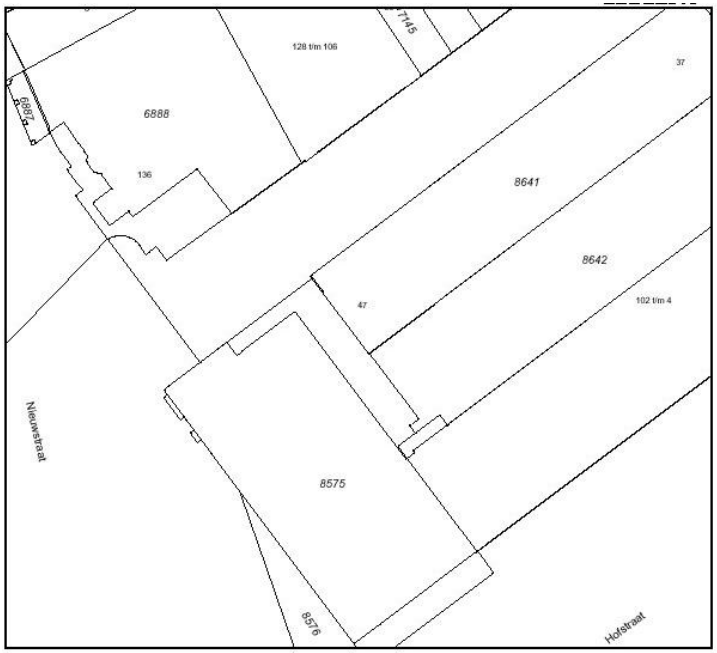
  To collect detailed data for the design for of projects involving roads, railways, etc.

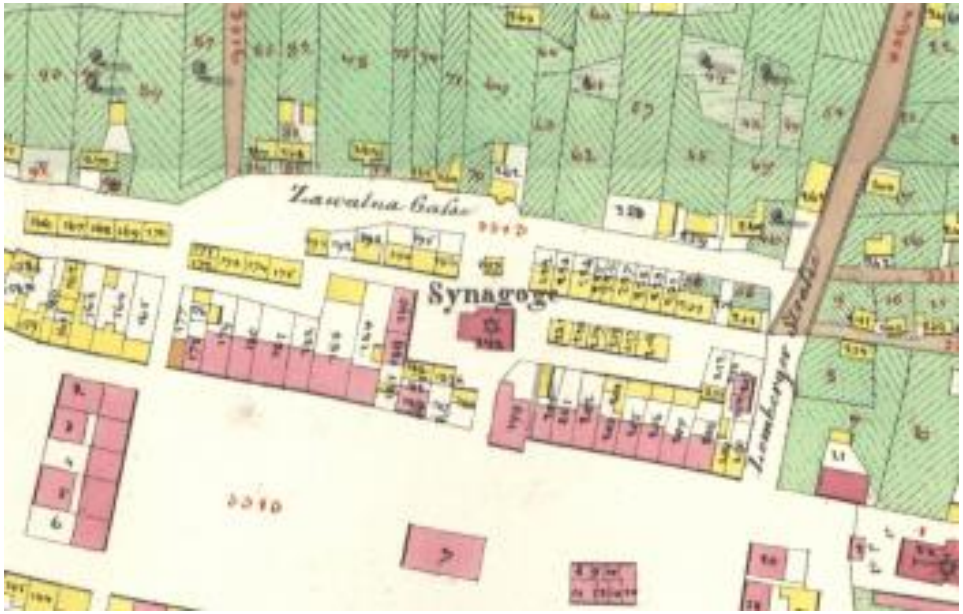


Classification – According to Applications

- Cadastral Surveys

  Showing boundaries of properties like houses, buildings, fields, colonies





Classification – According to Applications

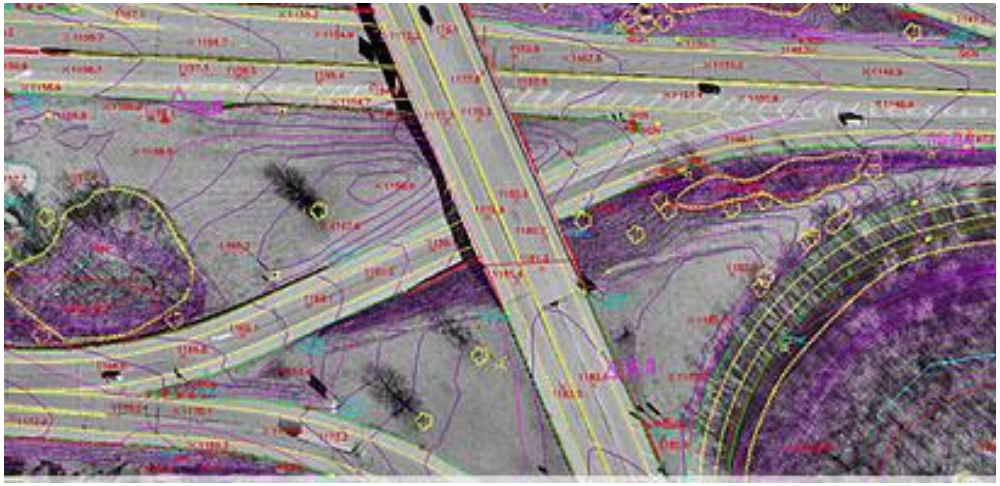
- Mine Surveys

  Control, locate, and map underground and surface works related to mining operations

Classification – According to Applications

- Photogrammetric Surveys

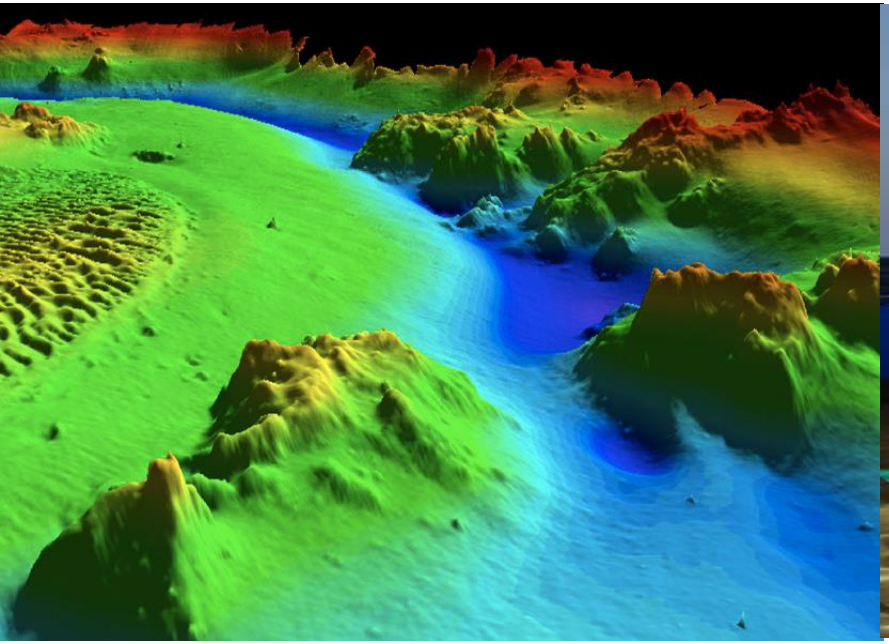
  Utilizes the principles of aerial Photogrammetry, in which measurements made on photographs are used to determine the positions of photographed objects

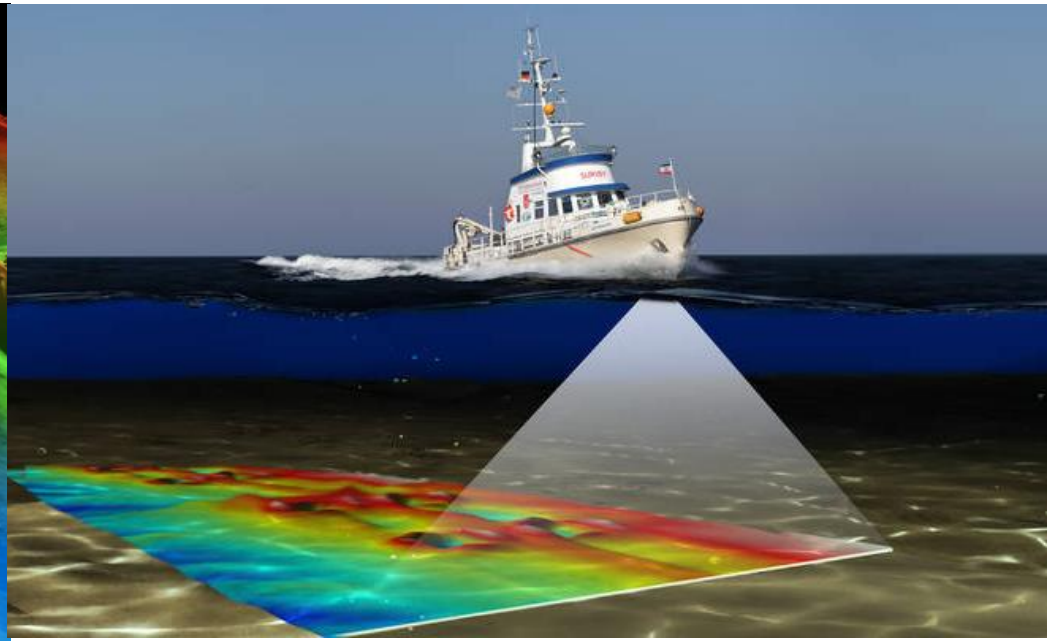


Classification – According to Applications

- Hydrographic Surveys

  Survey of bodies of water made for the purpose of navigation, water supply, or sub-aqueous construction





Evolution of Surveying Instruments

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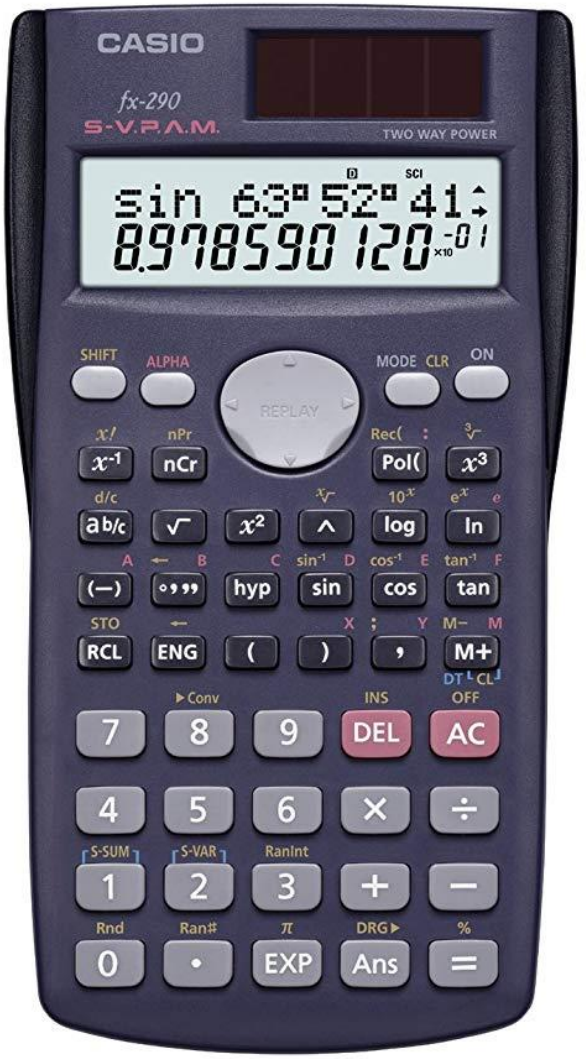

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https://infrastructure.eng.unimelb.edu.au/collection/

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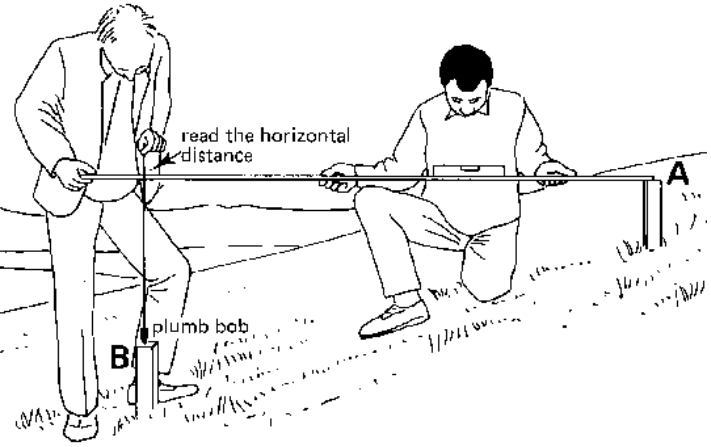
Types of Measurements in Surveying

1. Distance – Horizontal, Vertical



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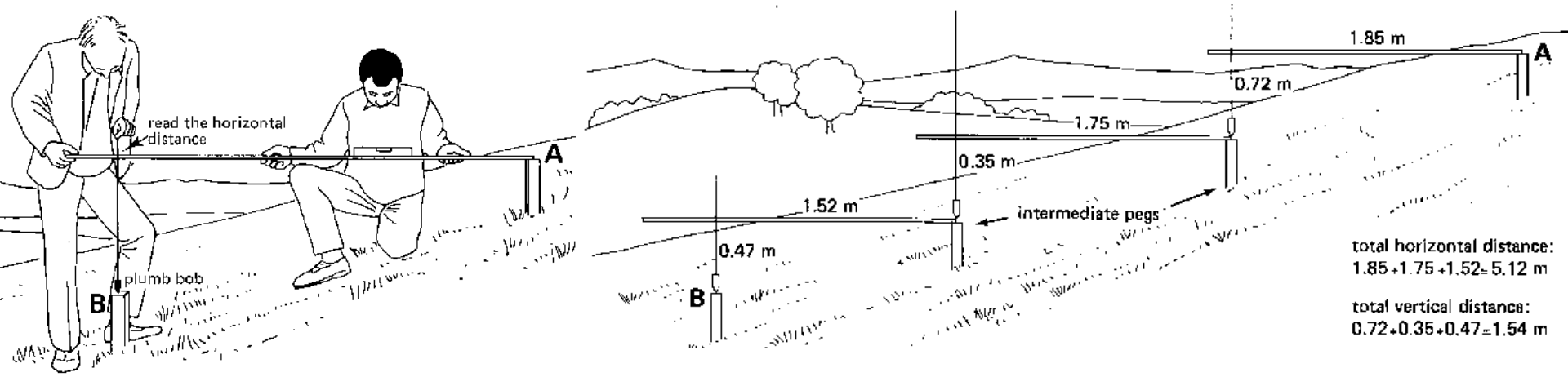

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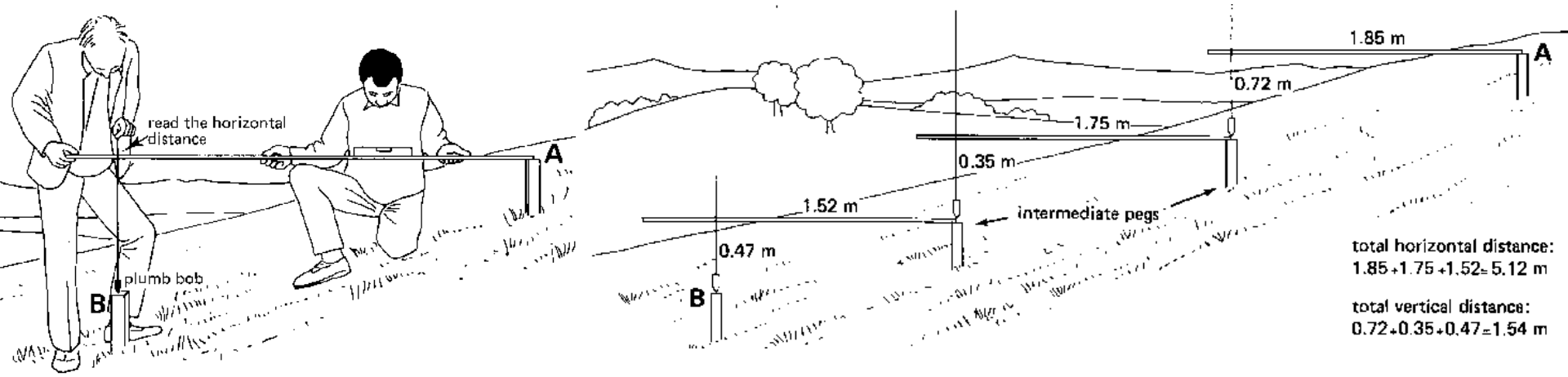

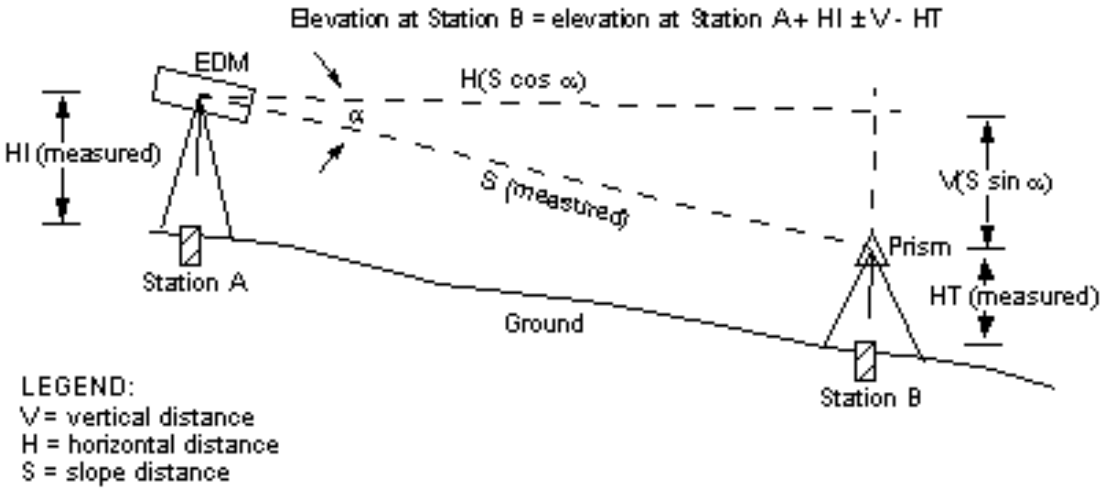

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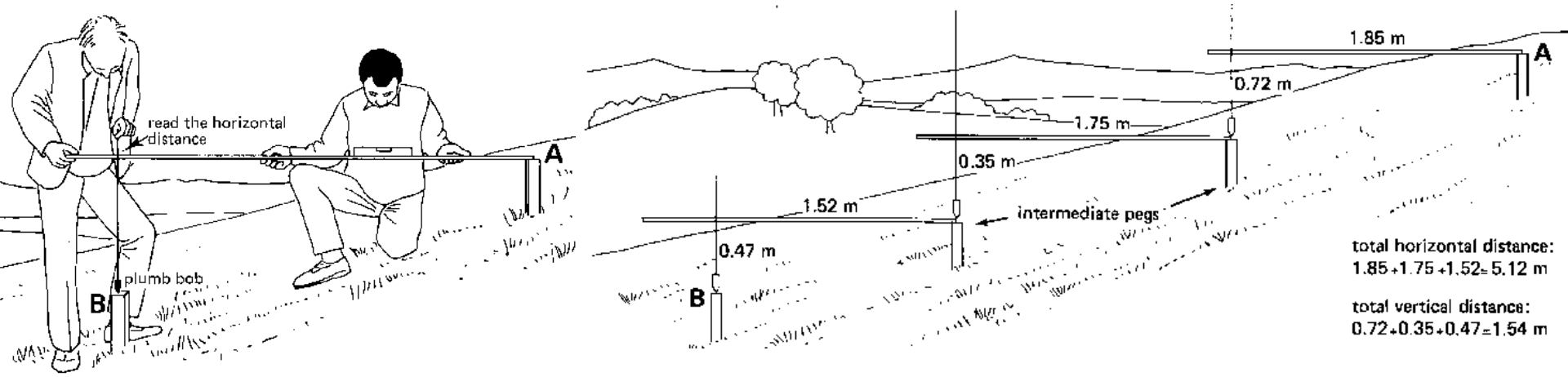

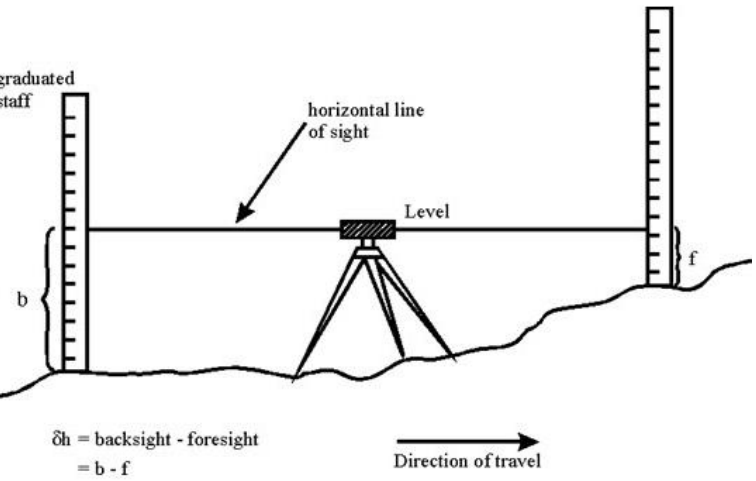

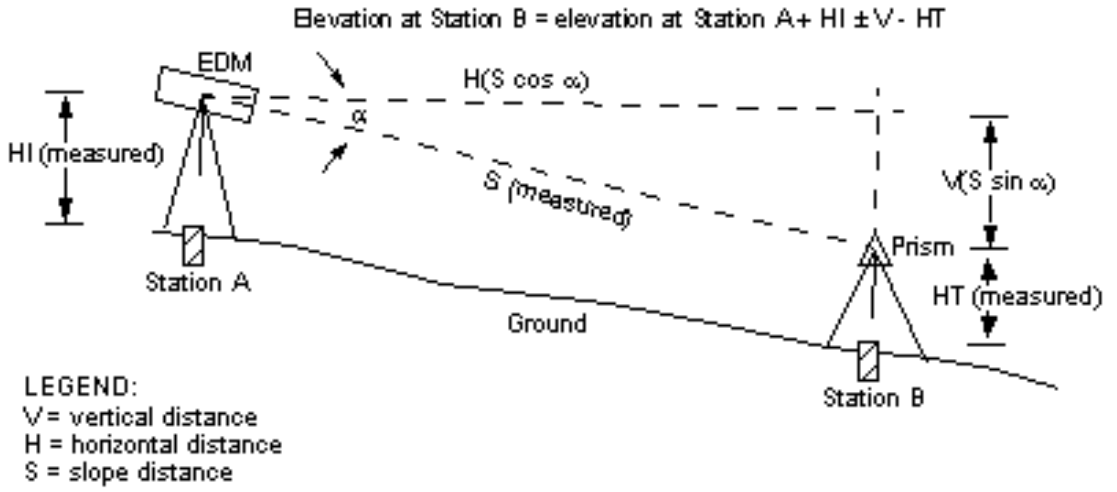

Types of Measurements in Surveying

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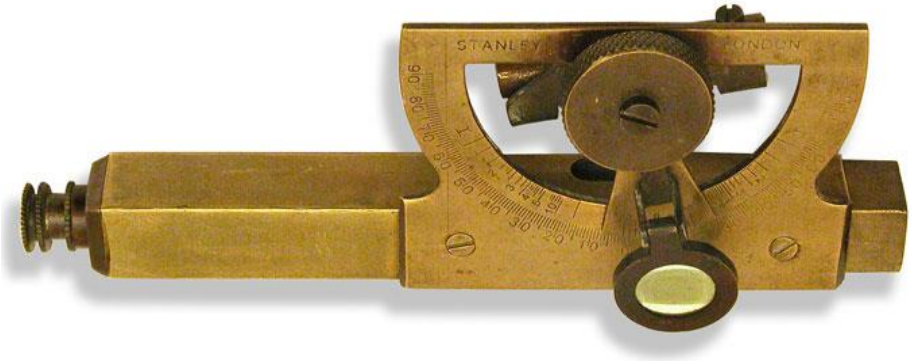

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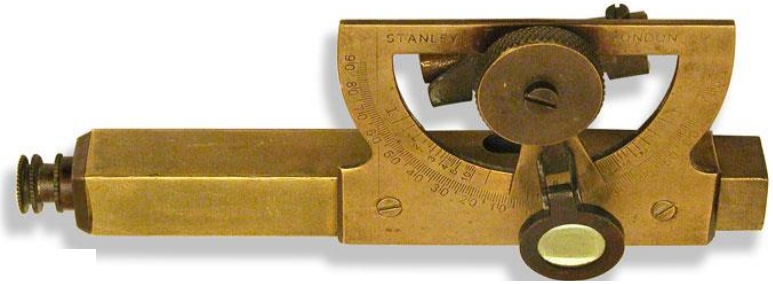
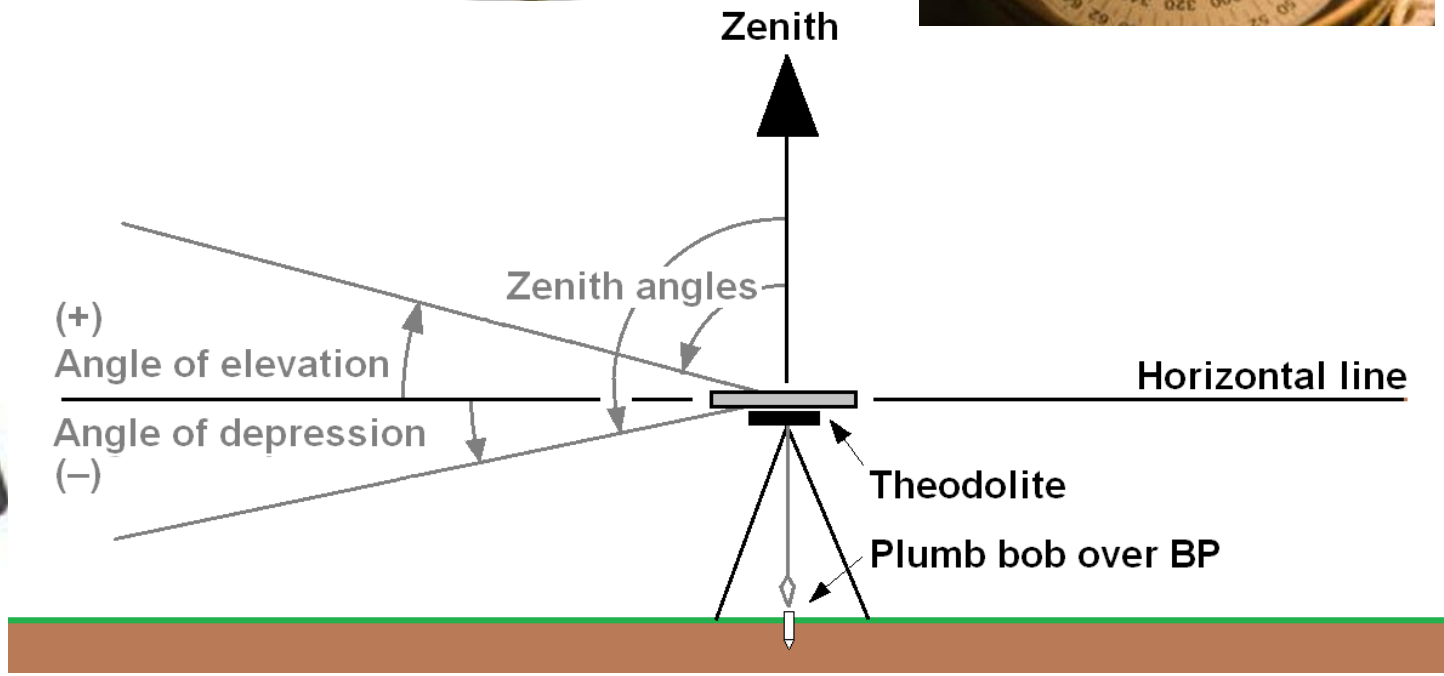


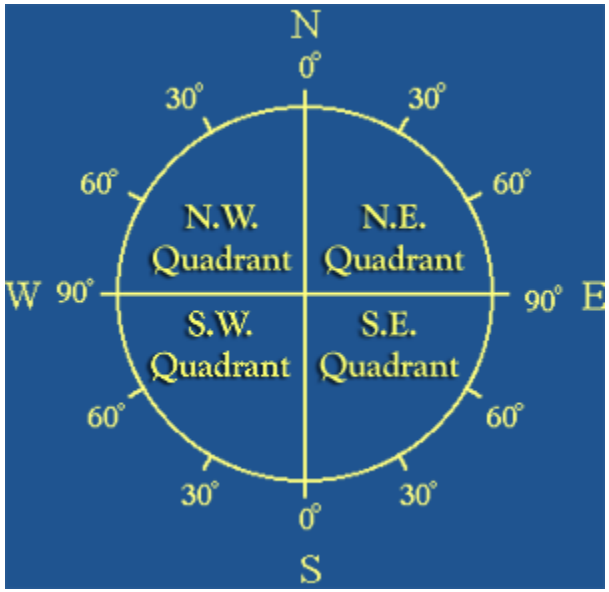


Types of Measurements in Surveying

Direction (Angle)

Bearing

- Whole Circle Bearing
- Quadrantal Bearing
- Reduced Bearing

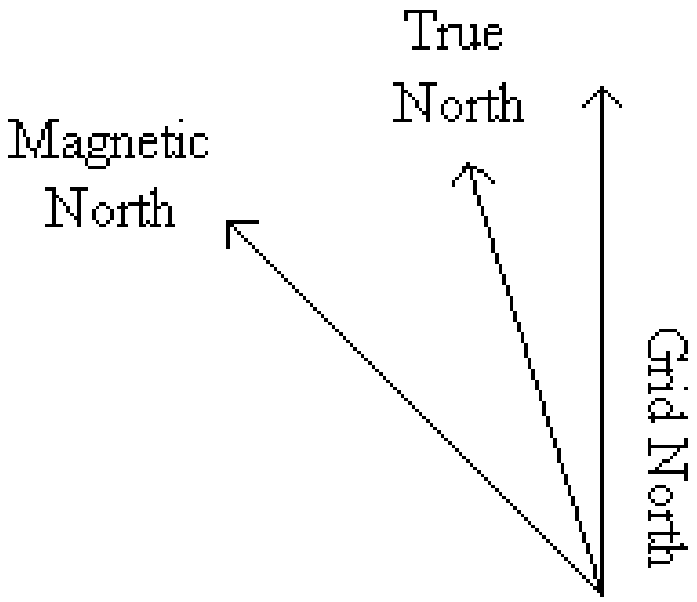


Types of Measurements in Surveying

Direction (Angle)

Bearing

- Whole Circle Bearing
- Quadrantal Bearing
- Reduced Bearing
- Magnetic Bearing
- True Bearing



Units of Measurements

- Angular
- Linear
- Area
- Volume

- Unit conversions???

English Units to Metric and vice versa

Units of Measurements

Quantity	Unit	Symbol
Length	kilometre	km
	metre	m
	millimetre	mm
Area	square metre	m^2
	hectare	ha
Volume	cubic metre	m^3
Angle	degrees	°
	minutes	'
	seconds	"
Mass (Weight)	Kilogram	kg
Temperature	Degrees Celsius	°C

Units of Measurements

- Unit conversions???

English Units to Metric and vice versa

$$1\ meter = 39.37\ inches$$

$$1\ meter * \frac{39.37}{12} \cong 3.2808\ feet$$

$$1\ foot * \frac{12}{39.37} \cong 0.3048\ meters$$

$$1\ mile \cong 1609.4\ meters \cong 1.6094\ kilometers$$

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$$1\ square\ meter \cong 1.1960\ square\ yards$$

$$1\ square\ meter \cong 10.7639\ square\ feet$$

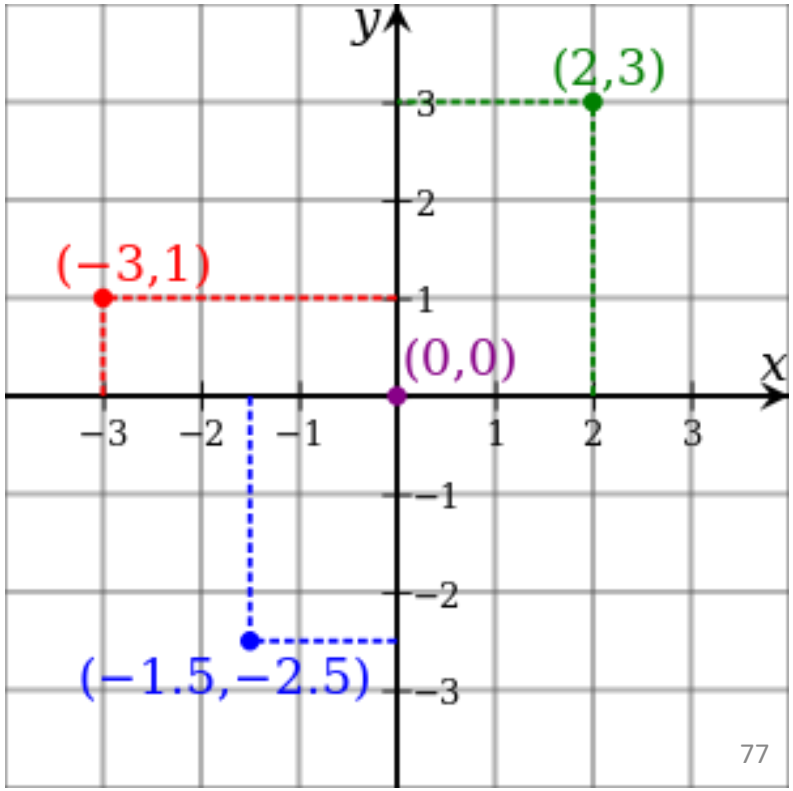
$$1\ hectare \cong 2.4710\ acres$$

$$1\ square\ kilometer \cong 247.1044\ acres$$

$$1\ square\ mile \cong 2.5900\ square\ kilometers \cong 258.9998\ hectares$$

What is a Coordinate System?

A system that uses one or more numbers, or **coordinates**, to uniquely determine the position of a point or other geometric element



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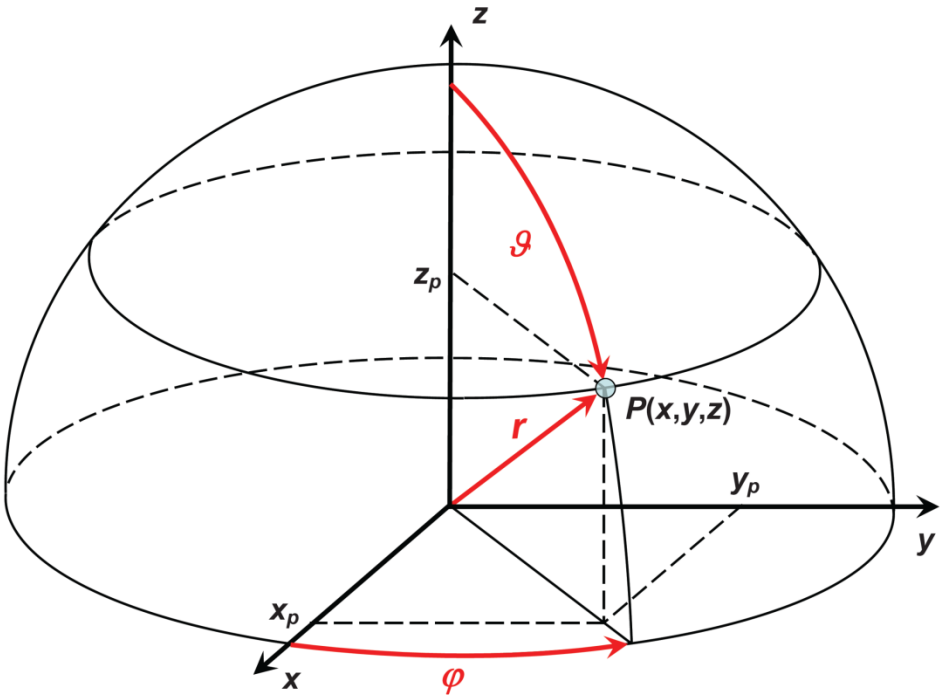
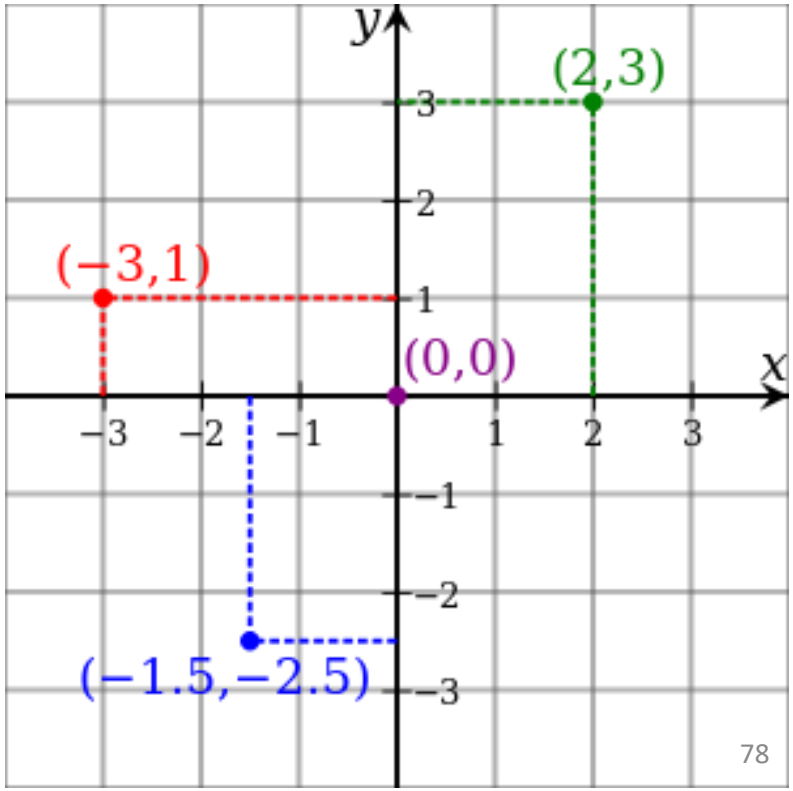
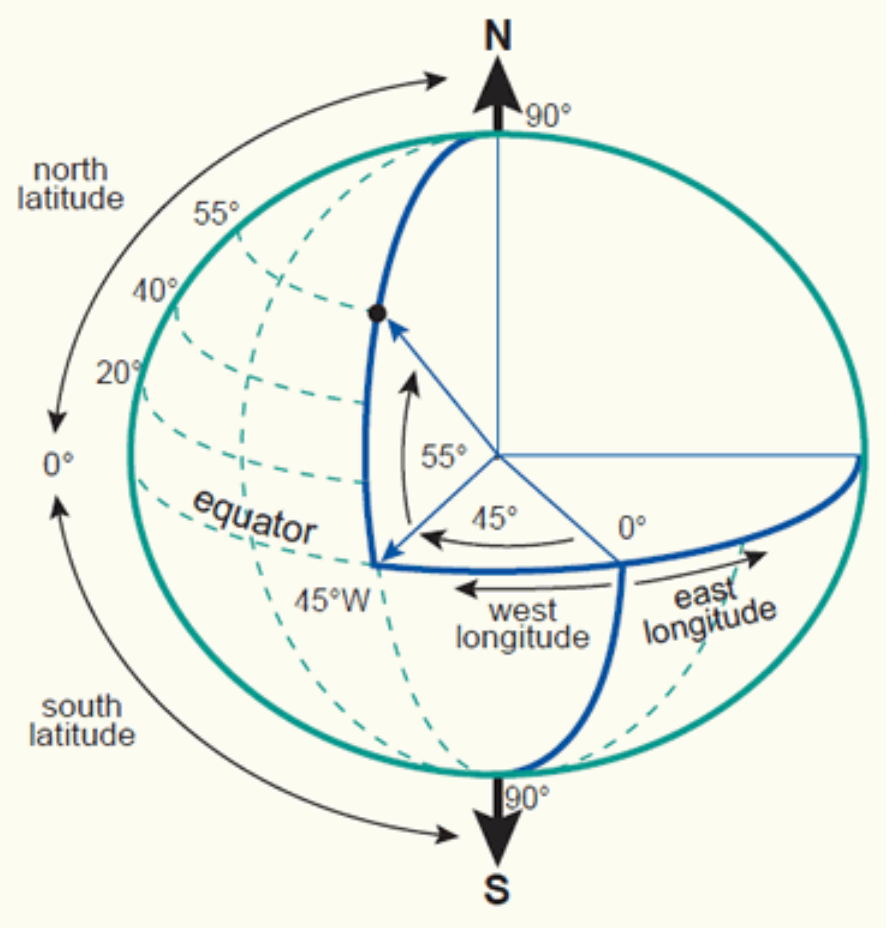




Geographic Coordinate System



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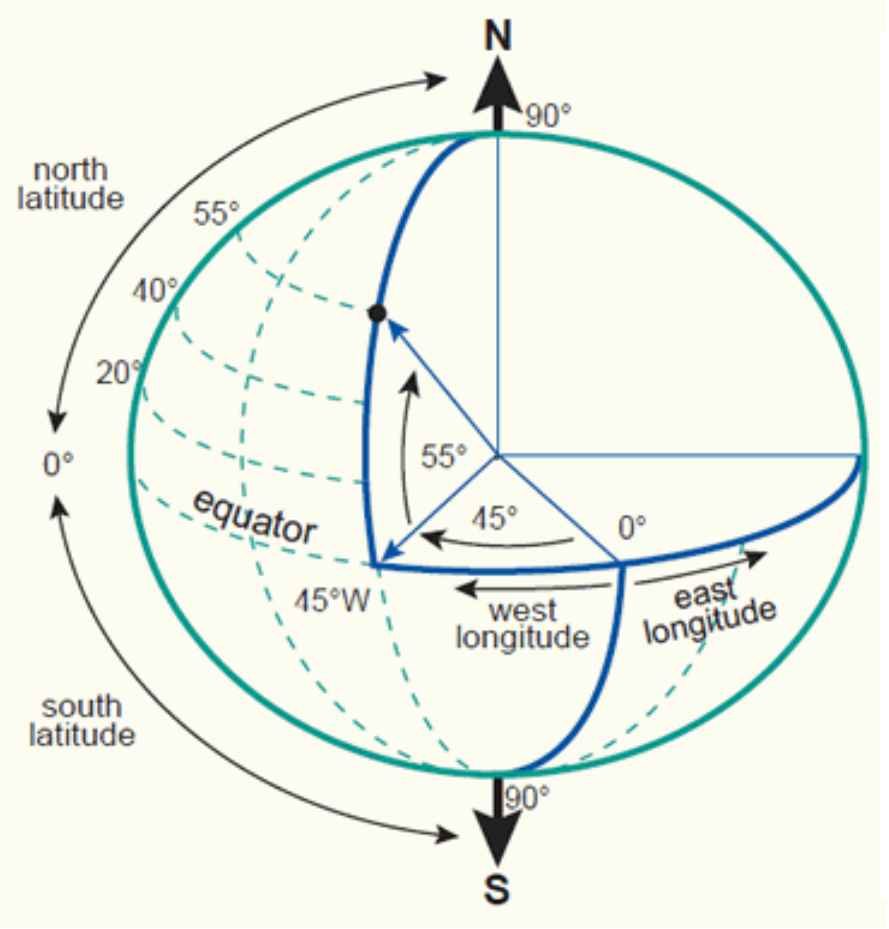
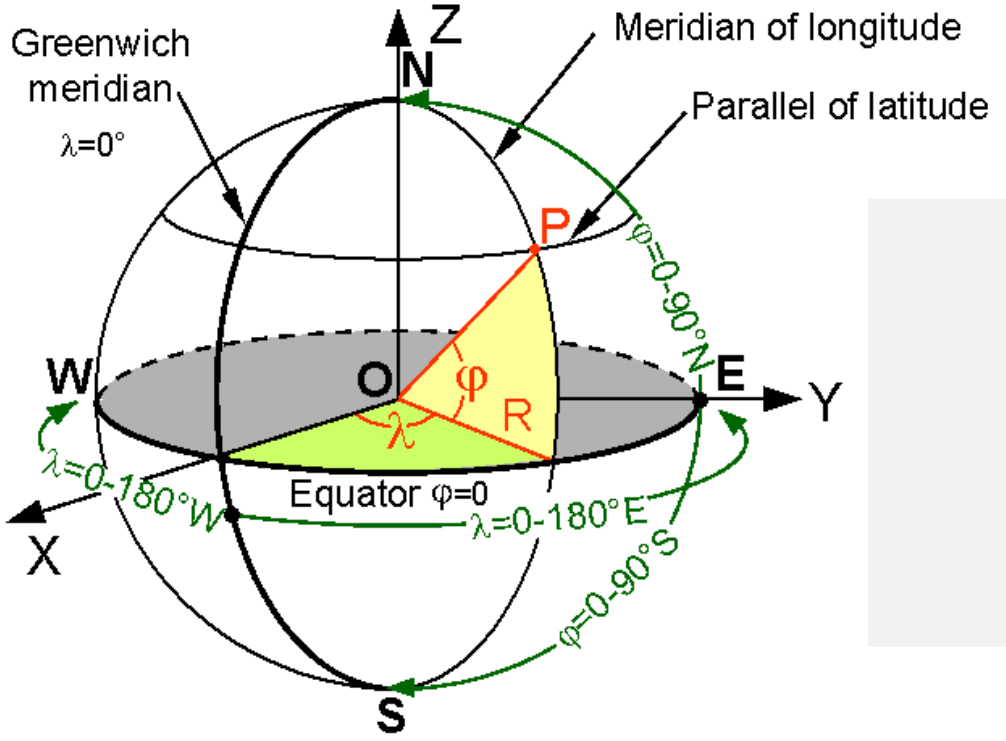
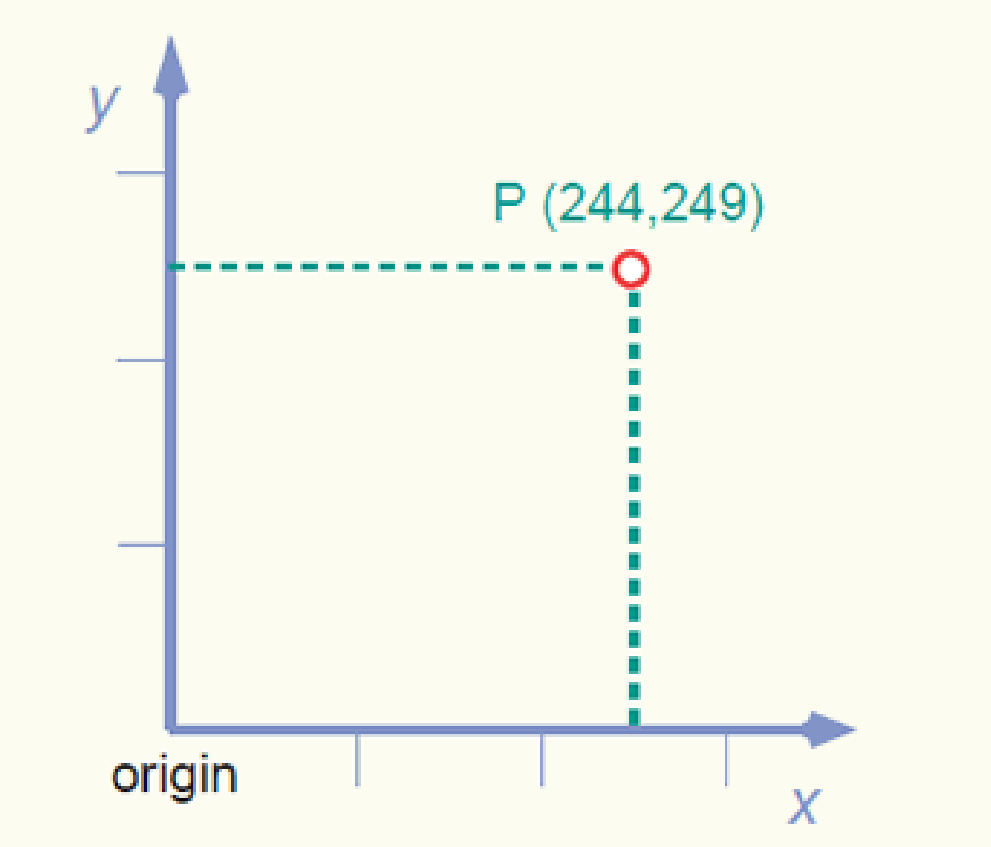




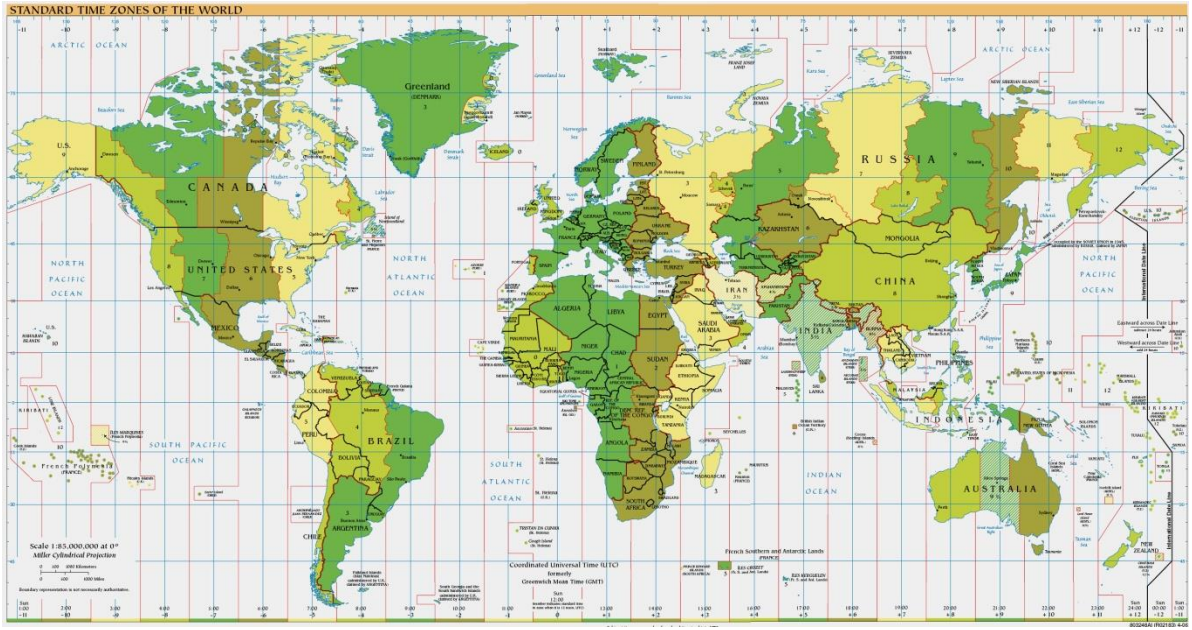
Cartesian Coordinate System

Horizontal axis – *X*-axis – **Easting**
Vertical axis – *Y*-axis – **Northing**



What is a Map?

Representation of a portion of the Earth surface on a Plane



Scale

Relationship between a given **distance** on the **ground** and the **corresponding** distance on the **map**

$$scale = \frac{distance\ on\ the\ map}{corresponding\ distance\ on\ the\ ground}$$

Working With Maps …

Surveying Techniques

- Chain Surveying/Linear Measurements

Surveying Techniques

- Plane Table Surveying

Surveying Techniques

- Compass Surveying

Surveying Techniques

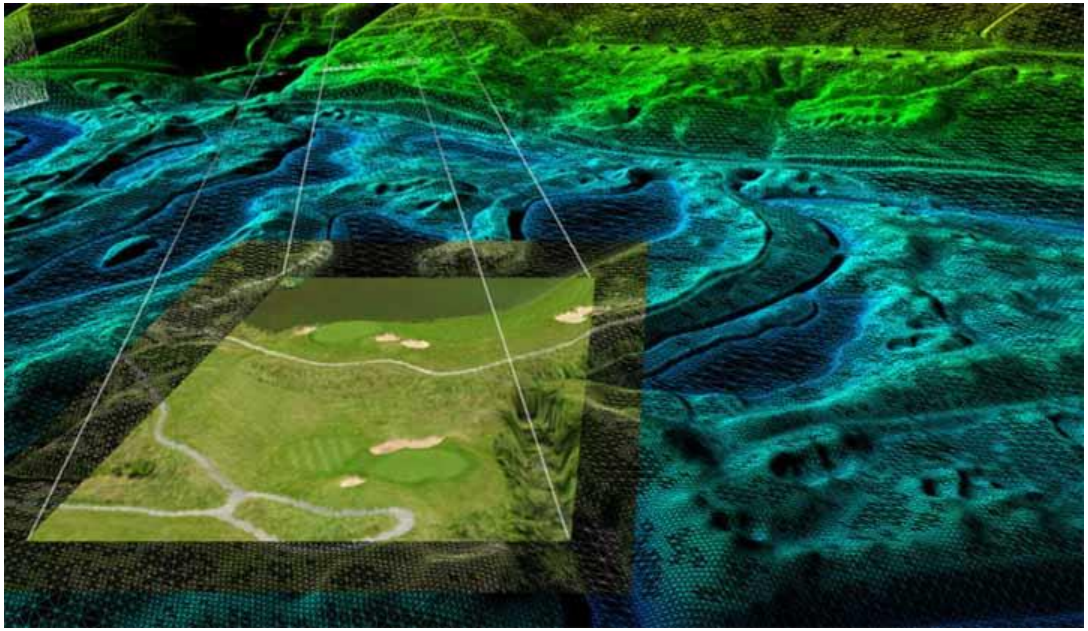
- Theodolite Surveying

Surveying Techniques

- Tacheometric Surveying

Surveying Techniques

- Aerial Surveying



Sources of Errors

Instrumental imperfections

Due to imperfections or faulty adjustment of the instrument being used

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Personal limitations

Due to personal limitations (e.g. eye sight)

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Natural causes

e.g. variation in speed of wind, temperature, humidity, refraction, gravity and magnetic declination

Types of Errors

Blunders

Mistakes and gross errors

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Systematic or Cumulative errors

Repeated size and sign

Affects accuracy

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Blunders

Mistakes and gross errors

Systematic or Cumulative errors

Repeated size and sign

Affects accuracy

Random or Accidental errors

Small and usually undetectable (noise)

Affects precision

Types of Errors – Blunders

- Can occur at any stage of survey (observing, booking, computing or plotting)
- Very damaging effects on results

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- Very damaging effects on results

Examples:

Miscounting the number of tape lengths, recording the wrong value , striking the wrong key, transposing digits (68 as 86)

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- Every measurement is immediately checked or repeated

Types of Errors – Systematic Errors

- Errors arises from sources that act in a similar manner on observations

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- Method of measurement, instrument used, and physical conditions at the time of measurement must all be considered
- Errors not revealed by taking the same measurement with the same instruments
- To check for systematic error is to re-measure the quantity by an entirely different method using different instruments

Types of Errors – Systematic Errors

- As it has a constant sign, their effect on the final result is cumulative

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- Examples :
  - Erroneous length of chain
  - Variation of temperature
  - Erroneous graduation of a instrument

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- Some random errors, by their nature, tend to cancel themselves
- Errors have the following characteristics;

  Small errors occur more frequently than large ones

  Positive and negative errors are more likely to occur

  Very large errors seldom occur