The wonderful world of maps

What is a map?

A dictionary defines a map as a representation of an area, usually on a flat surface. A map can be as simple as a sketch on the back of an envelope showing where the treasure is buried with no clue other than a shaky outlined island and an 'x' marking the spot. It can be detailed enough to precisely identify individual buildings, trees, soil types, or any other feature of interest. In this lesson we look at the evolution of mapping and mapping technologies and also at the great Irish survey of 1824 1842.

Early users of maps

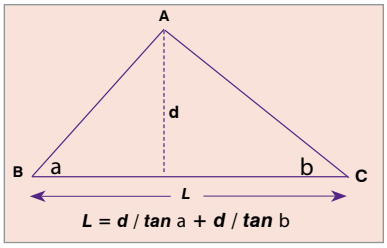
Rudimentary maps have probably always been used. Star maps appear in the *Lascaux caves* (17,300 years old). *Babylonian* maps from 2300 BC depict settlements, crop fields and *irrigation* sources on *clay tablets*. *Mesopotamian* maps of around 1600 BC show cities and tracks between fields and the built-up areas. In China around 240 BC maps were carved on plates. *Polynesians* wove intricate palm leaf mats showing tides, currents and islands; North Americans carved images of coastlines on bones.

How mapping technologies evolved

Mapping may have evolved as a development of *surveying*. Some type of measurement would have been necessary for building pyramids or roads. In ancient Egypt, rope stretchers, who stretched knotted ropes, established farm boundaries after the great Nile flood (3000 BC). They also used *Pythagoras's theorem* to establish *right angles* for pyramid builders. They used vertical wooden triangles, with a *plum bob* hanging from the *apex*, as levelling tools and notched palm sticks were used as *sighting instruments*. Without the use of a *compass* they aligned the Great Pyramid's north-south axis to true north with a deviation of only 2' 28'' (4% of 1). To do these things it was necessary to devise instruments for sighting and measuring. The early Greeks were also familiar with a technique used for mapping in modern times *triangulation*.

What is triangulation?

Ask yourself what you need to know from a map. You will probably agree that the basic requirement is to find the distance and direction from one place to another. Triangulation accomplishes this. First, two points, **B** and **C,** are chosen and the distance between them (*L*) is measured.



The line BC is called the *baseline*. If we can now measure the angles a and b, the location of distant point **A** can be established. This process continues until a whole area such as a country is covered.

The accuracy of the calculation of the baseline and the angles is critical. The long baseline facilitates the accurate measurement of longer distances. For the Irish maps produced during the great 1842–1843 survey of Ireland, a baseline at Lough Foyle measuring 12,697 meters was used. The illustration shows the triangulation used in the survey. It is interesting to note that it is linked with the triangulation of Britain.

The problem of the Earth's curved surface

Peel an orange carefully in one piece and then try to lay the peel flat on a piece of paper. This will clearly demonstrate the problem of representing a curved surface on a flat plane. For this reason maps of large areas involve some degree of distortion. Some parts may appear too large and others appear too small.

Triangulated map from the first ordnance survey of Ireland

Globes avoid these distortions because they represent curved areas on a curved surface. However, this solution is not always practical. Flat maps are much easier to produce and in the case of Ireland, the resulting distortion is not an issue for most users.

The position of points on a globe is usually represented by angles north or south of the *equator* (*latitude*) and angles east or west of *Greenwich* (*longitude*). The process of transferring latitudes and longitudes to a map is called *projection*. Carl Friedrich Gauss (1777 – 1855) proved that this cannot be done without some distortion. Consequently there are various types of maps using different types of projection. Each approach has advantages and disadvantages. Modern national mapping systems typically employ a projection called the *transverse Mercator* for large-scale maps in order to maintain low variation in scale over small areas.

There are many types of map

Early maps were often treated with suspicion and map makers even attacked. Maps were seen as a means of subjecting and controlling populations and colonies and of identifying land ownership to raise taxes. In fact, the term *ordnance* as in ordnance survey is a military term, originally meaning military equipment or provisions. Ordnance surveys were carried out for military purposes. Now, of course, maps are useful to everyone. Political maps show national and other boundaries. *Topographic* maps show *relief* (*contours*: lines joining points of equal height), natural features such as rivers and cultural features such as buildings; general purpose maps show features such as streets. Special purpose maps, such as tourist maps, show the features of particular interest to the intended user.

The famous survey of Ireland

Ireland featured in *Ptolemy*'s description of the world (around 120 AD). It was based on travellers' reports and was rather sketchy regarding the West and North coasts of Ireland and even less was known of inland areas. Mercator's map of 1584 was the first professional map of Ireland, but it too gave a poor representation of the West and North of the country. Increasingly accurate maps were produced during the 17th, 18th and 19th centuries, although they still concentrated on the parts of Ireland that were governed by Britain.

The wonderful world of maps

The triangulation of Ireland began in 1824 and was completed in 1842 for mapping to a *scale* of six inches to the mile. The work was carried out by the Royal Engineers, also known as the Sappers, over 2,000 of whom were involved. The surveyors produced many innovations which were used in subsequent surveys in Ireland and elsewhere.

A group of Royal Engineers engaged in the first survey of Ireland

Major Thomas Colby was in charge of the first survey. He designed *compensation bars* made of iron and *brass*. These maintained their length over a range of temperatures, providing a more accurate baseline. Major Colby actually walked 586 miles in 22 days in conducting the survey. Thomas Drummond was the principal surveyor. He jointly invented *limelight* which was bright enough to be seen from a distance of 150 km. The height of a point above sea level was marked with the shape of a *crow's foot* cut into walls, buildings and bridges. These are called *benchmarks* and can be seen all over the country. Sea level was defined to be the low water of spring tide at Poolbeg Lighthouse in Dublin Bay on the 8th April 1837. This reference point remained in use until it was superseded in 1970 by a point mean sea level at Malin Head, Co. Donegal, which is 2.7 m higher. As a result of this survey 1,906 maps were published.

The modern techniques

The history of mapping in Ireland is fascinating. Clearly the traditional forms of mapping have been superseded by modern technology. Surveyors still do their surveys although the fundamentals remain the same. Surveyors still triangulate but use a range of modern instruments,

Image from a simulated flight. Users can see the terrain without leaving the ground

The sighting instrument used to measure angles, called a *theodolite*, now records all data electronically. Optical remote sensing technology uses laser pulses to find the height of an object on the ground. Aerial photography is a key feature of modern mapping. All information is now stored digitally in large computer *databases*. This means that information can be reproduced in various ways. For example, three dimensional computer maps can be provided to facilitate decision-making on large construction projects. OSi also provides flight simulations that allow planners, architects, builders and other users to examine the terrain without leaving the ground. Today's maps provide a range and depth of information that would not have been considered possible at the time of the first survey. OSi are at the forefront of this revolution.

Ordnance Survey Ireland

Ordnance Survey Ireland (OSi) is the national mapping agency of the Republic of Ireland. It produces and sells a very comprehensive range of urban, rural, tourist and leisure maps at a variety of scales in digital and printed form. OSi also produces aerial photographs and digital terrain models.

Customers include:

- Individual members of the public
- Tourists
- Schools
- The construction industry
- Architects
- Engineers
- Property and legal firms
- Government Departments and local authorities.

Annual revenues amount to €22 million.

OSi also licences data for a wide range of computer based applications such as Computer Aided Design (CAD) and Geographic Information Systems (GIS).

OSi products are state of the art, produced using the most up to date technology to international standards and, consequently, the company is a leader in the Irish geographic information market.

OSi owns a network of 25 GNSS (Global Navigation Satellite Systems) stations around Ireland, continuously recording and streaming data from satellites back to the agency's centre in the Phoenix Park in Dublin. That information is then processed in real time. In all, OSi stores a total of some 640 terabytes in 30 separate databases. OSi has significant experience in data management and database management.

All products are available directly from the OSi shop (+353 1 802 5300) at the OSi headquarters in the Phoenix Park (near Castleknock Gate) through its online shop and through a national network of retail outlets.

For more information see www.osi.ie

Syllabus References

Leaving Certificate Geography

Core unit 3 (the geographical investigation and skills unit)

Students should be able to understand and use co-ordinate systems (latitude and longitude), grid references, scale, distance and direction, altitude and slope etc.

Leaving Certificate Mathematics

Strand 2: Geometry and Trigonometry

Students should be able to use trigonometry to solve problems in 3D, graph the trigonometric functions (sine, cosine, tangent), graph trigonometric functions.

Science and Technology in Action is widely used for project work in **Transition Year**.

Learning Outcomes

- The concept and purposes of a map
- The early history of mapping
- The evolution of various mapping techniques
- The concepts of sighting instruments, levelling tools, triangulation, projection
- Mercator and Transverse Mercator projection
- The evolution of mapping Ireland and in particular the 1824-1843 Ordnance Survey
- Some modern techniques used for mapping.

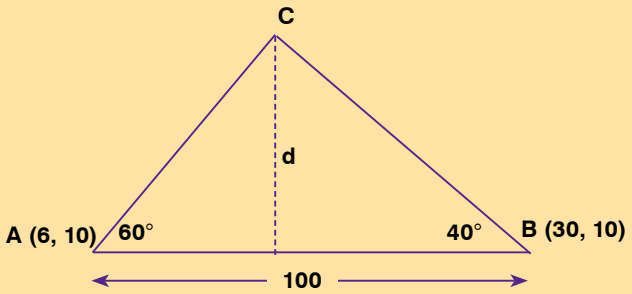
General Learning Points.

- Trig Point: The points used in triangulation are known as Trig points; small concrete pillars still survive on some spots
- A cylindrical projection takes a vertical, N/S axis (Mercator projection), a lateral, E/W axis (Transverse Mercator), or an oblique axis and forms a cylinder which is unwrapped. Each point on the sphere is projected onto the map. It is accurate along the axis and increasingly distorted moving away from the axis
- Scale: The scale of a map is the ratio of a distance on the map to the corresponding distance on the ground. It is expressed in words or as a fraction/ratio or both as in the Ireland Leisure maps (1 cm = 4.7 km and scale = 1:450,000). Maps are classified as Large scale, Medium scale and Small scale. There is no accepted definition of these. Moving from smaller to larger scale reflects the increasing size of the fraction represented by the ratio (1/7500 used for an urban map is a larger number than 1/50000 used for hill walking).

Student Activities

1. Triangulation

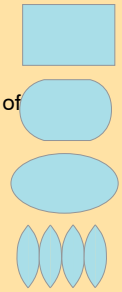
Calculate the value of 'd', AC, BC and the coordinates of 'C'.



2. Compare maps of the world

Find maps of the world that show different projections. What are the advantages and disadvantages of each type of projection?

Using the scale on each map measure the distance from Dublin to Buenos Aires (11,000 km). On which type of map is the distance represented most accurately?



True/False Questions

a)	A rope stretcher was a mechanism for stretching ropes.	T	F
b)	A quadrant is a sighting instrument.	T	F
c)	The compass was known to the ancient Greeks.	T	F
d)	A total station incorporates a telescope.	T	F
e)	Triangulation was known to the ancient Greeks.	T	F
f)	In triangulation a new baseline is required each time a new region is to be mapped.	T	F
g)	Mercator Projection produces distortion-free maps.	T	F
h)	The axis used for the projection for UK and Irish Maps is the Greenwich meridian.	T	F
i)	Transverse Mercator projection is used to reduce variations in scale.	T	F
j)	Topographic maps show relief.	T	F
k)	Colby's compensation bars are made of iron and brass.	T	F
l)	In 1970 the height of Irish mountains dropped by nearly 3 m.	T	F
m)	In digital photography the view straight down from an aeroplane is the 'vertical' view.	T	F
n)	A transverse Mercator map gets less accurate moving East or West from the origin.	T	F

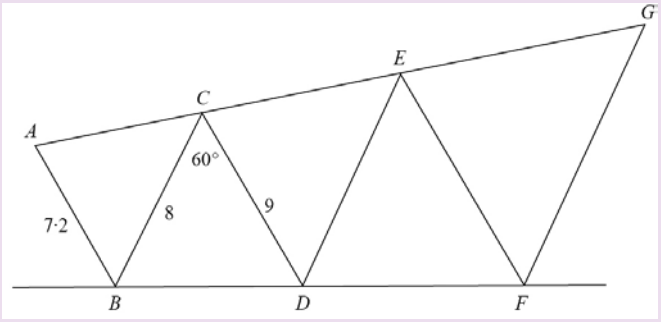
Check your answers to these questions on www.sta.ie.

Examination Questions

Leaving Certificate Mathematics (OL- PM), 2012, Q.7

Explain what is meant by a scalene triangle.

The triangle EFG is the image of the triangle CDE under an enlargement and the triangle CDE is the image of the triangle ABC under the same enlargement.



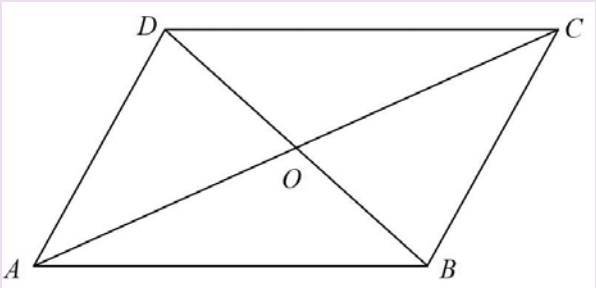
The proposed dimensions for the structure are |AB| = 7.2 m, |BC| = 8 m, |CD| = 9 m and | ∠DCB| =60°.

Find the length of [FG].

Find the length of [BD], correct to three decimal places.

Leaving Certificate Mathematics (FL- PM), 2013, Q.8 B

ABCD is a parallelogram.



The diagonals of ABCD intersect at O.

| AB | = 9 cm, | BC | = 6 cm and |∠ DAB | = 60°.

(a) Find | DC | .

(b) Find | ∠ ABC | .

(c) Name one pair of parallel lines in the diagram.

(d) Is the following statement true or false?

| DO | = | OB | and | AO | = | OC |

Give a reason for your answer.

Did You Know

- The earth's terrain can be mapped from space with the use of satellites, such as RADARSAT-1 which orbits 14 times a day, covering the entire earth every 24 days and TerraSAR-X which boasts a resolution of 1 m.
- Internal Survey: The original Ordnance Survey comprised two separates parts, the Trigonometrical (i.e. Triangulation) Survey and the simultaneous Internal Survey, the latter being the identification of features, including place names within the triangulated areas.
- James Clarence Mangan was employed as a copyist and scribe in the original mapping project. Mangan, the poet, translated place names freely, and did not get on with the more exacting O'Donovan (see biography). Brian Friel, in his play *Translations*, painted a grim picture of the Ordnance Survey's activities which he admitted himself was (intentionally) 'inaccurate history'.
- You may find maps from the original survey of Ireland in your local library. They are also available at www.osi.ie

Biographical Notes

Major Thomas Colby (1784-1852)

Thomas Colby was born in Rochester, Kent, England in 1784. At 16 graduated from the Royal Military Academy in Woolwich. He was soon asked to join the Ordnance Survey and in 1809 became its CEO. In 1820 he was appointed head of the Ordnance Survey. In 1825 the survey of Ireland began under his direction and was completed in 1847. He introduced many innovations and set new standards for surveying. In 1846 Colby was promoted to major-general and retired from the survey. He died in New Brighton near Liverpool in 1852.

John O'Donovan (1806-1861)

O'Donovan worked with a team of scholars identifying the correct origin of as many of Ireland's 63,000 townland names as possible. He made an enormous contribution to Irish history and literature and was considered one of the greatest Irish scholars of his time.

Revise the Terms

Can you recall the meaning of the following terms? Revising terminology is a powerful aid to recall and retention.

apex, Babylonian, baseline, benchmark, brass, clay tablets, compass, compensation bars, contours, crow's foot, database, equator, globe, Greenwich (longitude), irrigation, Lascaux, latitude, limelight, Mesopotamian, ordnance, plum bob, Polynesians, projection, Ptolemy, Pythagoras's theorem, relief, right angle, scale, sighting instruments, surveying, theodolite, topographic, transverse Mercator, triangulation.

Check the Glossary of terms for this lesson on www.sta.ie