

Members Talks on 13th December 2016

“Mapping Heights” by Nick Stapley

Ordnance Datum for British maps is taken as the mean sea level at Newlyn, Cornwall, originally from its tide gauge. This has been transferred to fixed marker, set in a covered container with an accessible marker 4.751m above ODN - N for Newlyn, a geologically stable location near the edge of the continental shelf, free from the influence of river outflow.

There were once 200 Fundamental Bench Marks (FDM) around Britain (now 190), each with a hidden and an accessible marker. There were also 750,000 Secondary Bench Marks (SDM); however, many have been lost to war damage and redevelopment since they were put in. Various types of marker have been used such as cut marks and flush brackets.

The equipment used to measure heights relative to a bench mark or known height is a plane table and measuring pole. Theodolites on the plane table have given way to laser equipment. The plane table is set level and readings on pole(s) at the known height mark and at the point to be measured are taken. The level setting would be normal to the local direction of gravity. The new measured height forms the basis for the next measurement of another point.



Rotation of the earth causes its diameter to increase at the equator so instead of being a sphere it forms an oblate ellipsoid or spheroid (the best fit is an ellipsoid designated WGS84). The shape has a significant effect on the strength and direction of the local gravitational field, as does the effect of land masses and ocean deeps. Local variations, depending on the density of the surroundings (eg on a rock face there is a void one side and dense rock the other) also have an effect. The gravitational field may be at an angle to a radius to the centre of the Earth; this needs to be taken into account for long distance surveying.

For the entire earth a datum based on mean ocean levels enables a zero height surface called the Geoid to be defined. This undulates about the WGS84 surface deviating below it furthest in the Indian Ocean, which the Indian tectonic plate traversed on its way to the Asian plate and the formation of the Himalayas.

The **Global Positioning System** (GPS) changed everything. Triangulation, from at least four satellites at known positions, gives both horizontal and vertical coordinates of one's position. The horizontal position will be relative to the GPS equivalent to the Greenwich meridian (using International Atomic Time) and the vertical position relative to WGS84. Adjustments are made to derive local coordinates using a Geoid model to determine height. A mobile phone with a GPS app may achieve 3m accuracy horizontally and 8m vertically in ideal conditions. This can be improved to cm or sub-cm accuracy using differential techniques and OS Net, a correction service for GPS.

“Updating my Central Heating System” by Roger Allsopp

At the Members Evening in December 2012 Roger described an air circulation system he had installed in his house. He had problems of open windows letting in midges & pollen, and noise; and of condensation in the kitchen & bathroom. He used chimneys (freed up by central heating) and over ceiling voids to route piping from an inlet, via a pump, to a filter and heat interchanger then a manifold whence air could be routed first to living rooms then the kitchen or bathroom. More piping then returned the air through another manifold, back to the heat interchanger, and out. It worked. Margaret, his wife, noticed when he took out the return manifold recently...

Roger, wanting to improve his computing ability, asked Andrew, his computer literate son, to help. A project was recommended: automate the passive air circulation system. Measurements of temperature, and perhaps humidity, would be made, valves would be added to the manifolds, and controlled by a computer, so that better use could be made of the air before it was exhausted. An Arduino micro-computer was chosen as the controller, and Roger is writing (pages of) code to get it going.

Roger brought the manifold to this Members Evening, and set it up with the pipe connectors on the domestic side facing the room. Each connector was fitted with a disc valve operated by a small

(but powerful) motor. Light from a lamp temporarily fitted inside the manifold was alternately blocked as the discs were turned from transverse to in-line.

This is work in progress, but he can now measure temperatures with sensors around the house. These show that his original concept was good, but he expects it to do better.