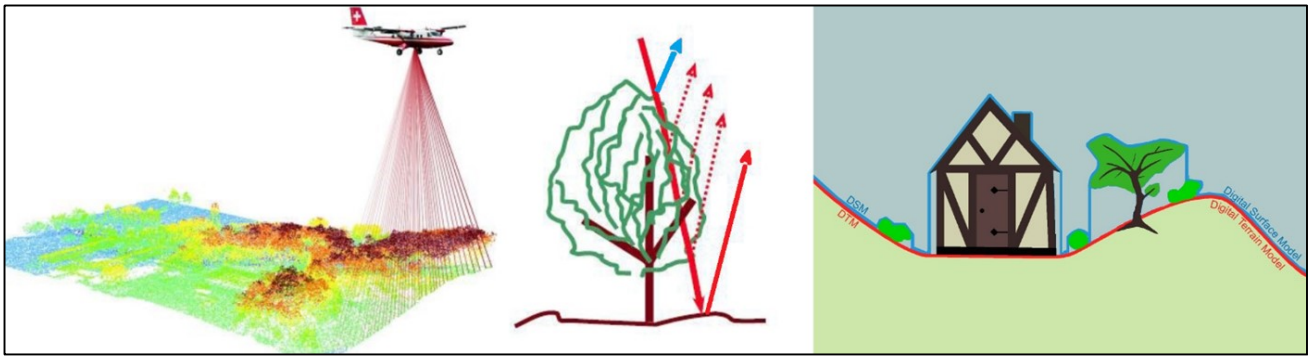
Ever wondered where our orienteering maps come from?

Mapping in TVOC – LiDAR - what it is and how we use it

LiDAR technology uses the light from a laser to collect measurements which are used to create 3D models and maps of objects and environments. The data is usually collected by flying at a fixed height over the area in a regular pattern, but it can be done from satellites.

Depending on the sensor used, LiDAR scanning units can fire hundreds of thousands of pulses per second. These light waves bounce off objects and return to the LiDAR sensor. The sensor uses the time it takes for each pulse to return to calculate distance (left picture). Each of these pulsed laser measurements, or returns, can be processed into a 3D visualization known as a '**point cloud**' (centre picture). This is used to create digital terrain (DTM) and digital surface (DSM) models of specific landscapes.



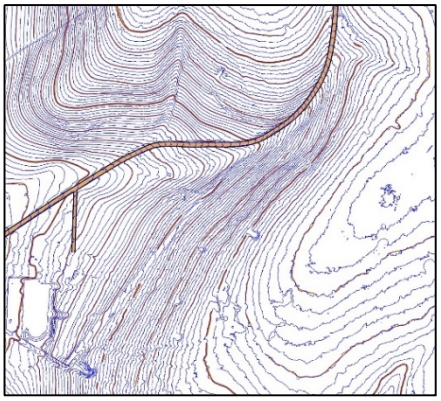
A digital surface model (DSM) is a three-dimensional representation of terrain and all the objects (trees, houses etc.), within that space. Regularly spaced elevation values, like contours, collected from LiDAR scans create a coordinate system that allows the earth to be reflected and modelled with a high level of accuracy. Digital terrain models (DTM) are just like DSMs, without the objects included, to map the terrain only (right picture).

That's how a LiDAR sensor works explained in a nutshell – but how did we get LiDAR data and is it useful for orienteering mapping?

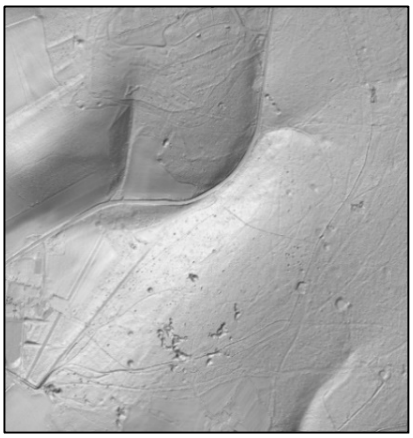
The Environment Agency has been acquiring data over the whole of the UK for some years (mainly for mapping drainage areas), at a resolution of 1m or 2m and making it publicly available. One of our orienteering club members was helping to analyse LiDAR data for the Chilterns 'Beacons of the Past' project (BotP) and noted that the work being done to look for archaeological features was using hill shading maps, which could also be useful when drawing Orienteering maps. The high resolution (0.25m) used in the survey, would provide very accurate terrain modelling particularly for shallow ground features.

We approached the Project team and were delighted to be given permission (with some provisos) to use the BotP data to assist in our Orienteering mapping. We were able to define areas we use for orienteering in the Chilterns and they provided the LiDAR data as LAZ (compressed) files. The files for each of our areas is about 3-5gB which required use of an FTP server arrangement to facilitate transfer to us.

The OCAD mapping software is very powerful for analysing LiDAR data. It can analyse the Point Cloud data (provided as compressed LAZ files) and produce contours, hill shading and vegetation maps. These analyses can be shown as background maps to our orienteering maps, to allow checking and modifying of existing maps or creation of new ones. A powerful PC helps speed up the analysis time which can be several minutes!

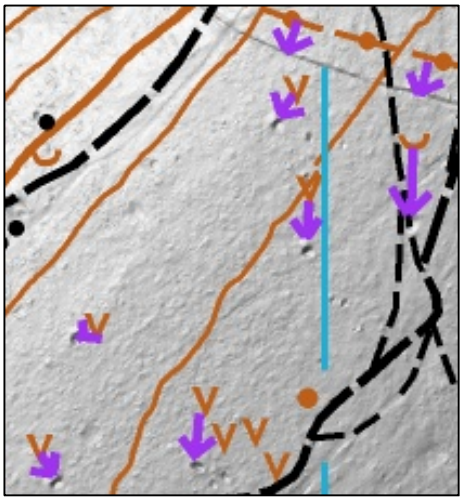


Our forest O maps use 5m main contours with a 25m index contour. OCAD can analyse any combination of contour lines, so it can do 2.5m contours for urban maps. The example (part of Bradenham with Bradenham Woods Lane) shows 1m contours in blue and the 5m contours in brown. The contour lines can be smoothed using TPI (Topographic Position Index) and Bezier curves to provide a satisfactory smoothed line. The unsmoothed 1m contours show some of the many pits and depressions but not as well as hill shading analysis.



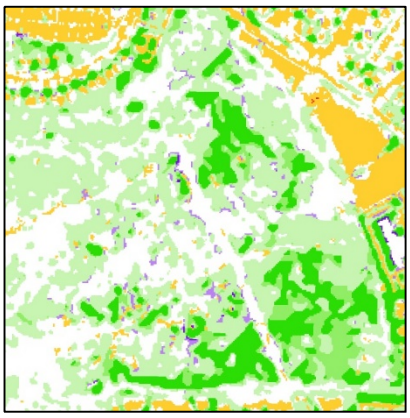
The hill shading analysis can be done with various options but the default settings provide good visibility of the ground features.

The picture shows the default hill shading analysis, in the same area as the contour map above. The road is clearly shown and the pits and depressions of various sizes.



A small section of the map, with the new hill shading, highlights some of the errors we have found in our original Bradenham map. The original pits, depressions, and earth walls have been compared to where they really are on the ground (shown by purple arrows). The software can calculate the error which varies from 10m to 30m in the example.

The LiDAR data can also provide information on the vegetation by using both the DTM and DSM data to assess the vegetation height using colours. In the example yellow is the ground up to 0.1m, green is for heights up to 12m and white is up to 30m. It can be used effectively to find clearings (yellow) in the woods.



An additional way to look at the model is to analyse data in the range 0-3m to provide a vegetation base map. Orange areas are open land, and green areas are vegetation with the darker the green, the thicker the vegetation. Purple areas show areas of brambles.

The map updating in Park Wood, Bradenham, The Coppice and Naphill Common is still in progress with all analysis completed and field work well underway for our planned event in December 2023.

The map extracts below show how the map has changed from 2012 when the map was created using just field work, through to the new 'in progress' 2023 map using the LiDAR and OCAD processes.

Original 2012 Map

New map in progress after field checks

Next Time: Mark Thompson will explain the mapper's workflow and how we progress from the original map to the new map.