British Orienteering
Digital Elevation Project 2012

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Summary

This project looks at the availability, supply and use of various digital spatially referenced data to improve the production and quality of orienteering maps.

Whilst the main aim was to examine the use of LiDAR data to produce contours under tree cover, we also looked at other type of Digital Elevation Material (DEM) data and the results in different types of terrain.

We have no doubt that the use of LIDAR and similar products to produce contours and the use of other data such as geo-referenced high resolution air photographs will become the accepted method of orienteering map production from now on.

The main conclusions of using LiDAR are:

- LiDAR data will help mappers to produce more accurate maps.
- Care must be taken to generalise maps so that they do not become illegible with the wealth of information that LiDAR can produce. Careful selection is a MUST.
- LiDAR data will certainly save survey time. Maps can be prepared before surveyors go into the field.
- It will be important for mappers to learn to interpret the data so as to get as much as possible onto the base map before survey on the ground. One might envisage seminars and workshops to share knowledge and experience.
- Forward planning will be important so that the fully prepared base maps are ready for the best time to survey areas. Usually December – May. There may be problems in upland parts due to snow.

The cost of LiDAR data in the UK is an issue. Elsewhere in Europe and the USA LiDAR data is a free resource available to the public. Here costs are borne by the user and at up to £100 per sq km will make mappers and clubs think twice about purchase. However it should be looked at as an investment. In the majority of cases this will be a one-off exercise with savings in surveying time and long-term benefits of higher quality, accurate maps.

Inevitably this is a fast moving field and this report will become out of date. During the project OCAD AG have released OCAD 11 with more advanced DEM capabilities and we are aware that other sources of remote sensing data will become available. One area we were not able to explore is the use of raw (LAS format) LiDAR data. Although OCAD 10 and 11 are able to process this, it is not readily available.

Introduction

The International Specification for Orienteering Maps states that "The shape of the ground is one of the most important aspects of an orienteering map. The correct use of contours to show a three dimensional picture of the ground-shape and height difference cannot be overemphasized."

Contour information has traditionally been derived from one of two sources. Mapping for open moorland areas, particularly for higher level events, has usually been based on a photogrammetric (PG) plot derived from stereo air photographs and is an accurate representation of the ground shape when carried out by a skilled and experienced orienteer.

New stereo-pair air-photographs needed for PG plots are no longer produced being replaced with digital ortho-rectified images and, whilst old stereo-pair photographs will continue to be available, the scarcity of skilled photogrammetric operators is unlikely to improve.

Forested areas and maps for lower level events have often been based on Ordnance Survey (OS) contours; these are usually too generalised for orienteering use and have to be enhanced by the mapper to show a useful level of detail.

DEM is now becoming more readily available in the UK and, together with the ability of OCAD 10 & 11 software to manipulate the data, makes it likely that it will become the primary source of height information for orienteering maps. LiDAR data is of particular interest as it has the potential to produce contour detail underneath the tree canopy from the Terrain data but other digital sources have been explored.

Project Details and Support

The project has had financial support from the British Orienteering Development Fund and from the local orienteering clubs who supplied support for the example/trial areas.

Essentials

Note that to use any of the data covered in this project the following are required:

- OCAD 10 or 11 are required to import and generate contour detail from LiDAR data.
- The orienteering map must be geo-referenced. Instructions are available at: http://www.britishorienteering.org.uk/images/uploaded/downloads/mappers_georeferencing.pdf
- **All information must be checked with a ground survey.**

Overview - Types of Spatial Digital Data

The following types of digital spatial information are available for use in producing orienteering maps.

Ordnance Survey Data

Ordnance Survey mapping data is available from OS online mapping service partners, see:

http://www.ordnancesurvey.co.uk/oswebsite/business/land-and-property/planning-partners.html

The OS 1:10000 data, suitable for maps at 1:15000 and 1:10000 are available either as a dxf or geo-referenced Tiff raster image. The OS Land-Form Profile contours are an optional extra. Costs range from £25 for1 sq km raster data to £95 for 4 sq km vector data in dxf format.

The OS MasterMap Topography Layer product provides a high level of detail suitable for producing sprint and urban orienteering maps. Costs can range from about £85 per square kilometre in rural areas to £350 per square kilometre in urban areas.

The OS OpenData Street View product is freely available for download from the OS web site. Whilst this does not provide the detail in OS MasterMap it usually has sufficient detail to enable existing orienteering maps to be geo-referenced accurately. See essentials above.

The OS 1:25,000 Explorer map series contain the same information as the 1:10000 data above.

Geo-rectified air photos

These are **aerial photographs** that are geometrically corrected ("ortho-rectified") such that the scale is uniform: the photo has the same lack of distortion as a map. Unlike an uncorrected aerial photograph, an ortho-photograph can be used to measure true distances, because it is an accurate representation of the Earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt. Source: Wikipedia http://en.wikipedia.org/wiki/Orthophoto

The air photographs as supplied are geo-referenced and appear in the correct place when imported into a geo-referenced OCAD file. These are best purchased as separate tiles (No mosaic) as these can be loaded separately. They can be switched off until needed and this saves a lot of time loading the map.

These photographs are usually available at 25cm and 12.5cm resolution. Cost per square kilometre are £37 for 25cm and £70 for 12.5cm.
Care is needed if the photographs are more than a few years old as ground work can change the undergrowth pattern, extremely useful in open areas for paths, earth banks and large areas of undergrowth as well as individual trees can be plotted.

Colour infra-red imagery at 50cms can be used to identify clearings in certain types of woodland. Cost is similar to 25cm air photographs.

Digital Elevation Model (DEM)

A **digital elevation model** (DEM) is a digital representation of ground surface topography or terrain produced from remote sensing data. For the purposes of this project there are two common types:
Surface DEM shows buildings and tree cover and an image is superficially similar to an air photograph. It is referred to as DSM when ordering LiDAR.
Terrain DEM has the data interpolated to remove buildings and vegetation cover to show the ground surface only. It is referred to as DTM when ordering LiDAR.

The following types of DEM were looked into:

LiDAR

LIDAR (Light Detection And Ranging) is an optical remote sensing technology similar to radar that transmits laser pulses and measures the properties of scattered light to find range and/or other

information of a distant target. It has many uses but in this context the raw data (LAS) produced from an aircraft flyover is used to produce Digital Elevation Models (DEM) that are available as Digital Terrain Models (DTM) and Digital Surface Models (DSM).
Source: Wikipedia
http://en.wikipedia.org/wiki/LiDAR

The cloud of LiDAR raw data is processed to produce DTM and DSM data in various formats including ASCII which can be imported into OCAD 10 and 11. The data is produced at different resolutions, usually 2 metre, 1 metre or 0.5 metre; this resolution is the distance apart across the ground of the laser pulses and produces a grid of point data that can be interpolated by appropriate software to produce contours, hypsometric layers and hill shading. The increase in the amount of data at the lower resolutions results in greater detail and cost.

IFSAR

Interferometric Synthetic Aperture Radar (**IfSAR**) is an aircraft-mounted sensor designed to measure surface elevation, which is used to produce topographic imagery.

GPS Devices

Whilst not directly part of this trial, GPS devices produce spatially referenced data that can be imported into the orienteering OCAD map file as tracks and waypoints that can be used as additional survey information and as corroboration of other data. Care must be taken that the GPS data is not used exclusively as survey data.

Suppliers and Costs

Overview

There are a number of suppliers of DEM data and mappers are encouraged to look at the available sources to check coverage and costs as the position changes over time and according to the area required. The method of supply can be different, for example some supply whole 1km grid squares whereas others can be tailored to a particular polygon. This can affect cost depending on the particular area. All suppliers have a web site to allow ordering on line and data can often be obtained in a few hours.

Coverage

Not all parts of the UK are covered by the various types of data. Scotland in particular has relatively little cover of LiDAR data to date, mainly confined to lowlands and river valleys.

Dates

It is important to check the date of air photographs and other DEM data. Whilst it is reasonable to assume the LiDAR terrain data will not change, it is essential to ground check, for example, vegetation such as clearings mapped from air photos.

Suppliers

Geostore (Infoterra/Astrium)

www.geostore.com

Geostore is provided by Infoterra and supplies a range of aerial survey photos, height data and OS products. Material can be ordered by area squares and polygon.

Geomatics

www.geomatics-group.co.uk

Geomatics is the on-line provision of Environment Agency data. It specialises in LiDAR data obtained initially for flood prevention work. Coverage is extensive for England and Wales at 2 metre resolution with about 60% coverage at 1 metre and about 10% at 50cm. The data is supplied in 1km squares, this can result in having to buy several squares to cover the required area of which only a part is required.

Whilst Geomatics offers a 66% discount for non-commercial organisations, discussion with the Environment Agency about their terms of reference have made clear that this will not apply to the production of orienteering event maps.

Bluesky

http://www.bluesky-world.com/

Bluesky provide a range of GIS products including air photography, LiDAR and other height data such as GeoPerspectives 2m DTM and DSM.

CentreMapsLive

http://www.centremapslive.co.uk/page/home

CentreMapsLive is a mapping portal and can be useful to identify what DEM data is available for a particular area.

BLOM

http://www.blom-uk.co.uk/ http://www.blomasa.com/products-services-en-0-5/products-services-test/lidar-height-data.html

A flight operations company who undertake LiDAR and air photo surveys with services covering consultancy and data capture through to data processing and digital models.

Types of Terrain and Suitability

Overview

The project looked at a range of orienteering terrain but concentrated on the requirements for long distance orienteering maps, in particular wood and forest areas as this is where the principal benefits are expected to be derived.

Broad leaf

LiDAR data of broadleaf woodland produced excellent results with a high degree of acceptability.

Coniferous

Areas of dense coniferous woodland were expected to produce poorer quality results. However in practice the results were acceptable even in the more dense plantations although it is reasonable to expect some degradation.

Open areas, parkland and moorland

It is suggested that it is more cost effective to use data derived from digital air photographs such as Next or GeoPerspectives for these areas as there is little extra benefit for the additional cost of LiDAR.

Examples - Trial Areas

Bramcote Hills Park, Broxtowe, Nottinghamshire

Bramcote Hills Park is less than 1 square kilometre in size, comprising a mix of broad-leaved woodland and parkland. It is a focal point for community participation in leisure and recreational activities and has been used for orienteering since the 1980s. It has two steep wooded hills, the eastern with rhododendron thickets, the western side, Stapleford Hill, has been quarried and has much contour detail. GPS data had indicated that the wooded hills were inaccurately mapped with several major features appearing to be out of position.

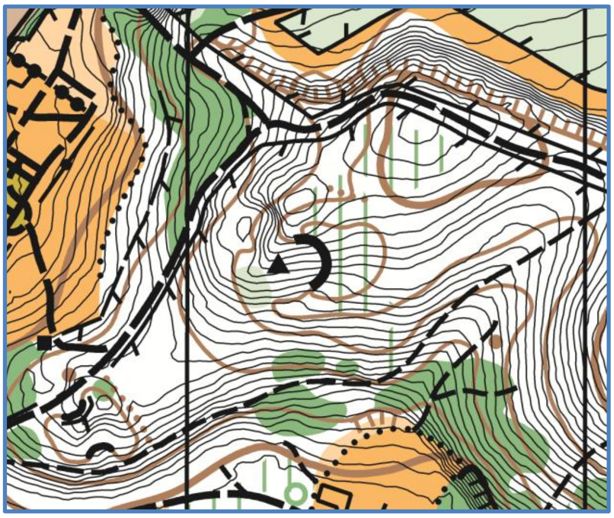


Figure 1 - LiDAR derived 1 m contours with original Bramcote Orienteering map.

LiDAR Terrain Data (DTM) at 1 metre resolution was purchased from Geostore and contours generated in the existing OCAD file. As expected the new contours matched the GPS data and confirmed that tops of hills, crags and platforms were out of position by up to 30 metres on the east side of the map. In this case the mapper re-aligned the original contours and features to match the DTM following a check on the ground.

Figure 1 shows part of the area. The DTM contours were generated at 1 metre intervals, in black on figure one. Original contours are in brown. A surprise was that the contours were as accurate in the fairly extensive areas of rhododendron, which have been cleared since the DTM data was flown. There remains a question of whether this is because of skill or chance of the interpolation process.

Comparison of LiDAR 2m and 1m resolution data

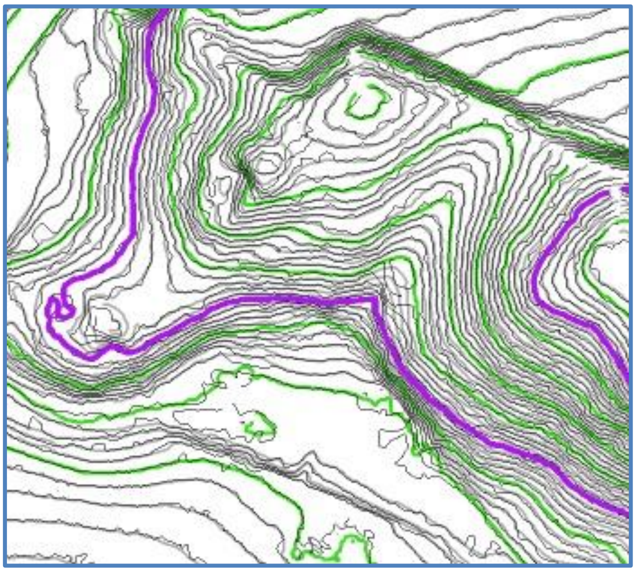


Figure 2 - Comparison of 1m and 2m resolution LiDAR DTM data

The 2 m resolution contours are purple = 25m index contour, green for 5m contour and grey for 1m contours.

The 1 m resolution contours are black and at 1m intervals.

Whilst there is more detail in the 1 m data as expected, this detail is finer than required for this area and did not produce any additional benefit.

It does confirm that both datasets produce accurate contours as there is little spatial difference between the two.

Note the contours at centre bottom close to the edge in figure 2, this area is actually level and flat; where a contour runs across a flat area the generated contour should be ignored. The level area can be seen in the hill shading images below.

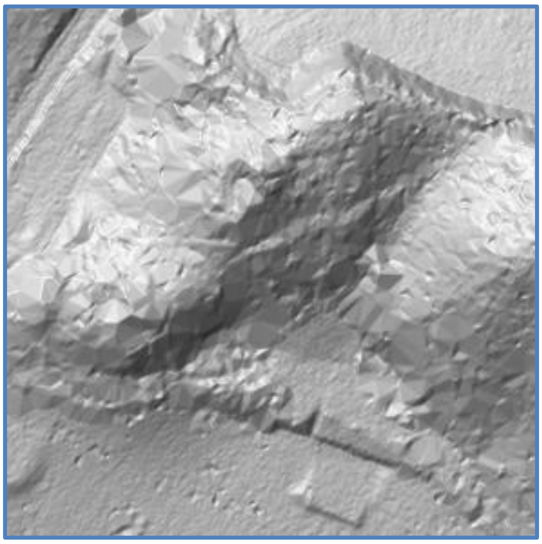


Figure 3 - Hill shading derived from 1 m resolution LiDAR data

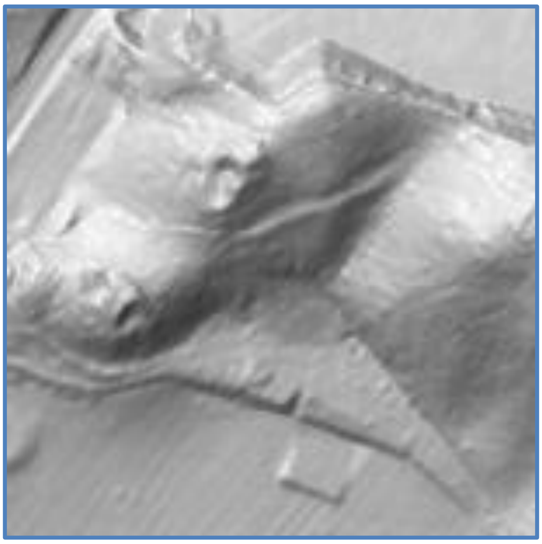


Figure 4 - Hill shading derived from 2 m resolution LiDAR data

Hill shading images can be generated by OCAD from the DEM data and loaded as background maps. The azimuth (direction - default north west) and declination (default 45 degrees) angles of the light source and exaggeration can be adjusted and a TIFF image file is generated, which can be automatically imported as a background image to the OCAD map file. By selecting different angles and directions it is possible to show additional detail as in the images above where lines of paths crossing the slope are clear.

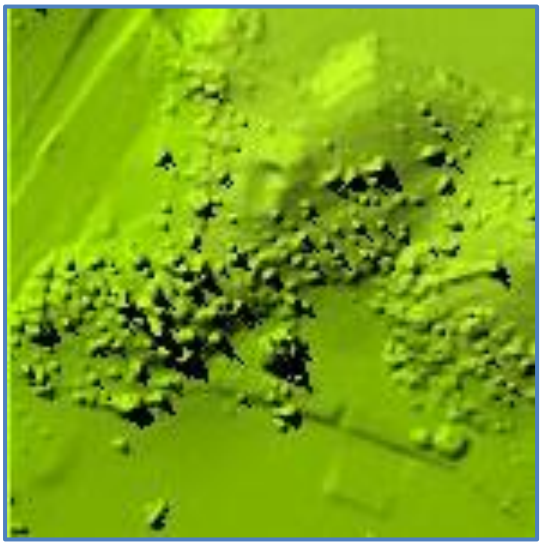


Figure 5 - 2m resolution DSM jpeg image

LiDAR data can also be purchased as jpeg images. Figure 5 shows the DSM extract of Bramcote as above. It could be used to identify vegetation in particular areas but is expected to be of limited value compared to a high resolution ortho-photo.

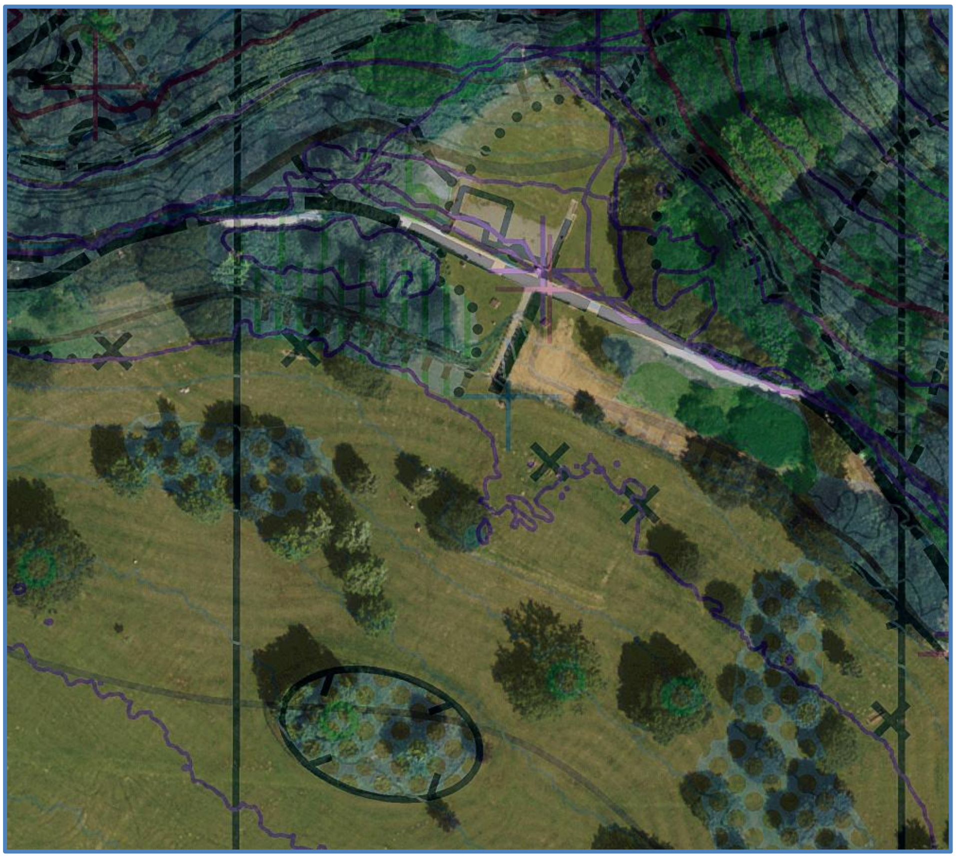


Figure 6 - 25 cm air photo as background to OCAD map

Geo-referenced high resolution air photos of open areas such as parkland can show remarkable detail. In figure 6 above the photo can be used to identify and reposition features with greater accuracy on existing maps or save ground survey time when preparing the base map for survey .

Virtuous Lady, Horrabridge, Devon

Erik Peckett - BOF Map Group, IOF Map Commission

Background

The Virtuous Lady/Wheal Franco Map was produced in 1998 for Devon O C by Brian Parker and Erik Peckett. The map was partially revised in 2005 for vegetation changes.

It is situated in West Devon just west of Yelverton and Horrabridge. It consists of the two steep sided valleys of the Tavy and Walkham Rivers. The slopes are covered in mainly deciduous forest much of it mature. The areas around are moorland which has many scattered trees, bushes and bracken. It is grazed by cattle, sheep and horses.

A feature of the southern area is that the bracken on the flatter areas is mown. This is for environmental reasons to help produce a habitat for a particular butterfly. It is also used for animal bedding and compost. It produces a very runnable area.

The valley sides have many remains of the mining industry and a large number of cliffs and crags.

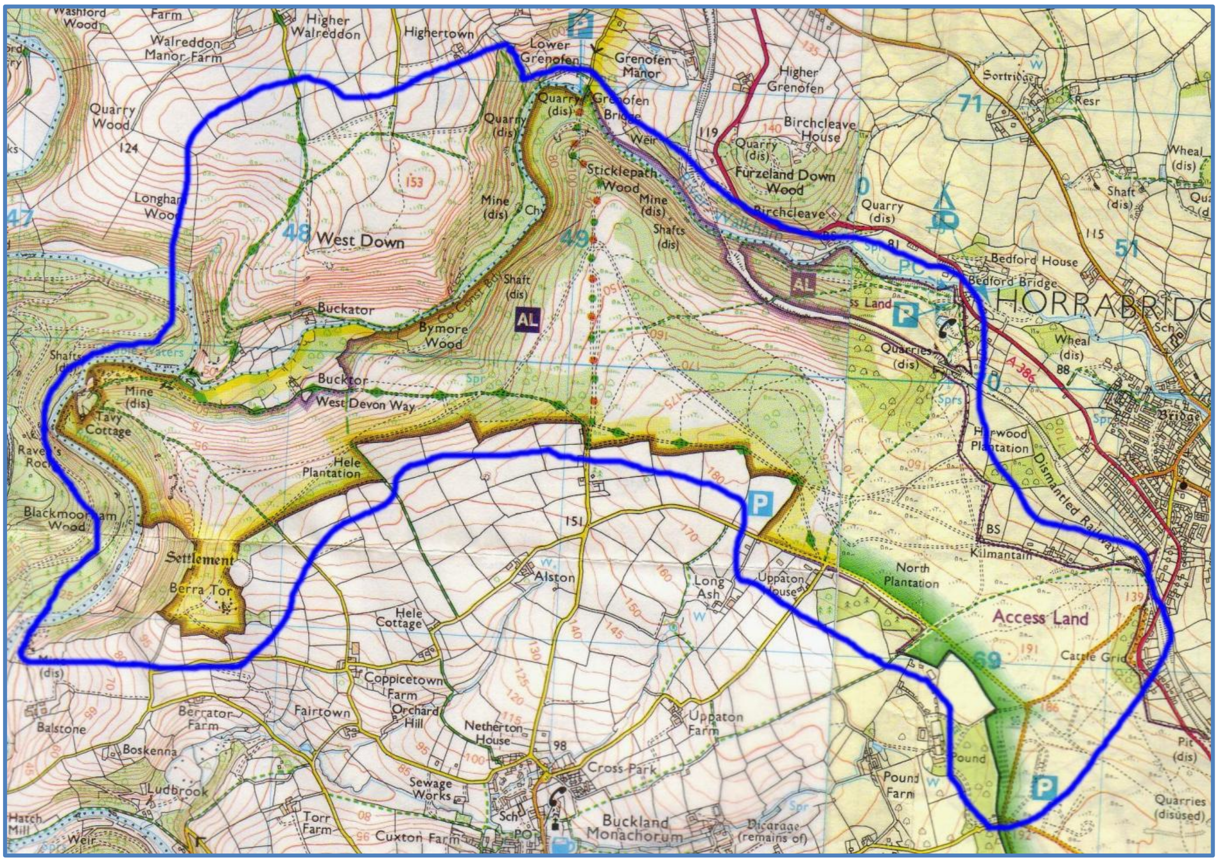


Figure 7 - OS location map of the area to show location and the shape of the site

The map was originally produced using the current techniques of 1998. A base map was produced from OS 1:25000 material. One consequence of this was that the eastern section which is part of Dartmoor and as an upland area had only 10m contours and thus the 5m contours had to be interpolated. Some photographs were available.

A result of using OS 1:25000 as a base map was that in scanning and enlarging, the maps became distorted. It was also difficult to correctly locate survey scans on the digitisers used at that time. Although OCAD 10 offers a “rubber sheeting” function to try and correct distortions it was not found on this occasion to be very effective given the long length of the area. It was decided to use OS material to locate the main details of the map.

Devon OC were seeking to revise the map to use the area in September 2013 for the Caddihoe Chase two day event.

It seemed a good opportunity to try out the use of LIDAR data to help revise the map. The Club was keen and agreed to purchase the geo-referenced photographs. The BOF Development grant purchased the LiDAR data from Geomatics.

Two problems arose, one immediately. The data is supplied in 8 one sq.km tiles based on OS grid. These did not correspond to the area required. The area of the map is 5-6 sq.km. Small portions at the edges had to be missed out for economy and there was a large area of fields on the southern border that were not required. There was also a small area with the moorland without any data. This was not a particular problem.

The second problem is that the Environmental Agency has decided that Orienteering is a commercial activity and should pay the Commercial rate for the data. Discussions are ongoing.

Initially Erik Peckett was to produce the base map from the LiDAR data, geo-rectified photographs and OS material. It was decided originally not to include the detail from the original map.

It was then hoped to engage the services of an experienced mapper to carry out the ground checking. It was hoped to get some idea of the saving in survey time produced by the LiDAR data.

This did not prove possible and thus Erik Peckett started the survey in February 2012. It was then decided to treat the eastern part of the area as if it were a new area as EP had not mapped this originally. The western end was treated as a revision, seeking to correct any errors in positioning of the original map and any changes in vegetation.

The second problem arose when the particular weather pattern of 2012 restricted access to the area during the Spring. In May the bracken had started to grow and in late June it was decided to wait until November to continue the ground survey.

Recommendation

It would be advisable for the preparation of a base map for a project of an area this size should be to start earlier so that survey could take place in November - May to avoid bracken growth. It might also be better to consider a two man team for the survey.

Working with LiDAR data - Producing the contours

I was originally concerned that my PC would not be able to cope with the vast amount of data needed to produce the contours. This proved unfounded. The production of the original 5 and 25 metre contours was simple and quick[1].

I had been advised by Thomas Gloor of OCAD that 2m data would be sufficient to produce the detail required for an Orienteering map and higher resolution might encourage over detailed and potentially illegible maps.

Each tile can be loaded separately. It consists of a grid 250,000 heights. The 2,000,000 point produced the contours in a very short space of time.

We also produced 1m contours for the area. Also very quick.

These produced a remarkable amount of detail. As the project advanced it was possible to pick out gullies, knolls and platforms. These then could be checked on the ground to ensure that they were sufficiently prominent to put on to the map. It was also possible to position crags and cliffs.

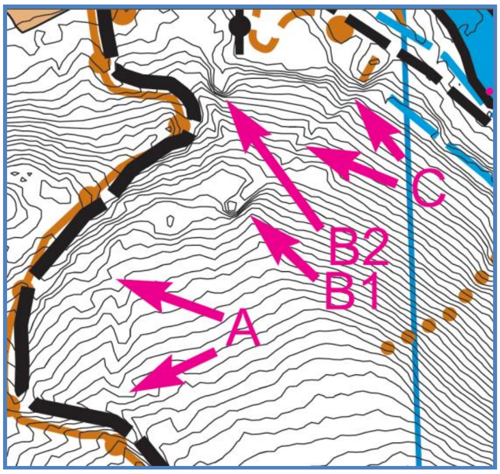


Figure 8- Virtuous Lady, Example A

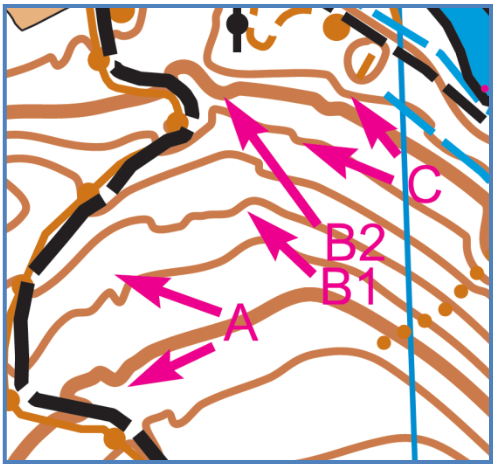


Figure 9 - Virtuous Lady, Example B

Example of detail obtained from 1m contours. Note the black colour seems to show detail better.

Example A

- A shows a possible gully
- B1 shows potential crag- the circular contour is the opening to the mine shaft
- B2 shows a potential cliff.
- C shows a potential gully / re-entrant

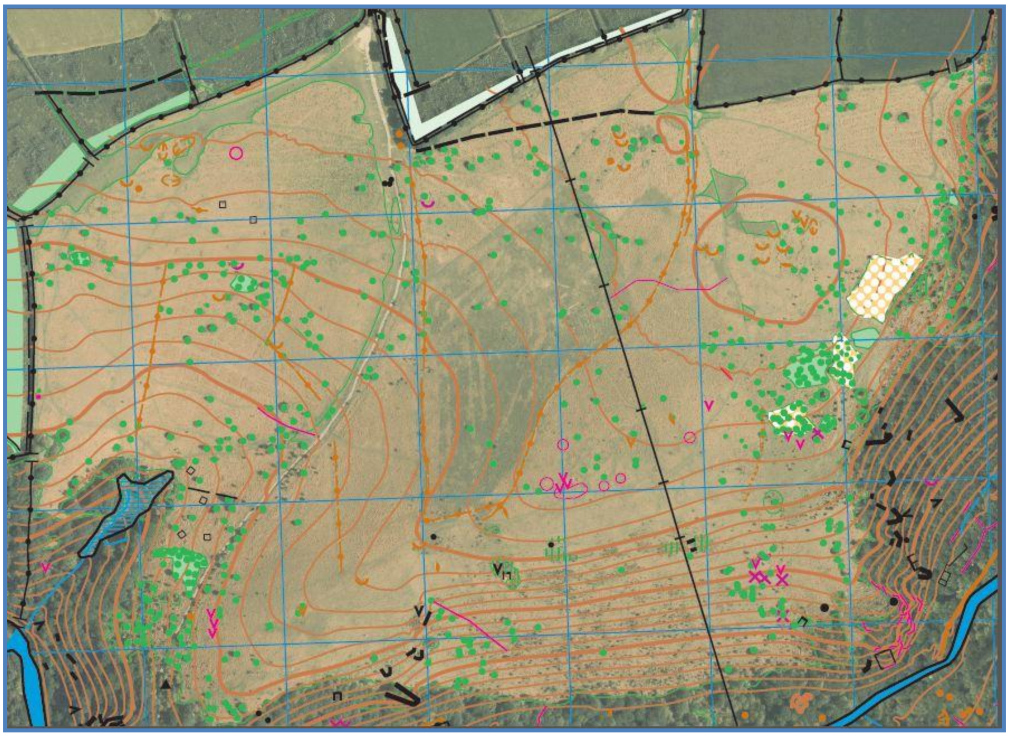
Example B

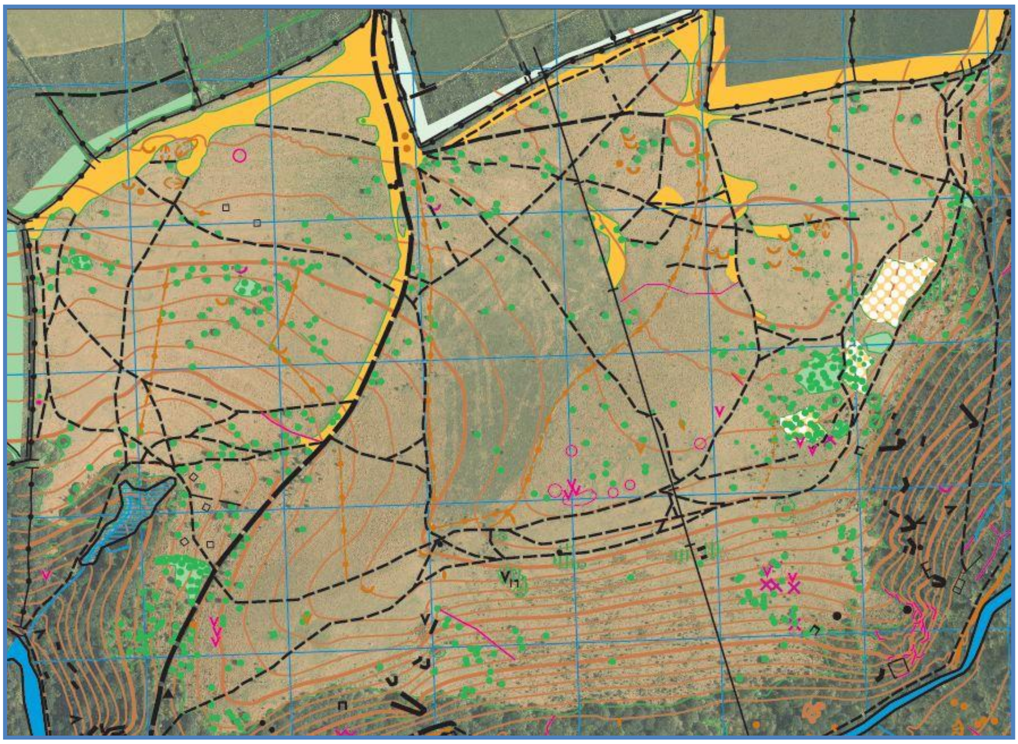
- Shows the same area with only 5/25m contours
- One feature of the contours is the wobbly nature of the line produced. This is probably a result of the algorithm that produces them. This is particularly noticeable in flatter areas where the visual perception is of a smoother appearance.

[1] The computer/system requirements for OCAD 11 can be found here.

OCAD 11 has a new feature that allows the contours to be smoothed more sensitively so that significant detail is not lost. Otherwise it may be that the contours will have to be redrawn manually.

Using geo-rectified air photographs - Example paths on West Down





(These photographs have a reduced dpi and are much better on screen - changing the photo to monochrome can show more detail)

Some detail can be extracted in forested areas. Clearings were plotable but this being mainly deciduous forest did not have any rides. I was able to pick out the poles for the two sets of electric cables that crossed the area.

Hameldon Hills

The Hameldon Hills map covers Pennine open moorland with complex areas of old quarrying and small areas of both deciduous and coniferous woodland. The project compared the PG plot used for mapping with LiDAR terrain data, Geo-perspectives terrain and surface data.

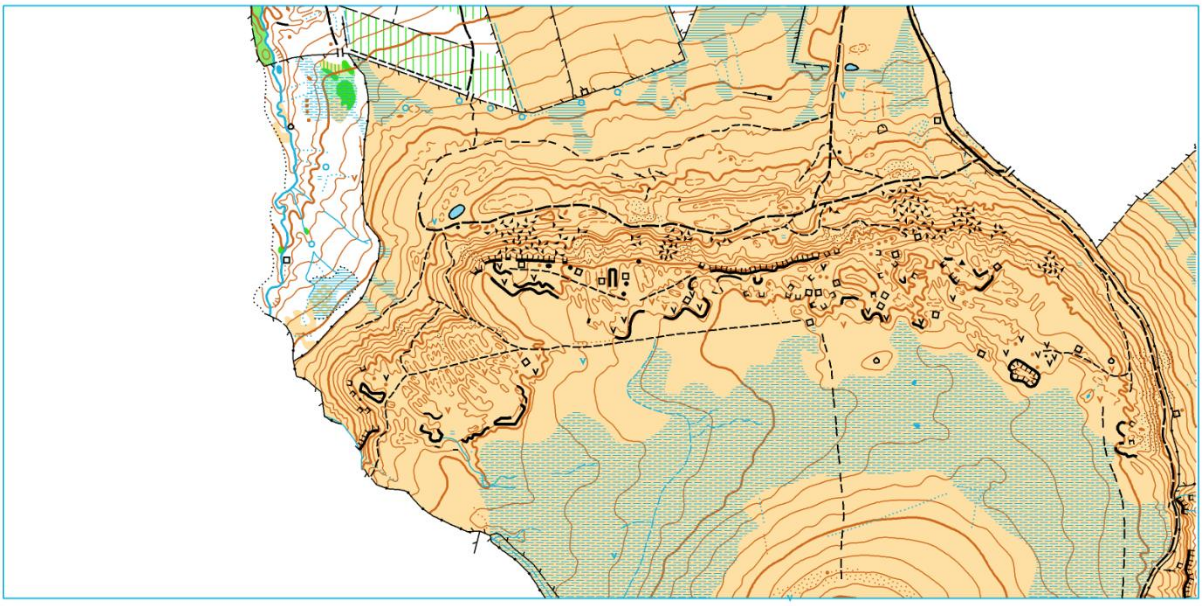


Figure 10 - Hameldon orienteering map extract

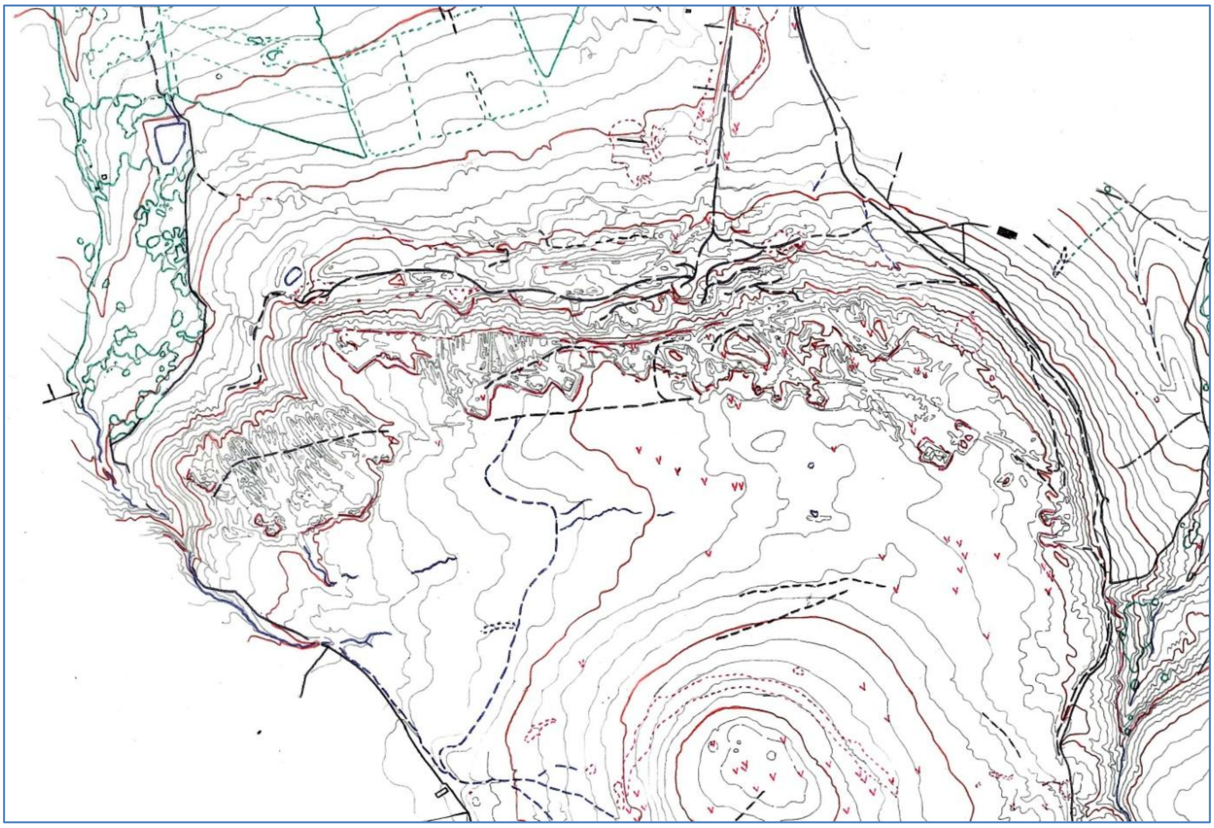


Figure 11 - Hameldon PG Plot

Advantages: identifies water features (streams), point features, vegetation boundaries ...
Disadvantages: contour detail in wooded areas not fit for purpose, availability, cost

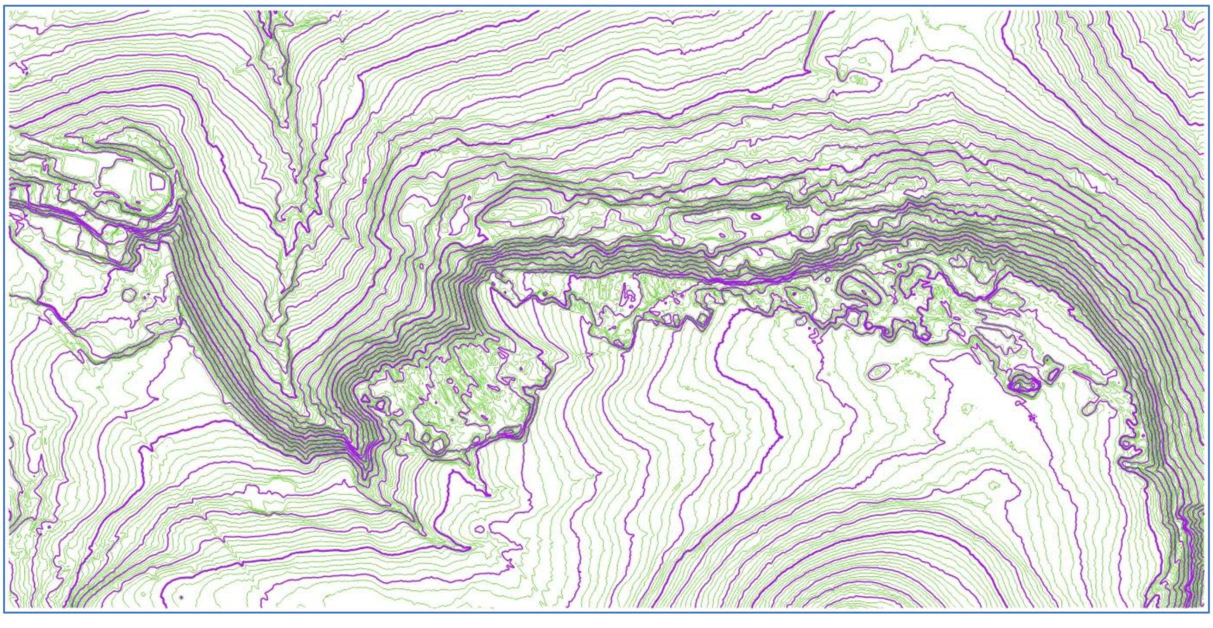


Figure 12 - LiDAR 2m DTM data - OCAD derived contours at 1m and 5m intervals

Advantages: Accurate contour detail both in open and forest areas.

Disadvantages: Cost - up to £100 per sq km

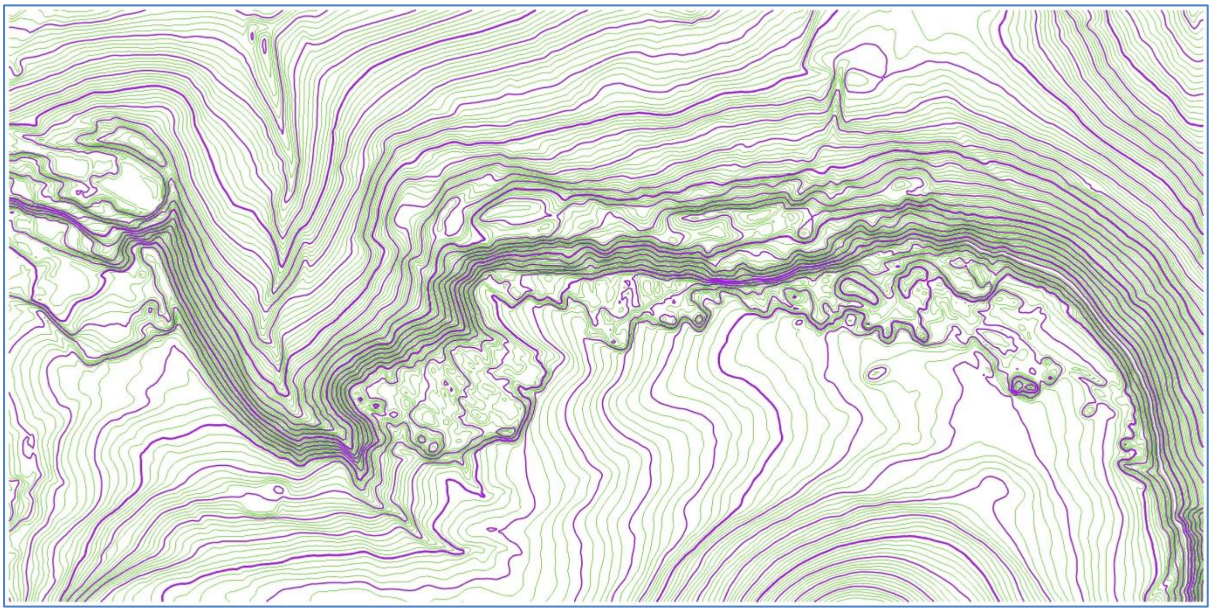


Figure 13 - GeoPerspectives 5m Digital Terrain data - OCAD derived contours at 1m and 5m intervals

Advantages: Accurate contour detail in open areas, sufficient for purpose. Cost: £10 per sq km.

Disadvantages: contour detail in wooded areas not fit for purpose.

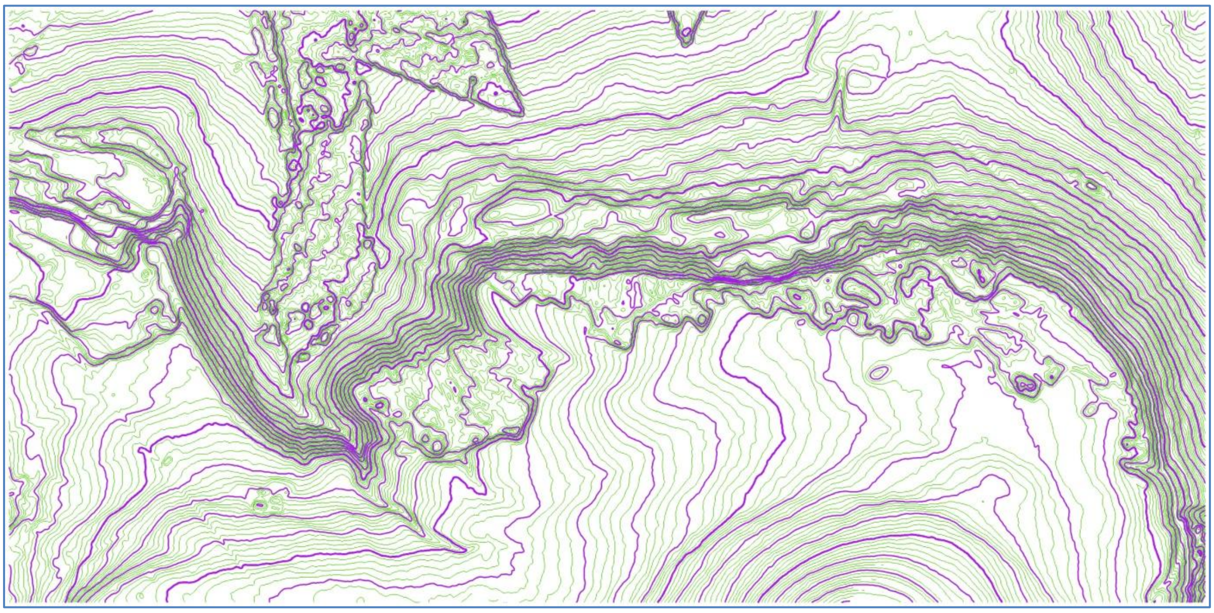


Figure 14 - GeoPerspectives 2m Digital Surface Data - OCAD derived contours at 1m and 5m intervals

Advantages: Accurate contour detail in open areas, sufficient for purpose. Note that Hameldon only has deep tussock grass, there remains a question whether the data is affected by other ground vegetation such as deep heather.

Disadvantages: Contour detail in wooded areas represents vegetation canopy.

Cost: £35 per sq km.

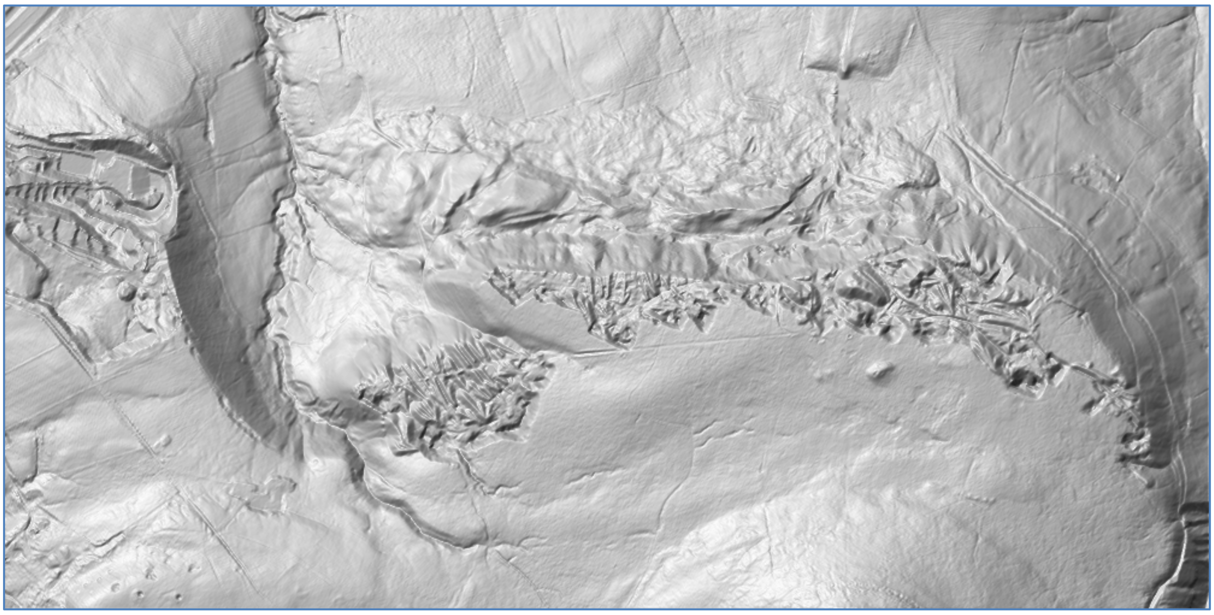


Figure 15 - LiDAR 2m DTM - OCAD derived hill shading

Advantages: By adjusting the angle and direction it is possible to pick out small features such as paths and gullies.

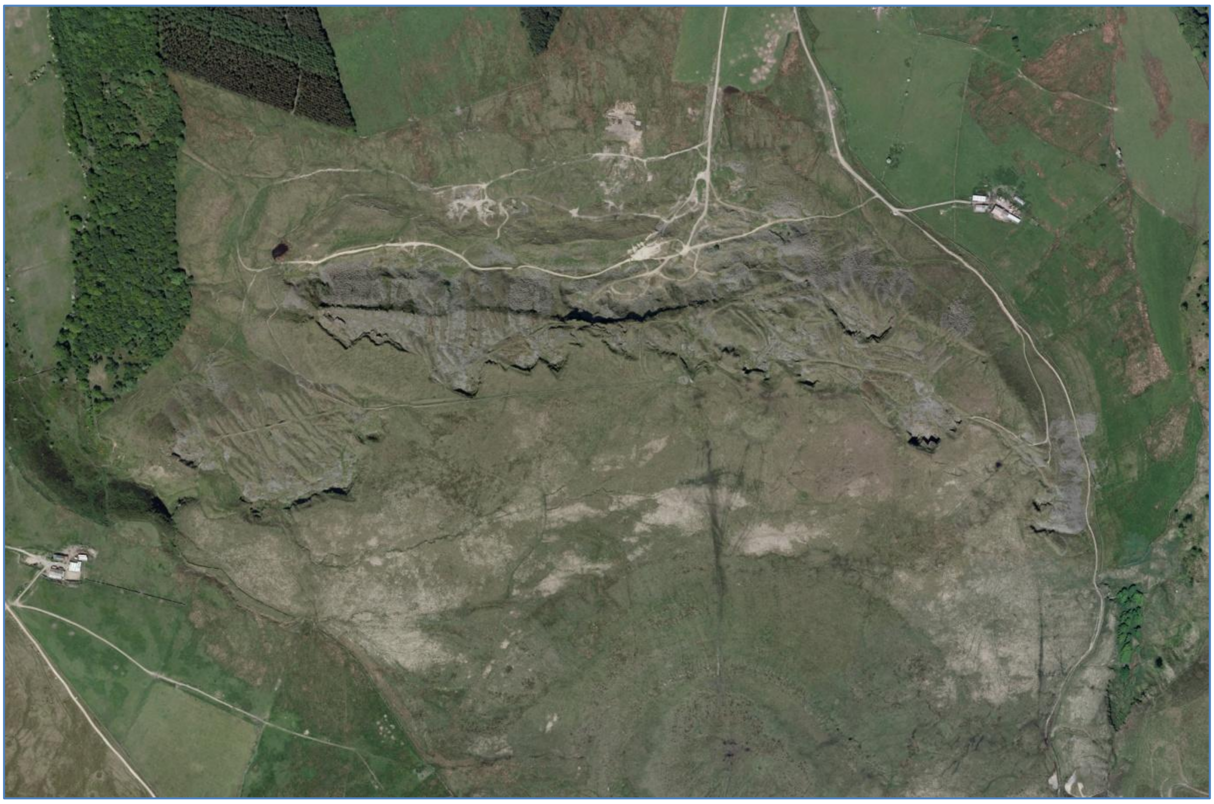
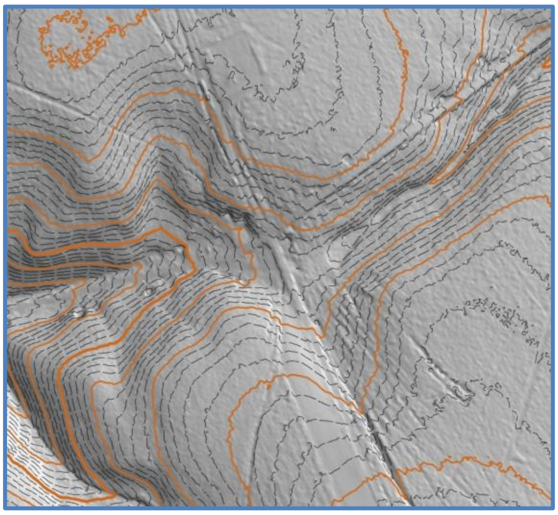


Figure 16 - 25 cm resolution air photograph

Advantages: geo-referenced TIFF files require no re-alignment when used as background in OCAD. High resolution shows great detail in open areas. Limited value in forest areas although vegetation boundaries, rides and similar may be clear. Cost: £35 per sq km

Cannock

Example of LiDAR in coniferous area (Dave Peel)



LiDAR at Cannock Chase

I used 4 tiles of 2m resolution data at 1m contour interval. The area included a mix of coniferous woodland, ranging from young trees to mature woodland, small areas of deciduous woodland, and a few pockets of open moorland.

Across the whole area the data gave a near perfect impression of the ground. It was possible to distinguish minor features including earth walls (formerly banks of rootstocks which had rotted down to less than 1m) and ditches. The area included a couple of small quarries which again were clearly indentified from the data. It would be possible to use the data unchanged for a near perfect contour only map. However as the final map required a 5m contour interval (necessary due to high difference across the area), it was not a simple case of selecting the 5m contours for the final map. These give a perfect height representation but alone did not give a good picture of the ground and needed to be altered in many areas to represent the subtle but significant ground shape that could be distinguished by the 1m contours. A good example was the small quarries which needed careful manipulation of the contours to represent the significant breaks in slope and small spur, re-entrants and knolls, which often happened to fall between 5m contours. I also found that there is a danger that one could easily add in far too many form lines.

An interesting bi-product of all this data is that it could be used to accurately map the route of the many twisting mtb trails which snaked through the area. Their exact location couldn't be seen in the data but their route could be tied to the subtle changes in slope, the minor earth walls and ditches reducing significantly the need for distance and direction measurement. This made, what is often laborious mapping, simple and pleasurable.

Sutton Park

OCAD 11 has the ability to calculate the difference between surface and terrain DEM and data, which in effect shows the vegetation height with various options available to adjust the results. The following example is of part of Sutton Park.

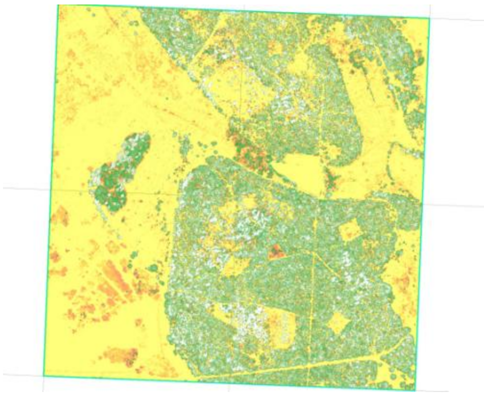


Figure 17 - Classification of vegetation height

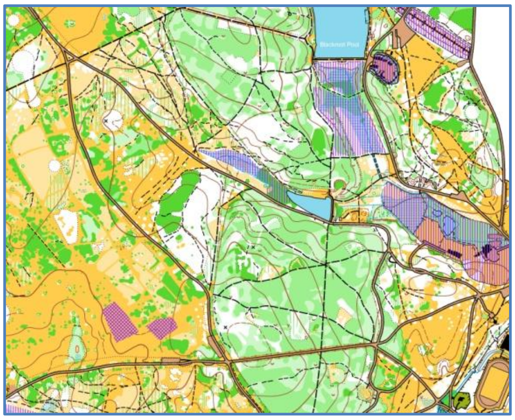


Figure 18 - The O map for comparison

Note that several areas of runnable woodland are shown the same as open areas in this example.

Sherwood Forest: Use of infra-red air photos

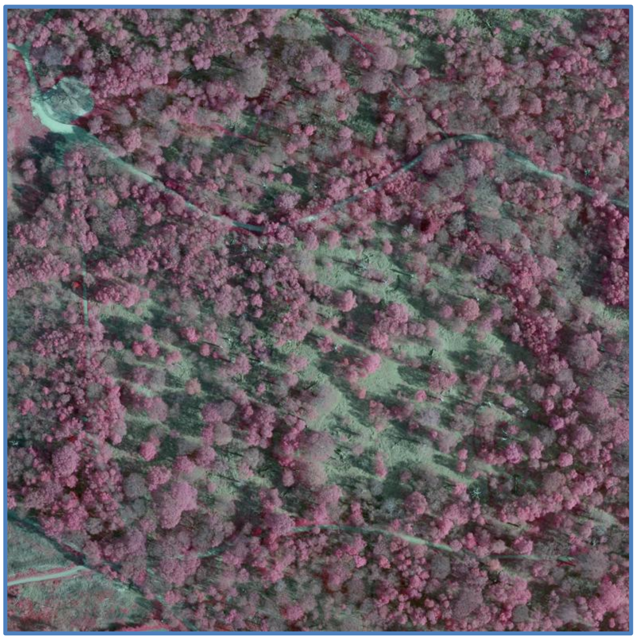


Figure 19 - Infra-red geo-referenced air photo

Infra-red air-photos of broad-leaved woodland can be useful to identify clearings. The success of this is to an extent dependent on the ground vegetation, in this case the clearings are short grass or bare earth. As with all other areas the mapper has to be careful to generalise and not over-map the detail but it can save ground survey time. Cost is £35 per sq.km.

Stanton: LiDAR - a cautionary example

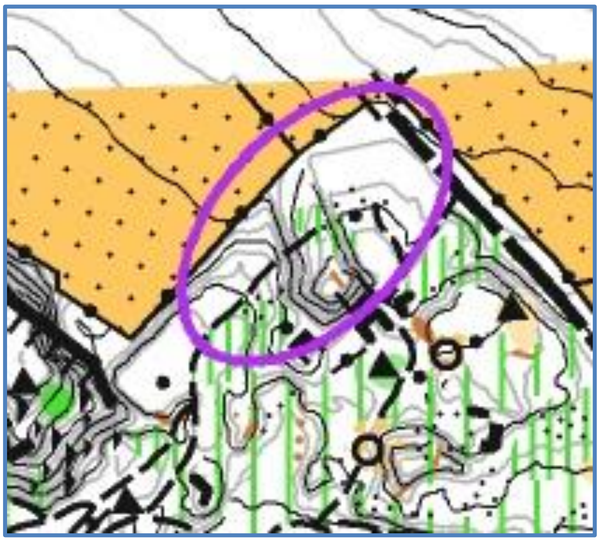


Figure 20 - LiDAR contours of a quarry area

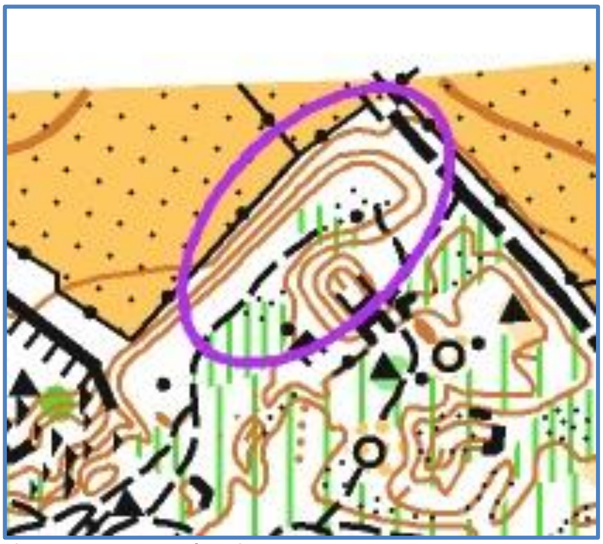


Figure 21 - O map showing spur

The LiDAR generated contours of the area circled show a re-entrant running South East into a large depression. In reality there is a spur running SW to NE as in figure 20 above.

It appears that the LiDAR data is at fault rather than the OCAD contour conversion. There is a similar anomaly close by and both are near to the edge of the flight plot. However the rest of the data was accurate and worthwhile.

This shows the absolute necessity to check any derived information with ground survey.

Hugset

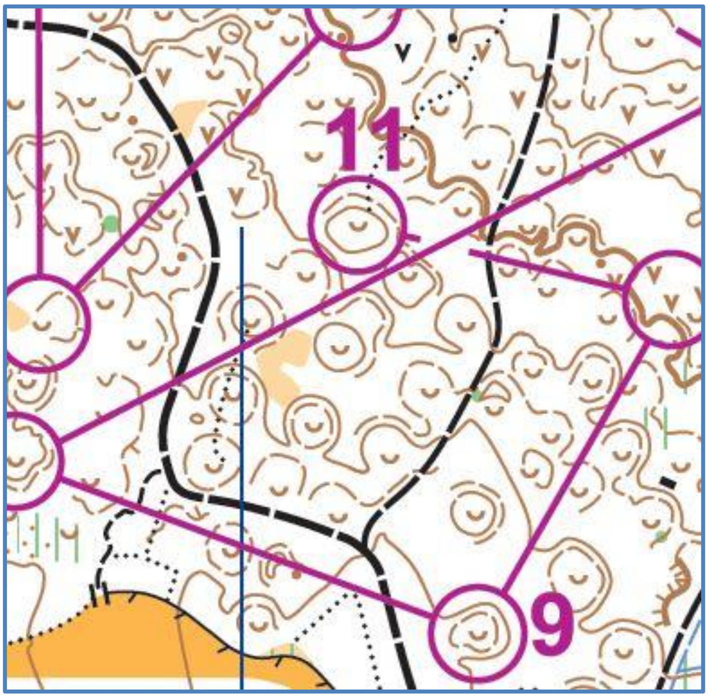


Figure 22: Hugset, courtesy SYO and Bruce Bryant.

An example of the final product is this extract of Hugset, an old, complex mining area covered by woodland.

Good Practice Guide - LiDAR

Is LiDAR the most suitable product?

LiDAR is most cost effective when used for wooded areas with contour detail. It is suggested that Digital Terrain Data 5m such as GeoPerspectives is acceptable and cost effective for open areas such as moorland and open parkland.

Which resolution do I get?

2 metre interval ASCII grid DTM data is fine for getting the general ground shape and the absolute / relative height of features. Larger contour details should be OK but fine detail will be missed.

1 metre interval ASCII grid DTM data will get most contour features but may still miss small point features (knolls / depressions) and narrow linear features (ditches) particularly if under tree cover. Should be used for intricate contoured areas.

0.5 metre interval ASCII grid DTM data will capture almost all relief features and could be used for very intricate contoured areas (if available). Note that this data is available as 500m squares so can be an economical option if only a small area is required at this resolution or for strange shaped areas.

It is also worth noting that the density of tree cover will add noise to the data. With denser tree cover the purchase of higher resolution data is probably of little benefit. Very dense tree or undergrowth may affect the contours produced if they prevent the LiDAR from reaching the ground.

Note that OCAD 10 cannot handle sub 1m ASCII grid data. It will need to be converted to XYZ data for OCAD to use it.

The DTM data can be used to create contours within OCAD and by default will produce 25m index contours, 5m contours and a 1m sub-contour interval.

The data can also then be used to create hill shaded images (create with the light from different directions). This is useful to interpret the shape of small linear or contour features which cannot be easily seen within the contours.

How do I smooth the contours?

Calculate contours selecting the appropriate new symbol.

Note that the new contours are placed according to their real world values. That is the 90 metre and 95 metre contours are shown as DEM 5m symbols and the DEM 25 metre contour appears on the 100 metre line. This cannot be changed. So if the placing of the contour is required on a DEM 1metre line these would need to be changed manually in OCAD.

The contours are generated as OCAD freehand lines and it may be preferable to select and turn to curves to reduce the file size and simplify the lines (particularly where 1m ad 0.5 m source files are used) as below:

Good practice: duplicate contour symbol (DEM 5m) and edit to purple 1.12 mm, duplicate index contour symbol (DEM 25m) and edit to red 1.15mm contour, duplicate contour symbol (DEM 1m) and edit to grey 1.0 mm

Hide the exiting contours, index contours and form lines (F4)

Alternatively OCAD 11 has different levels of smoothing:

Setting the "change to Bezier curve" tolerance to 0.20 gives the same results as the OCAD 10 level 2 smooth. Depending on the level of "noise" in the data it should be possible to tweak this level up or down a bit to get the required results with the minimum of redrawing afterwards.

The contours that result from a DEM file will be exactly the same regardless of map scale. The Bezier smoothing in OCAD appears to be determined by a distance value so results will vary with map scale. Smoothing level 2 seems to be the optimum at 1:10000. At 1:15000 smoothing level 1 is possibly more appropriate? This is where the variable settings of OCAD 11 may come in useful.

What do I do if DEM is only available for part of an area?

If LiDAR is available for part of an area and GeoPerspectives terrain data for the remainder, then the latter may be more accurate than usual under the tree canopy as it could have used the LiDAR as a starting point.

Is there anything else I should look out for?

LiDAR contours are unreliable in very flat, level areas (see figures 2-4), typically the generated contour wanders around the flat area, is irrelevant to the orienteer and will need to be simplified. Exceptionally the data can be wrong, it is essential to check on the ground.

What about DSM Data?

DSM data may be of use for the mapping of areas with either scattered individual bushes / trees and buildings - many ISSOM mapped area would be typical. It may also be useful to show rides / vegetation boundaries and clearings within forested areas. The DSM data is best used by creating a coloured hypsometric image which is then combined within OCAD with a hill shading image. This results in an image similar to those on the Geostore website.

DSM images are similar to air photographs but have an advantage that there are no shadows if the ASCII data is used to generate the image.

OCAD 11 has the ability to calculate the difference between surface and terrain DEM and data, which in effect shows the vegetation height with various options available to adjust the results. See the example for Sutton Park above.

What about hill shading?

OCAD can generate hill shading from the DTM data and the resulting TIFF images that are produced as background images in the OCAD file may show additional ground detail such as gullies that are not clear from the generated contours. The hill shading tool can be set for any angle and it is suggested that several angles are tried as, for example a feature running at the same angle to the light source may not show up but is likely to when at 90 degrees to the source.

Note that hill shading must not be used for the competition map. Our perception is always that the light source is from the top. Turning the map around as in competition would result in a reversal of up and down.

Acknowledgements

British Orienteering and the Development Committee for encouragement and funding, in particular Ed Nicholas and Dave Peel.

Ralph Coleman at Bluesky World for initial advice and demonstrations.

George Crawford-Smith PFO for use of Hameldon as an example area.

Mike Godfree DVO for use of Stanton Moor as an example area.

Devon Orienteering Club - part funding for Virtuous Lady

Nottinghamshire Orienteering Club - part funding for Bramcote

Last but not least, Rod Postlethwaite, Bruce Bryant and Robert Dove of the late British Orienteering Map Group for much of the input and comments.