



Working with LiDAR data – a guide for CLASP members

Advantages:

- can view subtle landscape changes;
- high-resolution feature detection (elevations are accurate to within 5-10cm);
- extensive coverage of UK now made freely available by UK government (based on flood-plain surveys carried out in recent years on behalf of the Environment Agency)

Features:

- can detect field patterns, architecture and other archaeological features not visible on aerial photographs;
- very high resolution data (5-10cm), can detect features not visible on satellite images;
- possible to move the position of the sun all around the compass and at varying elevations in the sky, so that features can be examined in shadow-relief from all sides

Accessibility:

- <http://www.geoeye.com/CorpSite/products/products/mjharden/lidar.aspx> (US projects);
- <http://environment.data.gov.uk/ds/survey/index.jsp#/download?grid=SP57> (UK)

Cost:

- The UK data is freely downloadable from the above Environment Agency site.

1. General introduction to LiDAR and its uses

LIDAR (“Light Detection And Ranging”) is similar in concept to RADAR, but using visible light instead of sound-waves to map the land surface. It provides extremely high-resolution detail on features at ground level. The detail provided by such images is unparalleled and will open up many new avenues for archaeological research, perhaps allowing for detailed mapping that, until this point, has been limited to aerial photographs, ground penetrating radar and magnetometry.

LIDAR imagery has helped archaeologists in many ways, most specifically in allowing them to map with high accuracy in a time efficient manner:

- In a 2001 study on Stonehenge, LIDAR data helped archaeologists to make locational corrections to known sites (with an accuracy of 15 cm), detect new sites, including field systems, cross banks and slight earthworks, digitally eliminate surface features (trees and buildings) to create digital terrain models, and examine topographic relationships.
- In the Vale of Pickering, the team found that an absence of crop marks was not the same thing as an absence of archaeological features, and many additional features were found using LIDAR.
- In the Loughcrew region of Ireland, LIDAR aided archaeologists in identifying previously unknown archaeological features.

Using LIDAR, archaeologists can create either a digital terrain model or a 3D visualisation of landscapes. One test of LIDAR data occurred in the River Trent regions in the English Midlands for the Rivers Ouse, and Foss in the Vale of York, North Yorkshire and River Witham in Lincolnshire. The archaeological team wanted to test the utility of LIDAR data in an alluviated landscape to examine geomorphological developments and to model past flooding. Combining the LIDAR data with aerial photographs allowed for comparative data analysis. The LIDAR system was connected to a differential GPS system, allowing for ease of data reconstruction. LIDAR data allowed the team to examine how humans had modified the overall landscape. Terraces appeared clearly, along with past creek ridges. The team also found that peat deposits had once covered the entire landscape, and that palaeochannels had higher soil moisture and additional organic debris. Future applications with LIDAR might take place in landscapes where features are only marginally different than surrounding landscape, or in areas where aggregate extraction, housing,



2. Downloading the LiDAR data

The UK Environment Agency site provides the data as free ZIP-file downloads:

- Each ZIP-file covers a 10km x 10km area of the OS grid.
- Each ZIP-file contains 100 ASCII text-files – each of which contains the data for 1sq.km of land.
- The data within each ASCII file consists of a header file defining a 1000x1000 grid (ie 1 item of data for each square metre of the land surface), followed by 1 million items of elevation data (ie the average elevation of each sq.m. of the land within that square km).
- Two types of ZIP-file are provided – the DTM (digital terrain model) and the DSM (digital surface model):
 - The DTM is the view of the “top” surface (ie the first reflection of the incident light-waves), including tops of trees and hedges/bushes/etc.
 - The DSM (which is the final reflection of the light waves, from the ground surface) strips away all the vegetation, and provides a “cleaned” view of the land surface itself – very useful when examining objects in woodland, for example!
- Each 10km x 10km ZIP-file typically contains 50-100Mb of data, so you will need to have adequate storage space available in which to archive it.

3. Viewing and analysing the LiDAR data

A software viewer is required in order to examine and play with the LiDAR data. The best software that we have found so far is the program “Global Mapper”, which is manufactured by Blue Marble Geographics (<http://www.bluemarblegeo.com/products/global-mapper.php>).

The software can be downloaded and used without cost – but in the free version its functionality is limited. In order to gain access to the full functionality you need to purchase and register the software (at a basic cost of about £485 incl VAT). However, the freebie limited-function version of the software is still quite powerful enough to provide CLASP with a very useful tool for landscape analysis.

CLASP Trustees are currently evaluating whether it will be cost-effective to buy a license to gain the full functionality of this tool.

4. Using “Global Mapper” – limitations, and work-around solutions

Two of the main limitations of the free version of the software are:

- You can only open a maximum of 4 files at a time.
- You can save your work (as a Workspace file, similar to MapInfo), but you cannot load a saved file unless you pay the money and license the product.

These limitations might seem pretty basic – but there is a simple way to get around the 4-file limitation, as Global Mapper does allow you to import a ZIP-file as a single file (and this ZIP-file can contain any number of separate files). So, all you need to do is create a ZIP-file and place all the files that you want to open into the ZIP-file, and then import the ZIP-file into Global Mapper. Easy!

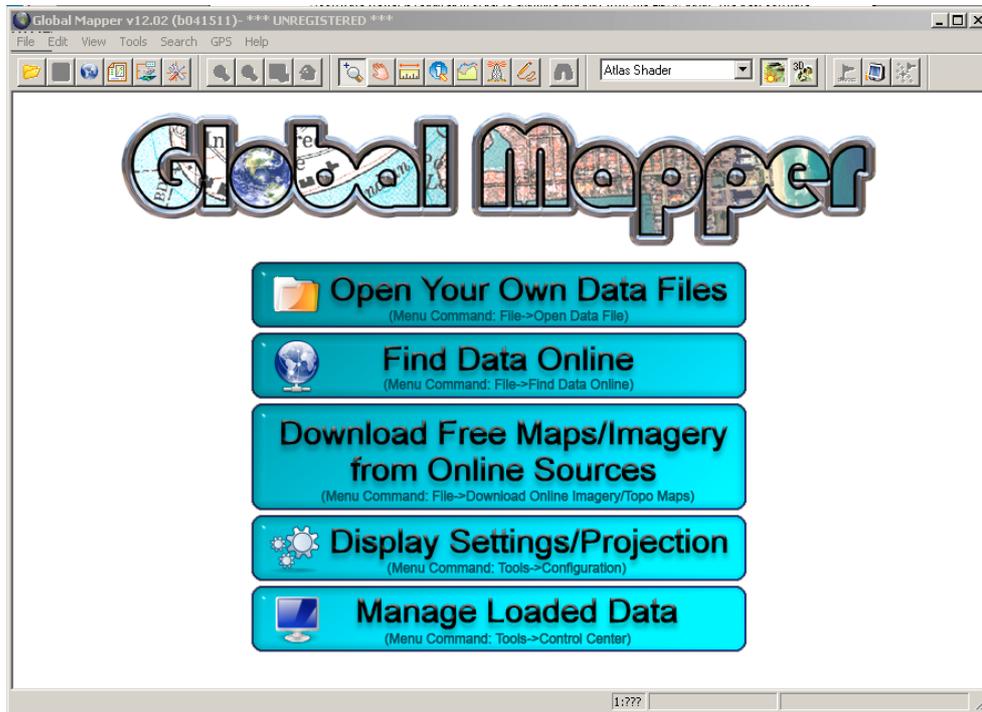
Global Mapper can recognise and open a huge range of different file-types – including MapInfo TAB files, BMP/JPG/PNG bitmaps and many more. This means that anything that we have already done in MapInfo can be easily loaded into Global Mapper and explored and analysed.

The reverse is NOT true – that is, LiDAR files from Global Mapper cannot be loaded into MapInfo. Therefore, if we want to examine data in 3D, such as geophysics plots against a 3D LiDAR data-set, we cannot use MapInfo and must use Global Mapper.

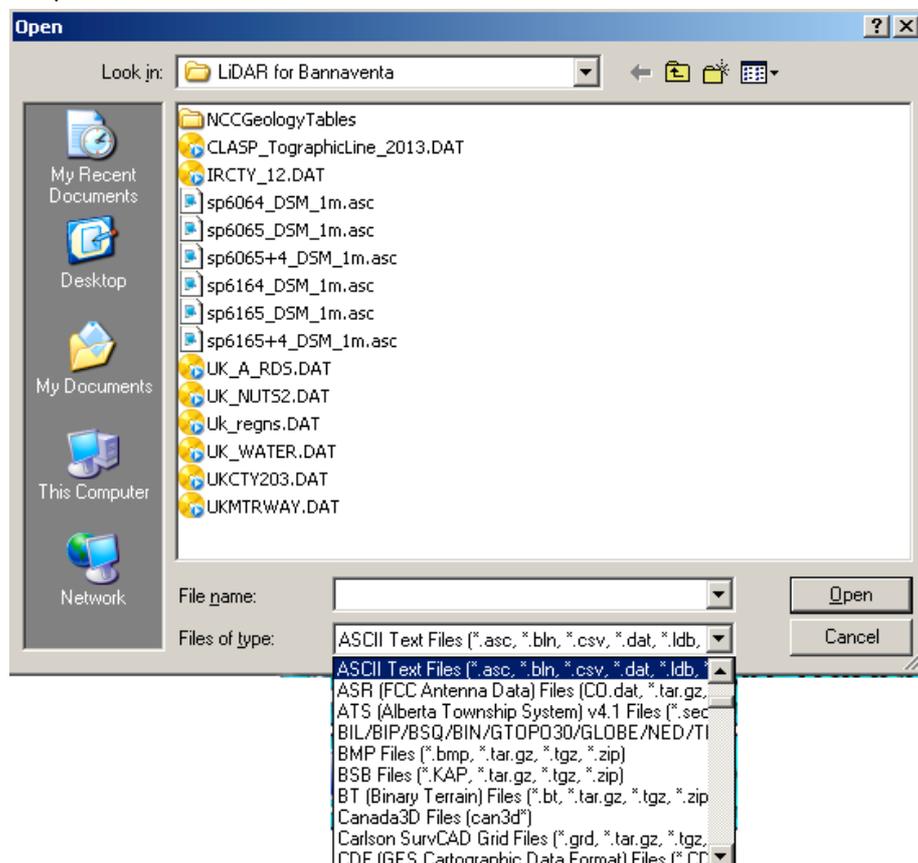


5. Exploring the basic functions of “Global Mapper”

The initial start-up screen is pretty self-explanatory:

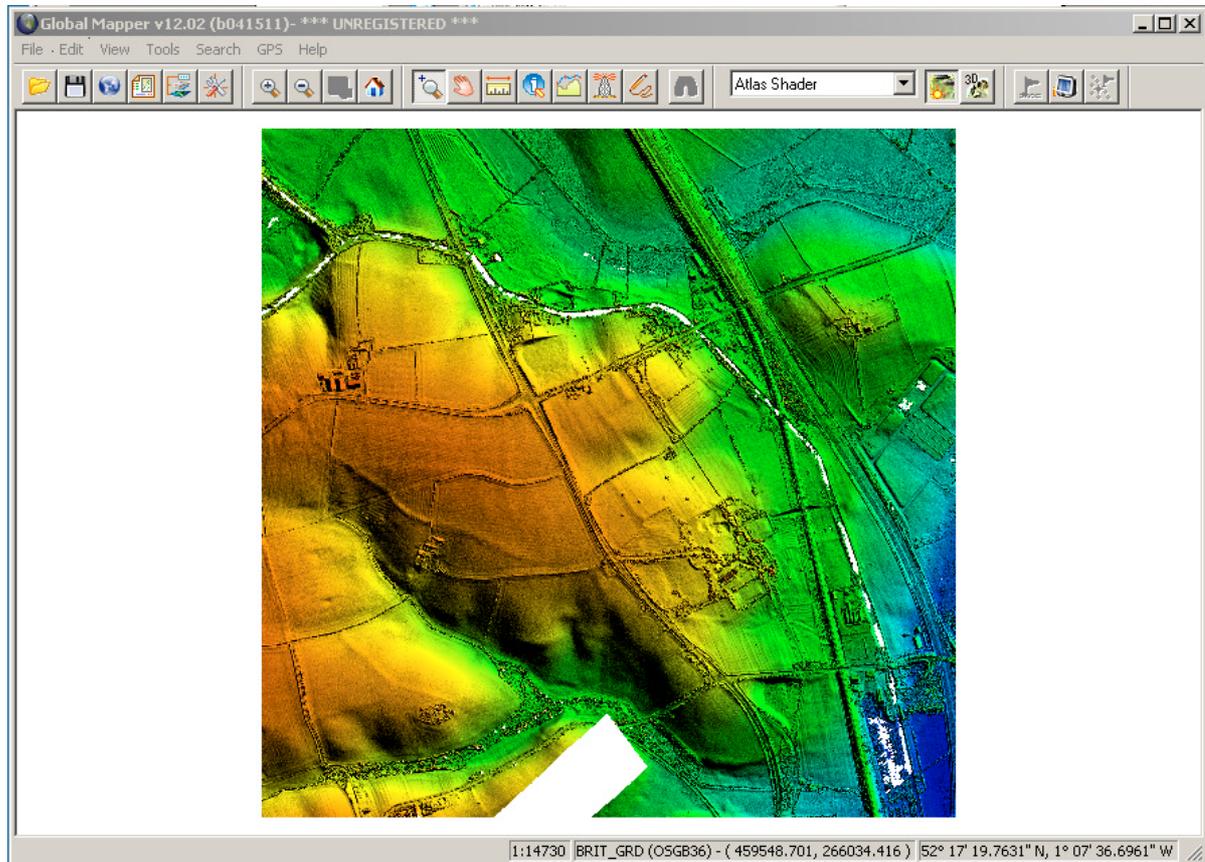


The first of these options – “Open your own data files” – is the only option that you will use. It opens a pop-up window from which you can select the type of file to open, and its location in your computer:





Here's a view of Global Mapper with 4 ASCII files loaded, containing the LiDAR data for 4 sq.km of land in and around the Bannaventa site:



First familiarise yourself with the most basic tools on the toolbar:

- **Zoom control** – select the magnifying glass icon on the toolbar, then use left and right mouse buttons to zoom in and out, or use the mouse to draw a box around the area to which you want to zoom.
- **Pan/shift control** – select the hand icon on the toolbar -- to move around the zoomed view

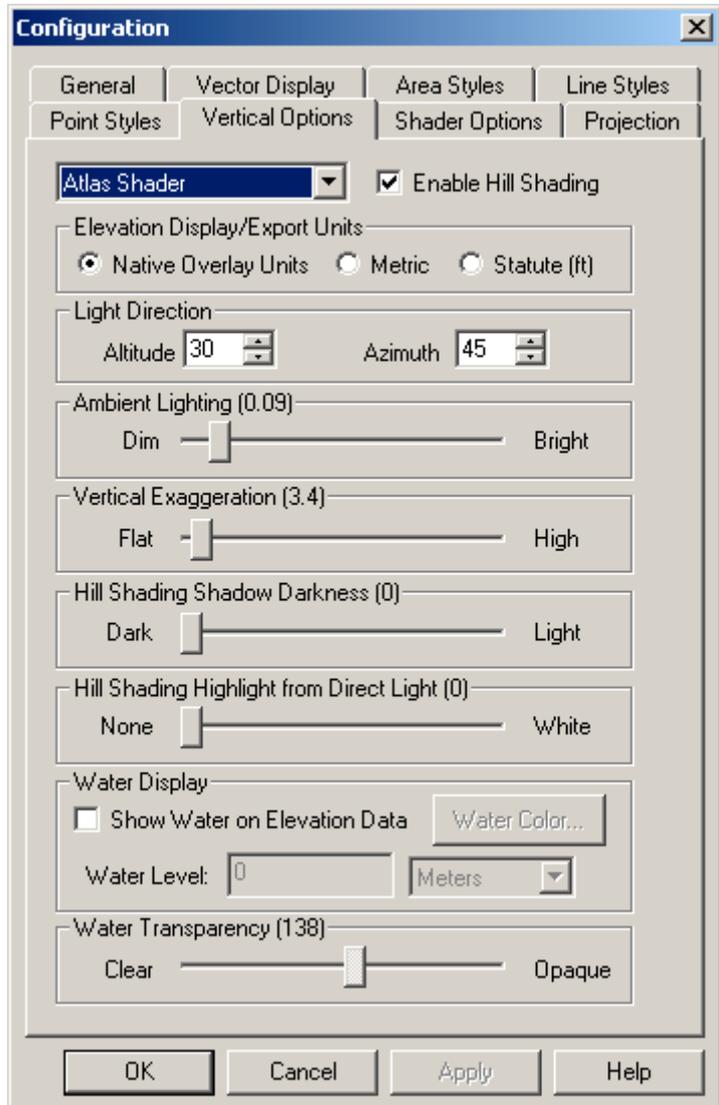
Next, familiarise yourself with some other important controls that are accessed from the drop-down File Menu above the toolbar:

- **File>Control Center** – this displays a pop-up screen in which you can see all the separate files that are currently loaded (it's just like the "Layers" control in MapInfo, except that it operates in reverse – ie the file at the bottom of the Global Mapper list is the one that is drawn last and therefore appears above the other files; with MapInfo, it's the file on top of the list that is drawn on top of the other files). You can use this pop-up screen to shift the relative positions of the loaded files by using the up/down arrows, and to make any of the files visible or invisible by toggling the tick-box against the filename in the list.
- **File>Control Center>Options** – if you have loaded some bitmap files (such as geophys plots, for instance), select a bitmap file in the Control Center list, click the Options button, then tick the "Texture Map" box in the sub-menu – this will "drape" the selected bitmap file on top of the 3D LiDAR map. This will allow you, for example, to investigate 3D aspects of your geophysics plot, by varying the altitude and azimuth angles of the incident lighting.
- **File>Configure** – this opens another pop-up window which gives you access to loads of useful controls, of which the most useful are:



- **Adjust sun’s position (altitude and azimuth)** – it is essential to view the landscape with several different settings for the sun’s position, as some features may only be visible with light incident from a specific direction.
- **Vertical scale exaggeration** – helpful when trying to view fine details. A setting of about 3-5 is sufficient exaggeration to reveal fine details without distorting the view too much.
- **Insert an artificial sheet of water** – tick the box “Show water on elevation data” and enter a value for the elevation at which you want the sheet of water to appear -- useful for understanding which landscape features lie at the same level, for instance. You can also vary the transparency of the sheet of water that you have inserted.

It’s best to explore these features for yourself, you will find them very easy and intuitive.



6. Some other useful functions of Global Mapper

The icon toolbar contains 4 more extremely useful tools, all of which are available in the unlicensed “free” version of the software:



- Measure distances and areas (“Ruler” icon, on far left in the selected blue rectangle above)
- Draw a cross-section profile across a line through the 3D landscape (on right of the “i” icon)
- Add features and comments in a separate layer (or layers), by using the Editing controls (far right in the above blue rectangle).
- Show information about the item under the mouse cursor (“i” icon, next to the Ruler icon)

We will now look at each of these powerful functions in turn.



6.1 Measuring distances and areas

Click on the "Ruler" icon.

Now you can use the mouse's left button to draw either a line (and the length of the line will be shown in the status bar at bottom of the screen) or a polygon (and the area enclosed by the polygon will be shown in the status bar at bottom of the screen).

The drawing is terminated when you click the mouse right button and select the option "Stop drawing".

If you start drawing a new line or polygon, the previous one will be deleted.

These tools operate in a very similar way to the measurement tools in MapInfo, and are very user-friendly and intuitive.

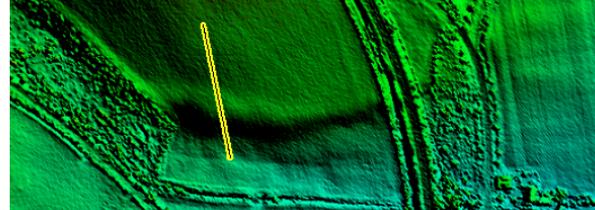
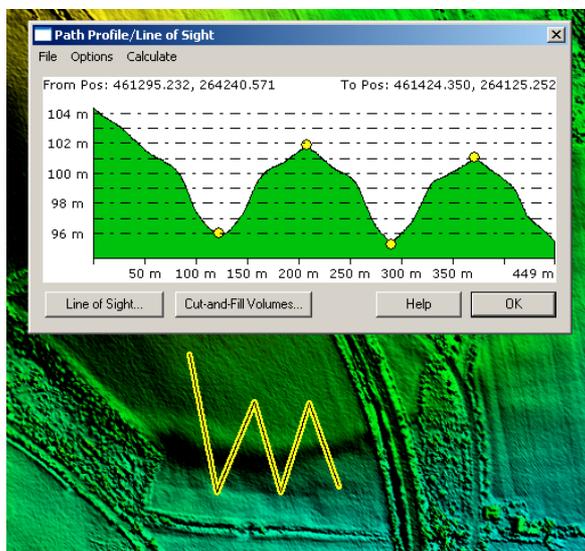
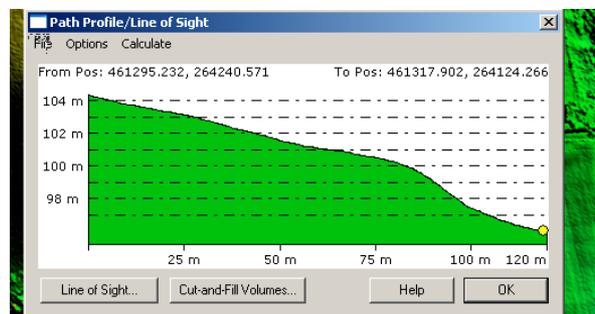


6.2 Drawing a cross-section profile across a line through the 3D landscape

This tool is extremely useful; it allows you to cut a slice through the landscape and view the profile in a pop-up box.

Click on the "Path Profile" icon.

Now you can use the mouse's left button to draw either a single line or a series of lines, to reveal the cross-section, as illustrated in the two screen-shots alongside. Clicking the right



mouse button terminates the line (or lines that) you have drawn, and launches the pop-up box showing the profile.

If you have drawn a line with several sections (for example, to cross a specific feature multiple times), the profile will show each section of your line. This option is useful if you want to examine how a landscape feature varies along its length.



6.3 Add features and comments in a separate layer using the Editing controls

Click on the “Editing” icon (looks like a pencil).

This will open a whole new row of editing options, allowing you to draw a line, an open shape or a closed shape (rectangle or freeform polygon), etc.



Choose the type of line that you want to draw, by selecting the appropriate icon from the sub-menu.

Then start drawing with the left mouse button, and press the right mouse button when you want to terminate your drawing.

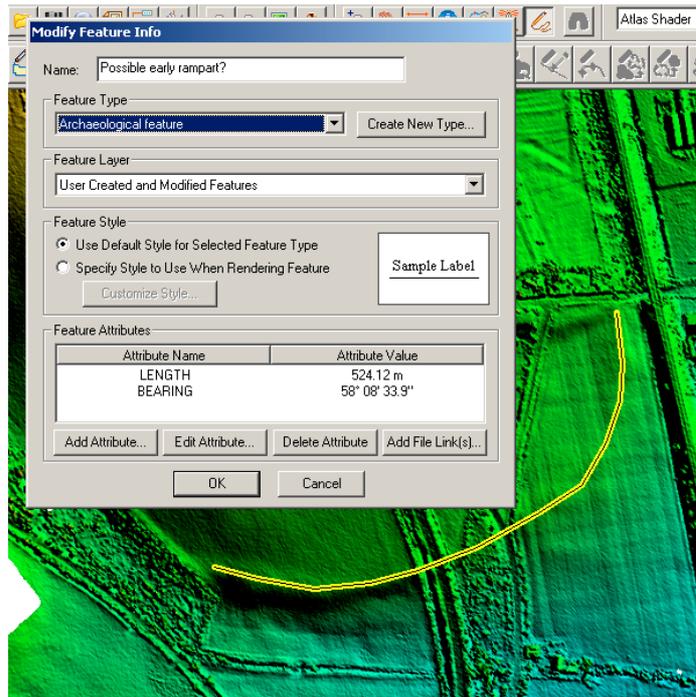
A pop-up box will now appear, in which you can enter descriptive details about the feature that you have drawn.

You can also customise the colour and thickness of the line, the font type and size and colour of the text that appears on the screen alongside the feature.

All these details will be saved to a separate layer in the Control Center, so that you can choose whether to reveal or hide the feature that you have drawn.

This set of tools is very powerful, so you should spend some time experimenting with the features.

You can create any number of edited features and comments, and they will all be visible on screen, along with your chosen title text



6.4 Show information about the item under the mouse cursor

Select the “i” icon.

Now, when you left-click the mouse over a feature, a pop-up box appears containing the details that you have specified for that feature. You can edit the details – for instance, to change the description, alter the line colour or thickness, modify the font type and colour, change the type of the features (eg from “Unspecified feature” to “Archaeological feature”), etc.

