Geographic Information in Forensic Investigation

Other important aspects that Dr. Horsfall took into consideration are visibility analysis, the shadow problem, the third dimension and beyond. See the web version and download the full article.

Dr John Horsfall of Hawkins, is a scientist who specialises in Accident Investigation. In this article he looks at how the increasing availability of high quality geographic data and the computing tools to use it is proving invaluable in Forensic Investigation.

Hawkins is one of the few organisations in the world with expertise in Forensic Geology. Traces of soil from vehicles or shoes can be analysed to establish their origin. The relative abundances of fossilised micro-organisms (micropalaeontology) can show very accurately where a soil sample originated.

For example, in the Soham Murder Enquiry, we were appointed by the Police to assist with finding the precise origin of soil deposits found on the underside of Ian Huntley's car. Mineralogical and micropalaeontological analysis of the soil together with detailed study of geological maps by Dr Andrew Moncrieff, Forensic Geologist, enabled the general area of outcropping from where the soil in question originated to be identified, but not in sufficient detail for precise determination. High resolution vertical aerial photography of the area showed the local surface geology relative to paths and tracks and assisted greatly in the rapid collection of soil samples which were then analysed and compared with samples collected from the car.

Forensic geology also has a role in fraud investigation. We have dealt with several road accidents where analysis of trapped soil deposits has shown that the crash happened far away (in one case over 2000 miles away) from where the owner had claimed. That can be very important if the car was not insured for the place where the accident actually occurred.

Road traffic accident analysis

A significant proportion of our work is in the analysis of road accidents both for Criminal and Civil cases. Whilst in a Criminal case the only parties are usually the Prosecution and the Defence, there can be many parties to Civil litigation. These are the people making a claim (the 'Claimant' or in Scotland the 'Pursuer') and quite often several 'Defendants' ('Defenders' in Scotland) including sometimes the Highway Authority responsible for the road, public utilities who have undertaken work, manufacturers of vehicles and of course those representing the drivers involved.

Detailed forensic analysis of the recorded physical evidence followed by calculations, computer modelling and occasionally also full scale tests will usually enable a greater understanding of what is likely to have happened and the probable causes. The forensic scientist or engineer then needs to present this information in as clear a form as possible, and ultimately give evidence as an expert witness to the Court. Our in-house team dealing with road traffic accidents includes specialists in a range of disciplines including Mechanical Engineering, Physics, Metallurgy and Highway Engineering.

At the most basic level, aerial photographs and large scale mapping illustrate and provide context. However, we soon discovered in the mid 1990s that even 'straightforward' vertical aerial imagery is a valuable tool for accident analysis.

It is straightforward to overlay the information from a Police scene survey plan onto an aerial image for analysis of the accident .NOTE that the accident shown here is an imaginary example for illustration purposes and does not show an actual incident" © Copyrite Blom Pictometry 2006

Police survey data

Following fatal and serious injury road accidents in the UK, Police Collision Investigation Officers will usually make a survey of the immediate vicinity of the accident using electronic total station equipment. These surveys are detailed and accurate but can only safely be undertaken whilst the road remains closed to traffic and must be made whilst 'volatile' evidence, such as tyre marks and fluid deposits, is still available to be measured. Police surveys rarely extend far from the immediate area of debris and physical evidence. Whilst the surveys and associated photographs are prepared to assist Her Majesty's Coroners following fatal accidents and the Criminal Courts when there is a prosecution, they are also extremely valuable in Civil cases. Fortunately Police forces in the UK are happy to make plans and photographs available to those involved in Civil matters, and the fees charged by the Police help to pay for the equipment needed by their investigators.

Especially in Civil cases we need to consider factors, such as the design of the road, which usually are beyond the remit of a Police investigation. For our analysis we need to know about the road environment further from the collision itself, albeit in less detail than for the immediate impact site. Superimposition of the Police survey plan onto a high resolution vertical aerial image shows the detailed survey against a background of the scene for a sufficient distance in all relevant directions and most importantly shows further features which are not on the plan but which might nevertheless be important in the analysis. For example it will show the road layout and markings on the approach to a bend or junction where a collision occurred, as well as the collision scene itself. This is now a routine procedure in our reports.

Local topography

It is usually important to determine the speeds of vehicles, their paths and the visibility available to their drivers. However the questions can sometimes be more complex. For example whether a road flooded because of rainfall greater than the design requirement or because the drainage system was inadequately designed. Such investigations require knowledge not only of the road but also of the surrounding topography and vegetation.

Investigation of the effect of wind on vehicles requires an understanding if the interaction between larger scale wind conditions and the local topography. Aerial images and detailed height data have made these investigations not only more accurate but also quicker, and hence less expensive, to undertake.

Adding our own surveys

The aerial image and superimposed data often need to be supplemented by further measurements which we make ourselves at the scene. In Civil cases forensic investigators typically become involved for the first time months or even years after an accident and rarely have the benefit of a road being closed to traffic. It is not safe to stand in the middle of a busy road holding a survey pole. We therefore use 'reflectorless' laser instruments which can be operated from a safe position well away from traffic. Road marking lines, cat's eyes and concrete kerbstones all have ample reflection coefficient for use with the instruments. Software which enables survey measurements to be superimposed directly onto an aerial image using a pocket computer in 'real time' at the accident scene is a particularly valuable tool.

Where was the accident?

A problem we sometimes encounter is of not knowing the exact location of an accident despite having a detailed local survey plan. Whilst it is straightforward for urban accidents to be located relative to easily identifiable fixed points such as street lights, we can find that accidents on rural roads have no suitable position information. The use of GPS, preferably differential, to identify collision locations can be very helpful but is still rarely used by Police investigators despite being available with modern total station instruments. Instead we often find ourselves relying upon both vertical and oblique aerial photographs to locate any identifying features visible on the Police scene photographs. Oblique coverage of the UK (examples from BlomUrbex illustrate this article) is increasing and for those areas where it is available, has proved extremely useful. The on line availability of oblique images with measurement tools is an exciting recent development.

The future

In the last 10 years, the use of two dimensional geographic data has become routine in accident analysis work and three dimensional data has an increasing role but is not quite routine yet. It is probably fair to say that all the components are available but sometimes there is a bewildering number of data formats for different software. Most of my colleagues and I have become accustomed to working and thinking in a CAD environment, with the comfort of a familiar command line and menu structure. The programs for 3D analysis can appear harder to learn and use although once familiarity is gained they are actually no more difficult, just different.

The next major development for the geographic data industry will, in our view, be integration of information from diverse sources into a unified structure so that conventional mapping, aerial photography, remote sensing data and field measurements can all be used together. We know that this work is ongoing by many firms (we are working with one of the software companies involved) and we look forward to the wider and easier use of geographic data, not only in accident analysis but also in many other fields with similar challenges. Other important aspects that Dr. Horsfall took into consideration are such as visibility analysis, the shadow problem, the third dimension and beyond. See the web version and download the full article.

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Aerial photo with 1 metre contours superimposed from the LiDAR digital surface model data, using Global Mapper. © Copyrite Blom Pictometry 2006 © Cities Revealed