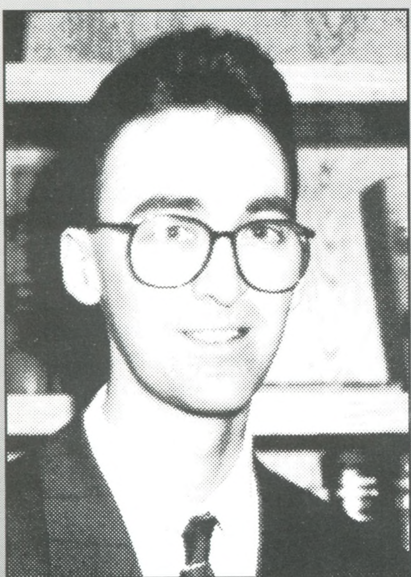


Photogrammetry in Focus
Digital Topographic Mapping

BY STEPHEN M. PERKINS, O.L.S.

For Land Surveyors and other land management professionals, the most common product produced by the photogrammetrist is topographic base mapping from aerial photography. This article will examine three specific base mapping products. All three are digitally produced, manipulated, enhanced and delivered. The three products however, are all markedly different.

The three examples are identified by the scale of the photography from which the data was extrapolated. Figure 1 depicts digital mapping from 1:15000 scale photography. This is considered medium scale mapping. This mapping is both thematic and general and yet can provide valuable planimetric and elevation data.

Small scale mapping such as that produced from 1:50000 scale photography can typically provide only coarse land use data. For the Land Surveyor, only very preliminary data can be obtained from it and therefore its discussion is not included in this article.

Figure 2 depicts digital mapping produced from 1:8000 scale photography. This is considered large scale mapping. This scale is typically used to detail urban infrastructure and accurate ground terrain. It is used in city wide mapping programs and is widely available in most large urban centers.

The final example depicted in Figure 3 is digital mapping produced from 1:2400 scale photography. This is very large scale mapping. It is highly accurate and can be used for engineering and design purposes.

All three examples depicted in this article are digitally produced. This however does not mean that the products are more or less accurate than their conventional hard copy counterparts. It does however give the owner of the data the convenience to output the data to a hard copy device at any scale. This is why I have chosen to label the data using the scale of the original aerial photography. It avoids inappropriately utilizing the data for a purpose for which it was not intended.

The fact that this is digital data does however improve the relevance and quality of the data in many ways other than accuracy. The major benefits of digital data are ease of use, flexibility, maintainability, and ease of non-graphical database association. Also, the modern computer can perform astounding mathematical feats at very high speed. This means that once laborious calculation for such information as distance, area and volume as well as complex dataset queries can be performed at the map/computer owner's leisure. The age of the digital map has enabled the data set owner to spend his or her valuable time using information from a map rather than calculating information from a map.

The particular example shown in figure 1 is mapping produced by the Ontario Ministry of Natural Resources for their Ontario Base Mapping project. The 1:15000 photograph scale is achieved through using a 152 millimetres focal length lens in conjunction with an aircraft flying height of 2300 metres. Each stereo model at this scale measures approximately 1.37 by 2.40 kilometres at ground level. Suitable for cataloguing information and detailing large land areas, this mapping is general in nature.

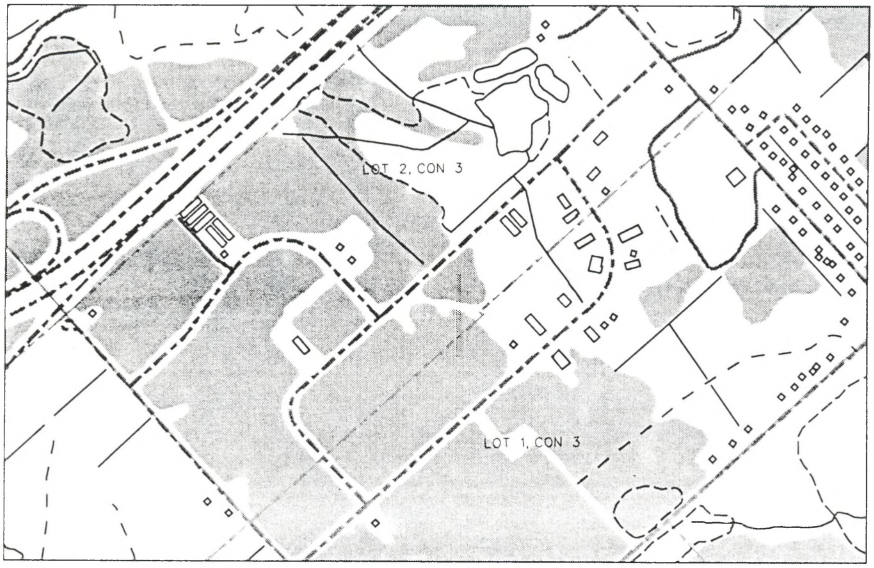
This mapping has one metre resolution. All planimetric coordinate values are represented to the nearest whole metre. The elevation values in the Digital Elevation Model (D.E.M.) however are represented to the nearest centimetre. This does not imply greater accuracy in the data, but allows for greater flexibility when modelling the elevation data. The D.E.M. file is appropriate for determining a 5 metre contour interval.

All linear and polygon elements in this digital mapping are topologically structured. That is to say, all linear elements that are continued by or closed to another mapping element use the exact same coordinate value to connect. Topological structuring is required by the various types of analysis tools offered by Geographic Information System (G.I.S.) products.

Located in the example are cultural features such as roads, trails, large

Figure 1

1:15000 Scale Photography



buildings, symbolized houses, and township lot and concession. Each different feature is 'tagged' with a coded number that is its feature code. The feature code number describes what the graphical element depicts. For example, all features that are attributed 'BR03300000', are large buildings drawn to scale.

In addition to feature codes, some elements are tagged with attribute data. For example, the township lot centroid is attributed with the lot and concession number for the lot they represent.

Vegetation, swamp, wetland and marsh areas are represented by a topologically-closed polygon. The polygon will either close upon itself or be forced to close to the mapping limits line. Each polygon has an associated centroid placed within the figure. The centroid determines the 'inside' and 'outside' of the polygon.

This mapping is generally used for planning purposes or inventory management. The photographic scale offers economical ground coverage and sufficient data capture.

Figure 2 depicts mapping from 1:8000 scale photography. Road edge data is captured instead of road centre lines and all buildings are captured as an outline of its roof rather than a symbolized square. These improvements are a result of the larger scale of photography. Using the same camera as for 1:15000 scale photography, the flying height decreases to 1200 metres above the terrain. The size of the stereo model also decreases. It has been reduced by the lower flight path to approximately 730 metres by 1280 metres at ground level.

This mapping type is usually delivered in digital files showing coordinate resolution to the nearest centimetre. Generally, contouring at 1 metre intervals is extrapolated from the stereo photography.

Information compiled from 1:8000 scale photography can yield an absolute positional accuracy of approximately 0.6 metres and absolute vertical accuracy of approximately 0.3 metres. However, these values can be greatly affected by the density and accuracy of the surveyed ground control.

In addition to the improved accuracy of the mapping product, more features are visible on the photographs. This includes individual trees, fences, sidewalks, telegraph poles, retaining walls and supplementary building features such as garages and sheds. This data can be used to catalogue built up urban area and is usually requested by cities and municipalities as a base mapping product.

The final example of digital mapping is by far the most accurate. It is appropriate for detailed engineering and construction work. It is usually requested as a fully three dimensional product. That is, all line strings in the mapping data set have continuously variable 'z' values as determined by the terrain.

The flying height above the terrain for the aircraft is approximately 370 metres and the stereo model is only 220 metres by 380 metres in dimension. Due to the low height and high relative velocity of the aircraft, a forward motion compensating camera should be used for photography. This special camera takes into account the velocity of the aircraft relative to the ground and can compensate for the motion by moving the film platent. Using this technique, very clear and detailed photography can be obtained.

With appropriate survey ground control, absolute positional accuracies of approximately 0.2 metres and absolute vertical accuracies of approximately 0.15 metres are

Figure 2

1:8000 Scale Photography

attainable. With this increase in accuracy, both the top and bottom of road side curbs can be documented.

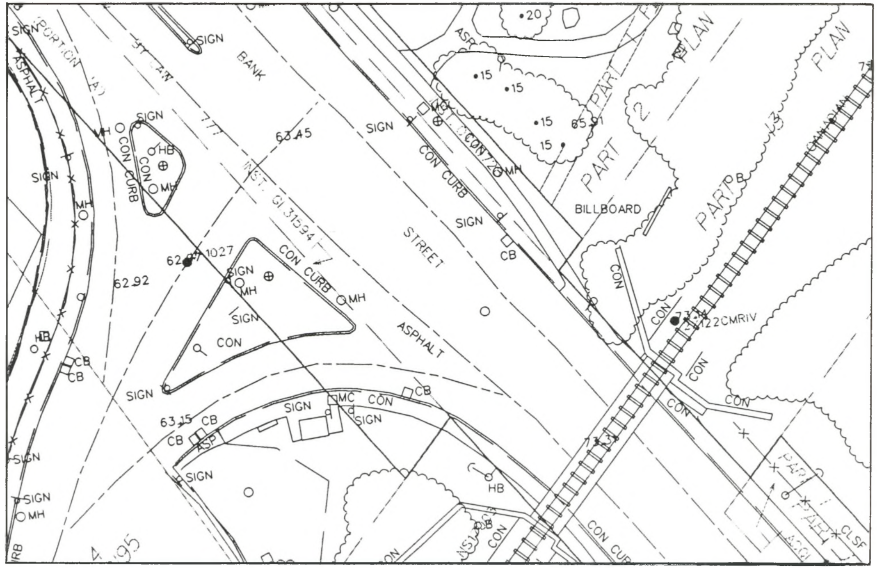
The highly detailed data captured from 1:2400 scale photography can easily be supplemented with total station survey work. The two products are easily interchangeable and can be integrated as one product. As can be seen in the example, survey work to determine property ownership has been integrated into the photogrammetric work.

The previous three examples depict varying scales of photography used to produce three different types of mapping. Each product can be used for various mapping and G.I.S. activities. Care should be taken however, not to use data for a purpose that it was not originally intended.

Computers, and the digital mapping that they can manipulate, are to be used as a tool to accomplish a certain task. Each scale of photography offers a specialized tool. Such is the case where you have a phillips screw and a flathead screwdriver, road design cannot be accomplished using coarse small scale photography. Also, land inventory cannot efficiently be performed using very large scale photography.

Figure 3

1:2400 Scale Photography



Content and accuracy in a digital mapping product are determined directly from the scale of the stereo photography.

Hopefully this article has generated some ideas for appropriate mapping uses in your survey related projects. If you have any specific questions or comments regarding photogrammetry, please send your correspondence to the Association.

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