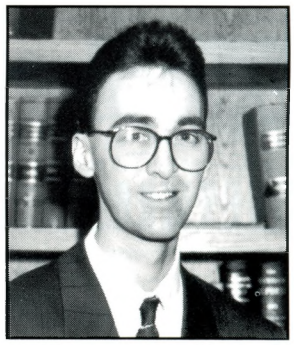

Photogrammetry in Focus
A Snapshot of the Profession

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

It is with great enthusiasm that I submit this first article to the *Ontario Land Surveyor*. I consider it an honour to participate in the quarterly and an honour to present ideas on photogrammetry to the readers. This first article will be a general overview of photogrammetry. In the future, I would like to expand on fundamentals and provide a forum for photogrammetric interests with respect to the Association of Ontario Land Surveyors.

My career to date has emphasized photogrammetry, however, I aspire to be a member of the greater community of Geomatics. Charting the earth, its composition, physical form, and resources, requires the expertise of many professions. The photogrammetrist's role is one of interpreting and cataloguing using photography, imaging and scanning.

An exacting and detailed definition of Photogrammetry is described in chapter one of Elements of Photogrammetry, by Paul Wolf. Roughly transcribed, it reads, "... photogrammetry is the art, science, and technology of obtaining reliable information about physical objects... [by] recording, measuring, and interpreting photographic images ... ". I took the liberty of excluding such phrases as 'electromagnetic radiation' for simplicity, but, the general definition remains intact. In addition to this text book definition, I would like to add that photogrammetry is a business and that the industry exists because there are benefits to using photographs. These benefits are usually cost related.

Where a cadastral surveyor uses a transit placed on the ground, the photogrammetrist uses an imaging device on a platform above the ground. Whether the platform is an airplane, satellite, or even a hill top, the data is remotely accessed. The power of photogrammetry is to remotely determine information.

While a cadastral surveyor examines local evidence and details, a photogrammetrist examines a general view. The cadastral surveyor can examine the limits of a property in a subdivision. The photogrammetrist can catalogue the positions of whole subdivisions relative to other subdivisions. Determining the method of survey involves determining the depth (or lack thereof) of a clients pocket. Photogrammetry can generalize large systems in a cost effective manner and provide general information for other professionals to use.

Traditionally, the cadastral surveyor divided the township's cadastral fabric for the orderly settlement of people. In the course of this work, and continuing today, the surveyor has accumulated certain skills. Within the immediate surveying family, the geodesist is perhaps the most technically minded. Concerned with exacting definitions and significant digits, the geodesist is the younger brother to the cadastral surveyor. Searching the family tree further reveals two cousins. Photogrammetry and Hydrography. These members grew up in the same neighbourhood and studied at the same school. However, their concerns are of a more general nature.

Those who have had the pleasure of flying, either in a commercial aircraft or a smaller private plane, can attest to the inspiring view of the world beneath. Cultural land use can be identified and entire terrestrial systems are distinguishable. The higher the airplane travels above the terrain, the more general the picture becomes. Where an astronaut travelling in space views a global system, atmospheric bound aircraft view a smaller more detailed sub-system. Dependant on scale, the images of the land forms below are general representations of the actual system.

The photogrammetrist cannot easily determine the exact location of survey monuments or determine legal ownership of property from aerial photographs. Nor can the photogrammetrist easily determine the form of the terrain beneath the surface of the water. However, the photogrammetrist does have the skills to obtain images of a system and interpret the images to develop a representative map.

A picture is worth a thousand words, to coin a phrase. An image is the single most important tool for the photogrammetrist. The image may be a photograph obtained from a camera or a digital image collected with a modern scanning device. A single image, however, is limited in usefulness. This is due in part to the changing scale of elements in the image. Elements in the image that are close to the camera have a larger scale than elements further away.

The true science of photogrammetry is realized when there are two images of the same scene, recorded from slightly different view points. It is this case, similar to our own vision, where a stereo image is formed. The stereo model, or that part of the two images where the scene is duplicated, is therefore the second most important tool for the photogrammetrist.

The resultant three dimensional model has definable properties. Most importantly, the model scale is uniform and accurate linear distances can be measured. Additionally, the perception of depth within the image can be used to accurately record the image's three dimensional nature.

The accuracies with which measurements can be made from the stereo image is dependant on a host of variables. The recording device (the camera), the recording medium (photographic film), and the playback equipment (the measuring device), all have relative errors associated with them. However, the more import issue concerning errors in measurements is the scale of the stereo model. The further away the image, or the higher the aircraft, the more space the model covers. The price, however, is a degradation of relative and absolute accuracy.

A stereoscopic plotting instrument is used to set up and measure a stereo

model. This instrument orients the left and right photographs in such a way that an operator can view the resultant image in three dimensions. Also, the coordinates of known survey points located in the stereo model can be used to calibrate the model to a coordinate system. Once set up, the operator can measure the coordinate values, x, y, and z for any point within the stereo model.

The more common stereoscopic plotting instruments in use today are analogue. Analogue plotting instruments work mechanically and use regular optics to allow the operator to view the stereo model. Many of these however, are fitted with digital encoders. This allows mechanically measured distances to be input directly into a computer for storage. In addition, on line computer graphics allow the operator to view what is being stored. Computer Aided Design and Drafting (CADD) programs are the most common interface between plotter and operator.

A higher quality and more costly stereoscopic plotting instrument is the analytical plotting instrument. A powerful computer is used to mathematically model the geometry of the stereo model. The operator views the stereo image created by the photographs but measurements are calculated by the computer. The errors associated with the optics and mechanics of the machine are eliminated with this system.

The latest technology in plotting instruments is the fully digital machine. Using scanned photographs, all of the functions of the stereoscope are processed by the computer. This includes processing the three dimensional image for the operator to view and from which to record measurements. Due to the limitations of computer storage, and because of the size of digitally scanned images, the full potential of these machines are yet to be realized.

Advances in technology have increased the photogrammetrists' toolbox in size and complexity. Maps can be produced more efficiently and with greater accuracy. The digital process can offer more information for the analysis of other products. However, the stereo pair of images will always be required to produce a three dimensional model.

Computers have changed the way photogrammetrists work and the type of work that is produced. The data collected from aerial photographs is no longer merely made into a hard copy map. The capacity for the computer to process intricate mathematical problems broadens the scope of photogrammetry. Three dimensional modelling, volumetric calculations, topographical studies and topological processing are a few of the new options.

The cadastral surveyor can participate in the use and creation of photogrammetric products. A large percentage of the cost of topographic mapping is the surveyed ground control. Both horizontal and vertical control is required for any mapping project. However, the cadastral surveyor's work need not end in the field. For volumetric calculations, the photogrammetrist can supply the terrain information for the cadastral surveyor to process. Also, digital mapping can be used to perform topological studies. A subdivision design or road construction can benefit from a topological study of land in the vicinity of the project area.

As experts in land related affairs, cadastral surveyors and photogrammetrists need to explore business opportunities together. An alliance has already developed due to the technical requirements of topographic mapping. This alliance is well represented within the expanded profession. However, cadastral surveyors and photogrammetrists need to examine the use of technology from both pursuits and amalgamate ideas so that the industry can better serve the land information client.

In future articles, I would like to further examine photogrammetry as it relates to surveying. Data collection, the map making process, representing terrain information, computer hardware and software, and G.I.S. storage systems are a few topics. I would also like to respond to reader comments and suggestions. Please send your correspondence to the Association.

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Upcoming Events:

May 27-29	Saskatchewan Land Surveyors' AGM	Saskatoon
June 4-6	L'Ordre des arpenteurs-geometres du Quebec AGM	Quebec City
June 6-10	Canadian Conference on GIS	Ottawa
September 15-17	AOLS Lecture Course	Toronto
November 25	AERC Oral Professional Examinations	Markham
November 26	AERC Written Professional Examinations	Markham