*Photogrammetry and the Small Land Surveyor**

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FOR most of its history in the United States photogrammetry was considered applicable only fof large mapping projects. The private concerns engaged in photogrammetry are, for the most part, large corporations. Many of these are completely independent having their own fleet of aircraft, cameras, photo processing, field survey groups, and compilation and drafting sections. They are geared particularly to the large mapping projects or the routine mapping project which fits the pattern of this system. The small or unusual mapping or design project is not conveniently or efficiently handled by such a system. In addition, action taken by the American Society of Civil Engineers in 1959 and endorsed by the American Society of Professional Engineers ruled that much of the photogrammetric survey work being performed was, in fact, engineering. As engineering, it should be performed by firms licensed to practice engineering. In many states, corporations may not be licensed to practice engineering. Thus, a void resulted in the development of the use of photogrammetry for engineering surveys. The engineers and land surveyors have been slow to recognize and correct this situation. Many states have found it necessary to set up their own photogrammetric sections within the state highway departments, and as a further result some highway consulting firms have established a photogrammetric capability for their own surveys. However, many of the potential applications of photogrammetry in the field of surveying are not being recognized, or at least are not being fully exploited, because of a shortage of qualified personnel and firms with the capability for developing this potential.

In order to obtain some information about the use of photogrammetry in highway work and to see what correlation might be drawn between the highway work and land surveyors, we recently asked the state highway department of all 50 states some questions about their photogrammetric activities. We received replies from 48 of the 50 states. Of these, 47 states use photogrammetric techniques in their state highway program. Thirty-one states do their work by contract and 25 states have an in-house capability. This total, of course, adds up to more than the 50 states; however, some states indicated that they worked both by contract and with an in-house capability. Twenty of the states even own their own photographic aircraft and cameras, and 30 of our states have an in-house capability for making their own control surveys. It is obvious that the National Highway Program has made a real impression on the photogrammetric field. It has brought into use many techniques and equipments which were not applied, and in fact, were not even available to the photogrammetrist before the highway program was initiated.

Let us now look at where the small surveyor stands in the field of photogrammetry today. What is a small land surveyor? What work does he do? Can photogrammetry help him in this work? What have we, as a society, done for this small land surveyor? What more should we do for him? These are interesting questions, and let me say at the onset that I have no real answers. My purpose here is to introduce a subject and to raise these questions. If we can generate an interest in the subject, and at some future date answer the questions, then we may have opened the door wider on a broad field in the applications of photogrammetry.

What do we mean by a small land surveyor? Do we mean a small man surveying land or, do we mean a large man surveying small parcels of land? I think we mean a man perhaps small in cash but very big in mind. I have defined a small land surveyor, for purposes of this discussion, as "an engineer performing tasks requiring the knowledge of survey techniques and who is working for himself or for a small engineering firm." This is obviously a rather loose definition, but perhaps it will hold together long enough for this discussion.

Today, the surveyor may be engaged in subdivision layouts where there are problems of street design, location of storm and sanitary

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sewers, location of water, and gas lines and so forth, in addition to the actual placement of the individual building lots on the ground.

He may be called on to isolate a discrepancy in the rural property surveys. Perhaps these may be more readily isolated and intelligently resolved with the assistance of aerial photography and photogrammetry. In addition, more complete and useful rural property surveys may be offered at a reasonable cost, utilizing the property survey as a basis. Some such benefits may be; accurate acreage of individual fields, topography to assist in laying out drainage systems and locating farm ponds, a general soil classification and the location of all farm buildings, fences, and utilities.

A surveyor may be called on to prepare progress reports and in-progress surveys. These may be performed more economically by utilizing photogrammetric methods on many projects, particularly if thought is given to this type of reporting when the basic control is established for the construction project.

Another job for the surveyor is that of stockpile inventories. These inventories may be made very accurately by the use of photogrammetry. The cut-off point for the inventory is established precisely at the time the photographs are taken. For the safety of the surveyors there is no need to schedule the inventory when the factory, mill, or mine is not operating. Also the inventory may be made more economically if it is to be repeated at regular intervals, since the ground-control once established may be reused.

Similarly, surveys required for partial payments to contractors for excavation or fill may be determined by photogrammetric methods, without interfering with the work in the construction area. Also, here again the surveys are generally more economical, if repeated at regular intervals, since the control may be reused.

Transmission line surveys, when made by photogrammetric methods, require a minimum of access to private land, and alternate routes may be readily investigated without alerting property owners. Further, if the transmission line is intended to parallel existing lines, the survey for the existing line may be utilized for control, thereby requiring only a very minimum of additional control. Also, the aerial photographs will assist in the preliminary search of properties to determine the taking lines.

In the selection of sites for various types of development projects, preliminary site surveys of several adjoining sites may be made, utilizing aerial photography without alerting the owners and in many cases utilizing the same ground control. Usually this will result in a distinct savings to the developer of the project.

These are but a few of the jobs which the surveyor is faced with today. I am sure that other surveyors and engineers, can think of many more jobs to which photogrammetry might be applied.

When the Tennessee Valley Authority needed maps of the area within which it was working, they proved that photogrammetry could be a useful engineering tool in compiling small-scale maps of large areas. Since that time the mapping field has been the major application of photogrammetry within the United States. It was acknowledged that these maps could be extremely useful in the reconnaissance and preliminary engineering surveys for large projects. However, the use of photogrammetry for small surveys and for large-scale detailed work was not readily accepted. It is only in recent years that acceptance of the use of photogrammetry by the design engineer, the land surveyor, the landscape architect, city planner and municipal engineer has occurred. Much of the credit for demonstrating to the design engineer and land surveyor the capability and the accuracy obtainable from photogrammetric surveys must go to the design surveys compiled in conjunction with the National Interstate Highway System. Since the first final design surveys were compiled in 1956, recognition of the application of photogrammetric surveys has increased rapidly.

In general, it has not been the reduction in cost of the design survey that has encouraged the use of photogrammetry. Instead it has been a distinct improvement in the product. The design-survey cost represents only a small percentage of the overall cost of most construction projects, and since so much depends on the accuracy and completeness of the survey, it is not the place to look for a bargain. Some of the advantages and improvements which have been made through the use of photogrammetry are:—the increase in planimetric detail easily obtainable—the improved accuracy in the positioning of the planimetric detail—the minimizing of costly omissions—reduction in time required to complete the survey—elimination of accumulative type errors in the survey—the freeing of the engineer and land surveyor of much of the tedious and time-consuming work of supervising and checking the compilation of map detail—the elimination of delays in schedules due to the weather—the increase in size of the area

mapped to include adjoining properties without trespassing or significantly increasing the cost of the survey. All of these factors have been instrumental in increasing the use of photogrammetry in preparing the surveys.

The person who is best qualified to supervise the compiling of the design or engineering survey is the engineer with a knowledge of the horizontal and vertical map accuracies required, and the type of planimetric detail to be compiled. The use of photogrammetric methods, in conjunction with ground surveys, has been shown to be of considerable benefit in compiling many final design surveys. As the engineer and surveyor become more knowledgeable of photogrammetry, they will see many more and wider applications.

If we look at the various technical publications and the reports of research development efforts being put forth in the general field of photogrammetry today, we can see that it is roughly divided into four major areas of interest. The first and, to some, the most interesting area today is that of photogrammetry in the aero space age. A second area of interest is that of the use of photogrammetry by government agencies in the preparation of general purpose topographic maps. The third interest covers a very broad field of non-cartographic uses of photogrammetry. The fourth area, and the one which we have been taking a closer look at today, is the use of photogrammetry by the small land surveyor. In the 1961 issues and the first two issues of PHOTOGRAMMETRIC ENGINEERING in 1962, we find that 11 articles have been dedicated to reporting progress of photogrammetry in use in the space age. These articles report such subjects as the Surface Roughness of the Moon and a Satellite's View of the Earth. In these same issues, we find 21 articles on large mapping programs. On the subject of triangulation and the use of electronic computers in the field of triangulation, we find nine specific articles.

As far as special applications are concerned, we find 53 articles covering such subjects as a Photogrammetric Study of Aerosal Particles in Thermogradient, Underwater Micro-contouring and Cumulus Cloud Photography in Photogrammetry. Mixed in with these articles on the various subjects mentioned, we find a total of *none* in the field of small land surveying. There is a tremendous field of development open to us in the area of small land surveying, and I believe that we as a society have been negligent in our efforts to develop this work. Perhaps you will say that those people who need photogrammetry for land survey work have been negligent in not developing it for themselves.

I believe it is the responsibility of this Society, through its members, to extend the uses of photogrammetry to all areas where it can be used. The only means of doing this is by carrying the subject of photogrammetry to those people who are not now using it but who can use it. This can be done by means of special articles in many technical journals and by a true extension effort. Only in this manner can we provide photogrammetric information to all areas of interest.

At Bausch & Lomb, of course, as manufacturers of photogrammetric instruments, we are interested in every possible area and every possible use of photogrammetry. We also believe that every member of the Society should also be similarly interested.

There is no question that a small land surveyor is not in a position to buy an airplane and an aerial camera with a complete photographic laboratory such as is required for accomplishing photogrammetric surveys. When added to the other required equipment, the cost would be prohibitive and he would be unable to make efficient use of this equipment in his relatively small operation. However, there is merit in his consideration of establishing a capability for compiling maps, using the aerial photographs as his set of field notes. Certainly the land surveyor or engineer, who has been compiling cadastral site and design surveys by ground methods up to the present, is in the best position to realize and appreciate the benefits which can be derived by introducing the photogrammetric techniques into his operation. With reference to the aerial photographs required, there are many photogrammetric firms today with complete photographic capabilities, which are available for flying and processing photography for others under a fixed price or a rental basis. In addition, there are a few firms which are engaged exclusively in flying and processing photography, as a service to other firms. In the future, with more small surveyors entering the field of photogrammetry, there will be a need for many more such flying services. It is logical in most instances to separate the photographic and photogrammetric phases of these efforts. Since the demands for photography fluctuate drastically, and the fixed operating cost is high, it is not practical for a firm to maintain a sufficient capability for its peak demands and still maintain a realistic cost per flying hours on the job.

As a Library of Photography is developed by the surveyor, site surveys, sub-division