Photogrammetry and Photographic Interpretation In Landscape Development

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•BASICALLY, photographs taken from an airplane are translated into accurate and detailed topographic maps or are used by the designer to gain less formalized data which is relevant to the design process, but not ordinarily incorporated into map form. These techniques—photogrammetry and photo interpretation—are, in any event, far too complex to be condensed into a necessarily brief discourse. Therefore, remarks will be confined to an examination of the application of these techniques to the practice of engineering or landscape architecture, with specific reference to highway and park design.

The choice between photogrammetry and the more classic survey methods is almost entirely a matter of comparative economics and considerations of season. Either procedure can be employed to achieve maps of similar scope and accuracy. Let there be no mistake, there is still a choice between these two methods. Today, almost 20 yr after the bomb dropped on Hiroshima ushered in the atomic age, America is still using, as well as building, new power plants that use water and coal as sources of energy. High-flying aircraft, cameras, photogrammetric plotters and tellurometers are dramatic tools, but they have not replaced levels, transits, plane tables, chains or rods—despite the fact that the basic principles of photogrammetry and photo interpretation were demonstrated and used over 100 yr ago.

Photo-survey methods, like atomic energy, advanced enormously under the impetus of World War II and in the years after the war. Proponents of the technique, either as a result of spontaneous enthusiasm or because they stood to profit therefrom, sold photo-survey methods as the end all and be all of engineering mapping. The technique is tremendously valuable, but has limitations.

It would be desirable, but unfortunately, it is not possible to apply one simple formula in determining when photogrammetry is applicable to the solution of a given survey problem. Far too many elements influence the propriety of choice in a particular case. Frequently, the only wise course is to obtain alternate proposals for both ground and air surveys, or else write very explicit specifications as to the character of the finished map, and then permit the contractor to select his own methods. Where a public agency is to perform the work, and both methods are available, it is not as easy to arrive at a simple choice based on economics. In such a case it is probable that the choice would be made largely on the basis of schedules and availability of equipment.

The elements which influence economic considerations are as follows:

1. Location of Survey Area.—The accessibility of the site, the time and cost of getting to it and the availability of housing for field parties can be an important factor in the total cost of a survey. Obviously, the cost mapping of an inaccessible plateau can best be done by aerial methods.

2. Size of Survey Area.—In general, small areas can best be done by ground methods. The cost of a plane and crew waiting for suitable weather, taking off and flying to and from the survey site, is as great for 10 acres as for a 1,000. Further, the proper setting-up of the photographs and establishing the so-called stereo model in the plotter, is another major fixed-cost element which is the same whether all or part of the entire overlapping area of the photographs is to be mapped.

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3. Character of Terrain. —The more rugged the terrain to be surveyed, the greater the economic advantage of using photogrammetric methods. It is just as easy (in fact, easier) to contour a steep slope as a flat one in a photogrammetric plotter. On the other hand, everyone is familiar with the difficulties and costs of sectioning steep terrain.

4. Character of Vegetative Cover. —Dense, evergreen vegetation cannot be satisfactorily penetrated by the camera's lens. If the percentage and distribution of conifers are such that it will require considerable ground-survey time to fill in the gaps in the photogrammetric map, it might have been just as cheap, if not cheaper, to do the job on the ground in the first place. Conversely, it is often possible to interpolate in the areas of dense cover with no significant loss of accuracy.

5. Scale of Mappings. —The smaller the scale of the map required and the larger the contour interval, the greater the economy in photogrammetric methods. No matter what the scale of the map, it takes the surveyor on the ground the same length of time to walk a mile. The eye of the technician, using the photogrammetric plotter, traverses the terrain at a speed related to the scale of the photos. For maps of a scale of 1 in. = 200 ft or smaller, and a contour interval of 5-ft or more, ground methods could not possibly compete economically with photogrammetry.

6. Season of Survey. —In climates subject to heavy snowfall where there is a significant amount of deciduous cover, the seasons for air photography are brief snatches of the spring and fall. Miss the season and one may be delayed as much as 6 months. Ground survey may then be the only answer. However, photos taken on one brief, clear autumn day can be measured at leisure in a warm plotting room while the wind and snow rages over the survey site. Field work can become inefficient when the hands, faces, and feet of surveyors are subject to excessive cold.

7. Character of Detail Required. —During the recent Cuban crisis, a favorite saying described the ability of a photo interpreter to read the headline of a newspaper which a man held 60,000 ft below. This sort of thing does not apply in ordinary engineering photogrammetric work. Neither does the camera penetrate the earth's surface. In urban areas where underground utilities, overhead wires, curbs, steps, low walls and inconspicuous fences may be significant details, a great deal of ground survey is needed—often so much that it becomes more economical to use ground survey in the first place. So, despite the raves of the enthusiasts, where the tolerances for meeting existing pavement and other structures are small, the accuracy of photogrammetry is less than ideal.

Where mapping is concerned, the choice between photogrammetry and ground survey methods must be made on the basis of economics and adaptability of time schedules. The required information can, with very few exceptions, be obtained by either method.

It is in the use of photographs taken for mapping purposes, or of others taken at the same time, at different scales or with special types of films, that the real dividends in aerial mapping methods are realized. In the early stages of a survey it is usually impossible to anticipate all the information that may be needed during the design process. To map all of the information which might ultimately be wanted could be hopelessly expensive. As a result, the designer is frequently forced to make field trips, or to request supplemental survey data, no matter how good the map he has to work with. However, when mapping is based on air photos, an infinite amount of data has been captured permanently, and is readily available to the designer through photographic interpretation.

Photogrammetry is a highly technical procedure requiring elaborate, expensive equipment and highly-trained technicians. Photo interpretation, however, is essentially a very simple practice, no more complex than the act of observing commonly-used types of photographs and simply by looking with a critical mind, deriving from them certain types of information.

Photo interpretation is not an esoteric practice. It involves relatively simple techniques which are readily applicable, although only on the basis of certain types of experience. Essentially, it is possible to express all the basic techniques and the required experience in terms of the need, to be able to recognize what one is looking for. For example, one could observe a red oak for 20 years without recognizing the tree as a red oak unless having a standard of identification: height, spread, shape, branching habit, foliage, etc. Similarly, the only way one can hope to identify an object in an aerial photo is by knowing, or by being able to visualize or imagine what it would look like in a vertical aerial photo. This can be accomplished only by study or experience.

In the fields of geology, forestry, agriculture, soil identification, and military operations, photographic interpretation can be considered a science. The special applications of photo interpretation in these fields are of such significance that the training of specialist interpreters has been both necessary and feasible. However, there is no need for such specialists in the field of landscape design, unless the photogrammetrist who serves by preparing maps from the photos is considered to be such a specialist.

Too much emphasis on the technical aspects of photo interpretation often serves only to scare off those who stand to benefit the most. The tools of the photo interpreter in landscape practice consist only of a simple stereoscope, a scale, and a magnifying glass. Perhaps a set of parallax wedges, if one wishes to measure slopes, may be added to the basic set of tools. However, they are seldom needed.

By far the most valuable tool is the stereoscope. With this, and a pair of overlapping photos of the project area, the designer has a three-dimensional model of the site available. Every stream, rock, bush and tree is there for his examination. It is amazing how often designers fail to keep air photos constantly at hand to make stereoscopic surveillance of the project site during the course of their work. There is no substitute for the intimate familiarity with the site which can thus be gained. No matter how complete and how accurate their surveys are, the use of aerial photos involves a continuous process of conscious translation—a rectangle on a map may signify a flat concrete platform or a ten-story building. No symbol can convey the difference. A note on the map is necessary to explain this difference and the designer must visualize the significance of the note. In the stereoscopic model the structure can be seen in three dimensions and thus give an incalculably more effective feeling of its character and size.

It would be impossible to attempt to be comprehensive about the special applications of photo interpretation to this field. Those who have not used a stereoscope to study a project site should get one at the earliest opportunity and try it. Any more specific suggestions as to special uses might prompt the inference that no other applications existed.

Instead, a few projects will be examined which are currently under design and in which photogrammetry was used as the survey method. The reasons for using photogrammetry will be indicated and the use of photographs to supplement the photogrammetry during the design process will be outlined.

One project involves the relocation of a State highway in the Finger Lakes region of New York. The general site for the highway parallels the lake shore, separated from the lake only by a continuous row of small summer residences which perch perilously on the slope between the highway and the lake. On the other side of the highway are steep, rocky slopes. The plans must show innumerable front steps, driveways and retaining walls.

A general route selction was made by the cognizant State agency on the basis of photogrammetric maps produced at a scale of 1 in. = 200 ft, with a 5-ft contour interval. (Maps of this scale are almost invariably produced by photogrammetric methods.) Scheduling of the project planning was such that the basic route location was determined late in autumn. Detailed planning was to be started immediately after determining the route location. Thus, if ground surveys had been selected as the basis for mapping, it would have been necessary to do the field survey either under intolerable snow conditions or the project would have had to be delayed for several months pending suitable weather.

The project area was actually photographed before the final route was selected. The effective width of the photographic band obtained was almost 2,000 ft, more than ample to allow for any variations which might have developed in the route-selection process. Actual mapping from the photographs was delayed until the route location had established the precise corridor for which it was necessary to develop topographic detail. This photogrammetric mapping was performed during the winter months when field work might might have been difficult or impossible.

Another consideration in choosing photogrammetry for this project was the character of the terrain—the steep hillside overlooking the lake. If conventional ground methods had been used the cross-section parties would have had to be roped together like mountain climbers. In spite of the fact that the numerous houses with retaining walls, steps, etc., had to be individually mapped from the ground, photogrammetry was considerably less expensive for this project than surface-survey methods exclusively would have been.

Another project is located at Rockland Lake State Park, also in New York. This planning job for the Palisades Interstate Park Commission, included access roads, two swimming pool complexes, bathhouses, parking fields, a golf course, ski development, and picnic areas. Three stages of photogrammetry have been or will be used in the design of this project.

As in the highway just discussed, basic planning was done at a scale of 1 in. = 200 ft on photogrammetric maps which had been prepared for the entire county in which the project lies and which were available at nominal cost. The plans produced at this scale were in the nature of land-use studies rather than comprehensive preliminary plans. The accuracy of the maps was adequate to permit the determination of what type of development was feasible and what the general location and scope of parking fields, general alignment of roads, location of main features, etc., might be.

When the general scope of the project was fixed on the basis of these 1 in. = 200 ft maps, new photographs of the project area were obtained. During a single flight, photographs suitable for producing both 1 in. = 100 ft maps with a 2-ft contour interval and 1 in. = 40 ft maps with a 1-ft contour interval, were taken. One in. = 100 ft maps were prepared for the entire project area, and on them complete preliminary plans for the project were developed. These plans defined the scope and character of all significant elements in the project and established controlling grades and dimensions. These same maps were also the basis for detailed contract plans for much of the golf course, picnic area, and ski area development.

For those features which required larger scale planning—the swimming pool and surrounding areas, parking fields and access roads—1 in. = 40 ft maps were prepared. These, of course, covered only a small part of the total park area.

It is obvious that it would have been prohibitively expensive to make surveys of the entire area by ground methods at any scale, particularly since only a relatively small portion of the total park area was ultimately to be developed. Photogrammetry was the only feasible approach. The development of the larger scale maps—1 in. = 40 ft—by air methods would not ordinarily have shown as favorable an economic ratio as for the smaller scale maps, but because the photos had been obtained at the same time as those for the smaller scale mapping, and because the same ground control was used for both phases of the mapping, the method used resulted in worthwhile savings.

To have attempted to map each tree, rock, and shrub, which might ultimately have been of interest in the design of the golf course or the picnic area, would have been prohibitively expensive. However, the designers had the photographs constantly available and were able to obtain, stereoscopically, additional relevant topographic information.

Another example also involved a large State park in a very rugged area in the Helderbergs, near Albany. Complete stereoscopic photography of the park lands was obtained, and by a combination of field examinations and intensive stereoscopic examination of the photographs, a basic land-use pattern for the park was developed. The major part of the park area was to be developed for picnic purposes and the major construction item was access roads. Basic data were obtained by conventional ground survey methods but, for reasons of economy, the survey areas were limited to the immediate environs of the road construction. The designer then prepared detailed plans from the ground survey data supplemented with information derived from stereoscopic examination of the photographs.

Finally, actual construction is one of the most neglected areas for the application of photo interpretation. Frequent and systematic air photography of progress at a construction site could provide a continuing check on the adaptation of plans to field conditions and provide a record of inestimable value. This is a possibility which might well engage the attention of commercial air photographers and permit the productive use of planes and cameras at seasons when they cannot economically justify their existence.