*Photogrammetry—Yesterday and Today**

DANIEL KENNEDY,
Central Region Engineer, Topographic Division,
U. S. Geological Survey, Rolla, Missouri

ABSTRACT: *The development of photogrammetry from its early start in the field of topographic mapping to its present uses in the many fields of science has offered the photogrammetrist a challenge and an opportunity. This evolution has produced many specialists in photogrammetry in addition to the topographic photogrammetrist.*

Applications of photogrammetry to these new fields, and to modern topography, and the role of the research photogrammetric designer in developing equipment to meet the new requirements are subjects discussed in this paper.

THE subject of the use of photogrammetry in topographic mapping has been most adequately covered in numerous papers before groups of this Society and other organizations, and it is not my purpose to summarize the papers today. However, there are two that cover both the subject of photogrammetry in the field of mapping and the early history of mapping in our country. These are a paper by Mr. Robert Lyddan, Assistant Director, U. S. Geological Survey, on "A Century of Topographic Surveying & Mapping,"[1] and "Improvements in Photogrammetry Through a Century"[2] by Mr. George Whitmore, our present Chief Topographic Engineer, and Mr. Morris Thompson. They are well written, take but little time to read, and provide a good background on a dynamic specialty.

When reviewing the historical background of the profession of topographic engineering, we are always impressed by two things: one, that in this country a century covers most of its vast activities; and second, that the greatest progress has occurred during the last quarter. The same changes have occurred in many professions and have either caused or followed the development of our country. Because of its going before, I like to think that mapping has shown the possibilities for resource and conservation developments, and thus has helped make America the productive country that it is.

Our Society, in choosing this city for its fall meeting, has placed itself close to the headquarters of the Geological Survey's Central Region, which is in Rolla, Missouri, and which serves sixteen States of the Middle West that comprise the area from North Dakota east to Michigan and from Oklahoma southwest to Florida.

At this point I will give information about the Rolla office. For those who are not familiar with our facilities we hope you will soon pay us a visit. A visit to one of the regional mapping offices of the Topographic Division by anyone who is interested in photogrammetry is a profitable experience, for mapping today employs as high a degree of application of photogrammetry as can probably be found anywhere.

In Rolla, the 50,000 square feet of floor space in two modern, air-conditioned buildings were designed for our purposes. We employ 569 people (at the latest count) of which 265 are assigned in the field. Mapping production operations today are so closely integrated with photogrammetric methods that it would be difficult to isolate any particular phase of the work that does not require some degree of photogrammetric knowledge or skill. Of the total man-hours involved in all phases of map-

[1] Paper No. 2632, reprinted from *Centennial Transactions*, Vol. CT, 1953, p. 836, American Society of Civil Engineers.

[2] Paper No. 2633, reprinted from *Centennial Transactions*, Vol. CT, 1953, p. 845, American Society of Civil Engineers.

* Presented at 1957 Semi-Annual Convention, American Society of Photogrammetry, St. Louis, Missouri, October 2–4, 1957.

ping a square mile of topography, 54 per cent is directly involved with photogrammetric equipment or methods. Of the balance, occasional use of aerial photographs or a general knowledge of the photogrammetric procedures is necessary.

Our Photogrammetry Section consists of 81 stereoplotting instruments on production, including one A-8, one Twinplex, 27 Kelsh plotters, and 52 units, which are being converted from Multiplex to the new ER-55. (At present, 33 of these have been completely converted.) Pantographs are now standard equipment on all of our units, and manuscript scale is now being made to publication scale in most instances

With this development of the technical sections have come the supporting ones not common in earlier days: the Plans and Production Section, Geodesy as a separate unit, and an Administrative Services Section.

This progress of the Central Region is typical of that of the other three regions of our Topographic Division. Their headquarters staff has also been changed to control effectively the planning and coordination of its work and the research and technical developments necessary to meet both current and future requirements.

In contrast to today is the Rolla office in the late twenties, when it was the place where field parties stored their equipment during the winter season. Later, in 1932, Mr. Sadler, as Section Chief, based his field headquarters there to supervise the topographic field operations in Missouri, Minnesota, North Dakota, South Dakota, Kansas, Nebraska, and Iowa. In 1935, due to crowded conditions in Washington—when the winter assignment consisted of each topographer inking his field work of the previous season, computing and adjusting control, and preparing his material for the coming seaon—I was sent to Rolla to establish a field drafting office. This was to consist of some of our field engineers supplemented by a few draftsmen hired locally. When we started to color separate our drafting, our blue-line boards were lithographed. This many times did not provide a discernible copy. Even though the inking surface was good, it was often necessary to do a lot of tracing and transferring. We drafted to our own standards as to line weights and lettering types, but, the results were far from our present standards. But then, our costs ($75 to $100) for the office preparation phases of a $7\frac{1}{2}$-minute sheet were not to present standards either. Since, the results were usable, the efforts were not in vain. From the start, our progress has been steady, and today our cartographic force is 120, using the latest of scribing techniques, and producing excellent copy for reproduction and for intermediate use before printing.

In field operations, we integrated aerial photography early in the thirties. The first use was with home-made projectors to plot the ridge lines and drainage, and then to get other planimetric detail, usually from photographs taken for the AAA. Later, we graduated to the use of stereocomparagraphs (the first purchased by me for $260, complete with drafting arm). These gave (sometimes) fair form lines that could be depended on to hold their elevation value for a half mile or so, but whose real value was that of giving true character and shapes to the contours obtained.

In 1938, Mr. M. J. Harden, who had been trained in Chattanooga with the first assigned photogrammetric unit formed by Geological Survey personnel for work with TVA, was returned to Rolla to start the Central Region's first photogrammetric section. This consisted of 3 units of multiplex.

This history of the Rolla office is a fair parallel of the developments in topographic mapping during the last quarter of a century. Also, it brings the realization that photogrammetry is not quite as new as some advertisements we read would lead us to believe.

Another misconception, particularly common to us in the mapping profession, is that photogrammetry is applied as a technique mainly in our own particular field of interest. The fact is that it has long since traveled out to be a useful technique in so many divergent fields that we are continually inspired by new applications. I would like to discuss some of these briefly to point out the achievements of the past and to imply the tremendous challenge of the future in this ever-growing field.

An interesting new application of photography, which promises to be of great benefit to the expanding highway program, was described in the September 5, 1957, issue of *Engineering News-Record*. This concerns the new highway design method that is being perfected in the Photogrammetry Laboratory at Massachusetts In-

stitute of Technology. This integrates aerial photogrammetry and electronic computing. By a system of point-by-point stereoplotting of an entire band of terrain with respect to known reference lines, any number of trial alignments can be tested and compared.

Photo interpretation, using the term broadly, embraces a use of air photos that is in a field apart from what is literally photogrammetry. It's true that in some of its phases measurements are made, as in geology where the beds and outcrops are measured; but in most interpretive work the expert uses his knowledge of his particular specialty and with this, from the photographic imagery, by reasoning, makes certain deductions and evaluations. Photo interpretation can be used in highway location for soil studies, location of gravel pits, geology, types of drainage, man-made structures, and a host of other ways. Photo interpretation in the military organization is today so much a specialty that special units have been established, with their table of organization, in the Army, Navy, and the Air Force. From the recognition of an aircraft to types of defense installations on a hillside are thousands of required tasks, and it would take all the time allotted to me to even list part of them.

The use of photogrammetry in cadastral surveys followed the development of the new high-order instruments, and already two of the large Government bureaus, the Forest Service and the Bureau of Land Management, are using it in speeding up the subdivision of the public lands and in other problems involving surveys common to Government and private-ownership lands.

Tests are now current where the structural engineer is using photogrammetry for measuring stress deformations in beams, columns, and girders. Particularly these methods will be applicable in studies connected with prestressed and preloaded concrete.

During the past few years in the Geological Survey, the Division of Geology and the Topographic Division have cooperated by conducting schools of photogrammetry for the geologists to help both in their measurements and in interpretation of land forms and geologic structures.

In the field of medicine, stereopairs are enabling the radiologist to better interpret *X*-ray pictures, and perhaps the day is close when plastic surgeons and oral surgeons will use them more.

The present use of data obtained photogrammetrically for earthwork computations in highway construction is but a furtherance of a technique developed many years ago in measuring coal supplies. This method is also being used on earth dumps and borrow pits when the volume of the material is significant.

A recent use, and one worthy of notice, is in the automobile industry. The application of photogrammetric techniques to the shaping of forms, from new models to new cars, may replace the standard use of templet measurements.

If the present trend in auto and other accidents continues, with the large numbers of injured who will require plastic surgery, it might develop that, in addition to a driver's license, each individual will be required to have a stereo-pair of photographs of his face so that repairs can be made that will compare to his former measurements. This is not a nice thing to consider, but the problem is here, and the use of the proper techniques of photogrammetry may provide valuable assistance.

The measurement of certain types of surfaces, like glaciers, waves, and ground in the process of subsiding (where extensive mining operations have occurred), provides excellent opportunities for photogrammetry.

The Geological Survey is now conducting studies on the application of terrestrial photogrammetry to glacial phenomena.

Subsidence studies are more numerous. Not only can the measurements be made now, accurately, but the element of risk due to cave-in, while making the survey, is eliminated.

Wave structures and actions in large bodies of water are being studied by photogrammetric methods, and tests of velocity effects on sedimentation are going on in several places. Some of these have developed conditions that at present preclude getting usable data. Turbidity and the backlash of stopping the flow are two obstacles that must be overcome before photogrammetry can be useful. A possibility exists of correlating the water surface to the sediment profile for any given velocity or grade.

There are many more who use photo-

grammetry, from the tailor to the police officer and insurance inspector, and like all uses, these are based on the ability to adequately photograph the subject and then possess the means to accurately measure the image.

It seemed appropriate to touch upon these many fields before returning to the specialty of contour mapping to show the vast area where the photogrammetrist can operate, for too many have looked only on topographic mapping as a means of expression and of livelihood for the photogrammetrist.

We have a tendency to use technical improvements to increase our production rather than increase our quality, and this may not be the proper procedure. Maybe our product should get a little better each year—show more detail to greater accuracy. Recently an article appeared in *Fortune*, "The New Precision," in which it is stated that measurement, the prime essential of high precision, is itself becoming a specialized business. And it shows the picture of a wafer of germanium holding a strip of aluminum and a strip of gold, each 1/1,000 of of an inch apart. Gold wires 4/10,000 of an inch thick make contact with the strips. Heating melts the aluminum and the gold into the surface of the germanium precisely 5/1,000,000 of an inch. We don't require (yet) measurements of this order in photogrammetry, but it does make me wonder how much we are losing by our limitations which are fixed at the order of about 1/10 millimeter.

We have made remarkable improvements in our photogrammetric equipment the past ten years. We have not done as well with our field surveys, which are so necessary in topography, but we are on the way to improvement. Two new instruments, the Tellurometer and the Geodimeter, one measuring microwaves and the other light waves, by their accuracy and speed will cause many changes to be made in our control techniques, especially in obtaining horizontal control.

Photogrammetry has demonstrated its usefulness in many fields to many people. To those of us in topographic mapping, it has proven itself invaluable. To those of us who have known it a long time, we think its growth is just beginning. To you younger people now entering it, I would give this advice: Don't revere too much what been accomplished, but assume that you can do better; then go ahead and make photogrammetry achieve its vast potential.
