

If now the visible moon's surface is photographed from our earth in two extreme libration positions, two stereophotographs are obtained as if the photographic stations were located at L and R , which determine a fairly favorable stereoscopic base $[b]$. It is obvious that the accuracy of the directions LM and RM must be extremely high due to the considerable distance between the moon and earth, which amounts to about 240,000 miles. Such a high directional accuracy can be obtained only by making the photographs through a high performance telescope with a

very long focal-length. Using the 80-foot focal-length telescope of Mt. Wilson Observatory in California seems to be a feasible way. If such photographs are available, it seems possible that a planimetric and elevation accuracy of about 200 ft. can be reached by using high-precision measuring devices. The use of such devices and automatic plotting procedures which would produce contour lines on the moon's surface are at present under investigation at The Ohio State University, Princeton University and some other universities.

*American Commercial Practices in Large-Scale Topographic Mapping**

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ABSTRACT: *This paper is an attempt to place in print information which although of common knowledge to a number of photogrammetrists has not been well publicized and may be novel and of interest to many others. The paper discusses generally the private commercial company aspect of photogrammetric mapping. Representative company equipment, personnel, client relation, and technical operations are covered.*

A GREAT expansion of the science of photogrammetry in the United States in the last fifteen years has encouraged a release of a large amount of information which has been made available internationally through such publications as the "PHOTOGRAMMETRIC ENGINEERING," "Photogrammetria," and numerous other publications on various phases of photogrammetry and its associated sciences. This information has dealt principally with the activities of governmental bodies, universities, and other quasi-official organizations. It has concerned descriptions of new techniques of mapping, new applications of instrumentation and details of actual projects which various public agencies have undertaken. All of this information has been most important and interesting and absolutely essential to the growth of the science of photogrammetry. However, one aspect of photogrammetry has been described very lightly in the literature.

A review of recent publications indicates a scarcity of information concerning the practice of commercial photogrammetry in the United States. This is most unfortunate for a tremendous amount of effort and money is now invested in the pursuance of photogrammetric engineering by private companies. It can be assumed that these companies, working competitively, would be responsible for developing new approaches, techniques, and equipment to more efficiently compete with their contemporaries. Of course it should be recognized that not much information is available for exactly that reason. A company which has developed an efficient technique for producing maps is not enthusiastic about revealing such information to its competitors unless it can be protected by legal methods such as patent or copyright.

The author has been in the interesting position of having had during the past fifteen

* This paper is condensed from the original paper prepared for presentation to the IX International Congress of Photogrammetry.

years, experience both with government agencies and commercial firms in the fields of both research and development and actual production of maps. The comments in this paper are derived from observations limited necessarily to a small segment of the entire private commercial practice of photogrammetry in the United States. Although the statements herein are based on a limited sample, nevertheless, it is felt that this sample is quite typical and represents practices which are most common. The paper is not intended to be a critique and does not assume the responsibility for passing judgement on practices now in use. The information is given in a purely objective spirit and it is hoped that it will provide information to the general photogrammetric community which is not readily available in the literature at this time.

In March 1957 Prof. Charles Miller of the Massachusetts Institute of Technology published in PHOTOGRAMMETRIC ENGINEERING a report on the status of private photogrammetric mapping activity in the United States. This fine and timely study revealed a very interesting situation existing in 1956. With Prof. Miller's very kind permission there is, presented herewith a very brief summation of some of the facts in the study. In 1945 there were four private companies engaged in the practice of photogrammetry. This figure increased steadily until in 1955 there were 32 such firms. It is now estimated that in 1959 there were at least 50 companies. According to Prof. Miller's report, in 1955 all private companies combined were responsible for \$14,700,000 worth of photogrammetric services. In addition he also notes that there was \$8,300,000 spent for commercial aerial photographic services, not including photogrammetric work. It is interesting to note that of this money spent in 1955, 33% came from the U. S. Federal Government, 27% from State and local governments and 40% from private industry.

In 1955 there was a relatively large number of very small companies and a small number of very large companies. Prof. Miller's figures show five companies that did over \$1,000,000 volume of annual business and 21 companies which did less than \$100,000 annual business volume. It is believed that since 1955 the number of smaller companies has grown considerably, whereas the number of large companies has more or less been maintained or actually may have been reduced by one or two.

Private photogrammetric and mapping or-

ganizations are commercial entities and as such are predicated on showing a profit as the reason for their existence. In the past few years this field has become more and more competitive. There are practically no general rules or regulations governing the behavior of private mapping companies other than those rules applicable to the operation of any commercial corporation. Several of the state governments do attempt to control mapping companies by insisting that such organizations have their work certified by registered professional engineers. However, this is not as yet a common practice. The governing dictum is usually the specification for the particular project as prepared and decided by the client. The choice of method and procedure is very often left to the mapping organization and is not included in the specification. Of course in a very competitive situation this can be extremely dangerous because the mapping companies may be tempted to work at the very limit of their technical capabilities in order to be in a position to quote the lowest possible price. Some clients have attempted to avoid this situation by actually specifying the technical procedure to be followed.

The clientele for private mapping organizations is very much as categorized by Prof. Miller in his report; that is, the Federal government, State and local government and private industry. Since Prof. Miller's latest figures (1955), it is quite likely that the percentage of work requested by State and local governments and private industry has increased and the work required by the Federal government has decreased. This trend has taken place in spite of the fact that some State governments are now establishing their own photogrammetric organizations.

The mapping work accomplished by private organizations is predominately of the very large-scale type. This ranges from scales of 1:12,000 to 1:600, with the most common scales at 1:2,400, 1:1,200, and 1:600, with 5', 2', and 1' contours respectively. These maps are prepared principally for engineering studies and public works, such as highway design, drainage studies, city planning, public utility projects, and the like.

The actual work assignment is obtained in contract form by one of three methods. These are open competitive bidding, limited competitive (pre-qualified) bidding, or straight closed negotiations. The Federal government and many State and local governments will announce a project and request

all and any interested companies to submit proposals. The lowest bidder will receive the contract unless for obvious reasons the company is not qualified. The limited competitive bidding is usually resorted to by some local governments and by many commercial engineering organizations. Under this procedure several firms are selected which are considered to be acceptable to the client. These firms submit their bids and the successful bidder is selected, but not necessarily only on the basis of the lowest bid. Consideration may also be given to the technical plan which is to be used. The third procedure, a straight negotiation between the client and the photogrammetric company, is not normally used by any public organization but is used by commercial or private companies that prefer to assign all their mapping work to one particular company with whom they have had satisfactory relations.

There has been much public discussion and argument concerning the virtues and faults of the various systems for obtaining work. Each of the three methods mentioned above has its advocates and its critics. This paper does not presume to discuss this question.

The type of personnel that staff the organization of these private mapping companies is of interest. There is a very definite scarcity of academically trained geodesists, photogrammetrists, or photogrammetric engineers in the United States. This is due to the fact that this science is a relatively new one in the United States, and has undergone a tremendous expansion in a few short years. The few universities that do offer study in these fields cannot possibly meet the demands of both government service and industry. It is, therefore, most common to find that the great majority of supervisory personnel have obtained their knowledge of mapping and photogrammetry through practical experience and their own personal readings and research. A surprisingly small percentage of the management group in the private photogrammetric field has had formal academic training as engineers or possess university degrees in associated fields. When they do it is not at all surprising to find that the study has been in such areas as mechanical, electrical, or chemical engineering or in one of the sciences. This is by no means meant to be a criticism or implication that these men are not adequate for the task. On the contrary, the wide and varied backgrounds which these men have, bring to the science of photogrammetry a flow of fresh thought which could not possibly come from the more orthodox

thinking of the men trained in the specialty. Of course such situation also has its disadvantages as well, which are quite obvious. Actually a tendency exists under such a setup for extremes in management; that is, the good men tend to be exceptionally good and the poorer men tend to be unsatisfactory.

With the growth of private photogrammetry and the development of a competitive spirit, there has also risen a unique type of profession or occupation known as the photogrammetric or mapping salesman. The basic function of this personality is to obtain mapping work for his organization. He accomplishes his objective by visiting various potential clients and alerting them to the capabilities of his own organization and how it can meet the desires of the potential client. Although this particular personality may be considered as a salesman or a sales engineer, aside from his commercial worth to his company he accomplishes a valuable service to the photogrammetric community at large, often sometimes to his own detriment and dismay. Many times he visits organizations that are completely unfamiliar with the capabilities and advantages of the photogrammetric method of mapping and he will spend considerable time and effort in educating these people in the field of photogrammetry. However, after he has done an excellent job in educating the client, it will often turn around and either award the project to another company or ask for competitive bids which do not always yield the project to the original salesman. Sometimes these salesmen in their zeal overstate the capabilities of photogrammetry and the resultant project, when completed, is the cause of disappointment to the client. In such cases the science of photogrammetry receives a definite setback. However, in general, the photogrammetric salesman gives a valuable and creditable service to the introduction of this science in areas where it is not known or is not well understood.

The photogrammetric equipment used by the private companies more or less reflects the competitive spirit under which they operate. The highest premium is placed upon a maximum output per dollar of equipment invested. A minimum amount of required operator training is desired. Recognition is taken of the fact that skilled labor is a very expensive commodity and, therefore, machines must be so designed that the human operator can work under optimum conditions. By far the most common class of plotting instrument utilized is the dichromatic anaglyphic double

projection type, particularly that which yields a projected stereo model which is a five-time enlargement of the aerial negative scale. It is more or less accepted by most commercial mapping organizations that such type of instrument, when in good calibration and well cared for, is capable of yielding stereo plotting accuracies very close, if not equal, to the accuracies obtained with the more complex and expensive optical train universal type instruments. The universal plotters, of which there are a considerable number in the United States, are utilized principally for aerial triangulation or special cadastral type mapping where horizontal coordinate data of points in the stereo model are required with a high degree of precision. Operators of such type equipment naturally require a higher degree of training and are relatively scarce. They are quite naturally paid a higher salary than the operators of the anaglyphic projection type equipment.

With respect to actual equipment that is now being used by commercial mapping organizations in the United States, it is estimated that there are approximately 300 to 400 anaglyphic direct projection type plotters in use. The large majority of these project the stereo model at five times the scale of the aerial negative. The anaglyphic projection equipment consists principally of the Bausch & Lomb Multiplex, the Balplex, the Kelsh plotter, and the Nistri Photomapper. The latter two instruments have been modified occasionally to be used at six and seven time enlargements as well as the customary five. Compilation of the stereo model with this type of equipment is usually directly at the scale of the projected stereo model, particularly for large scale mapping. Very little use is made of pantographs, coordinatographs, or other devices for changing the scale of the stereo model.

The universal type optical train stereo plotters are much less common than the anaglyphic projection type. Their possession is restricted principally to the very large companies who can afford the necessary investment. Among these instruments in actual commercial use at this time can be found examples of production of Zeiss, Wild, Santoni and Nistri. It is interesting to note that in the

greatest majority of instances where companies use this type of equipment, it is usually used in conjunction with the anaglyphic double projection type.

The principal types of aerial photography used by private commercial firms in the United States today are the 6" or 152 mm. wide-angle metrogon and 6" wide-angle distortion free type. The format of such photography is pretty well standardized at 9"×9". A small amount of aerial photography with the 8¼" (210 mm.) focal-length with a 9"×9" square format is obtained and is used mainly for mapping in extremely mountainous or heavily forested areas. Film cameras are used almost exclusively. A wide variety of aerial cameras is used including not only all commercial makes now available but also a number of surplus U. S. Air Force type mapping cameras.

Private photogrammetrists in the United States now face a stimulating challenge. A tremendous amount of work is yet to be accomplished. It is well known that the United States is not well mapped at very large scales. The government agencies are principally concerned with large-scale mapping at scales of 1:10,000 or smaller. The very large-scale maps at scales of 1:10,000 or larger are relatively scarce except in very heavily populated areas. Of course such very large-scale maps are absolutely essential for intelligent community planning as well as sound engineering. The large population expansion in recent years, and no doubt in future years, will increase the size of communities and result in more and more demand for mapping services. These the government cannot readily supply without heavily overtaxing its existing facilities. Therefore, it will fall to the private commercial photogrammetrists to satisfy these demands. It is to be hoped and expected, because of the competitive spirit of these private companies, that we can look for development of better, faster mapping techniques but at a lower cost per unit area mapped. Of course development of these new procedures and equipment will ultimately be of universal benefit to the private photogrammetrist and the government photogrammetrist, both in the United States and internationally.