

chance to train on the type of map which they may be likely to encounter in an emergency.

During the past conflict, the great share of the maps furnished troops were quite similar to those just described. Time and facilities did not permit conversion of these maps, over the areas which they had to fight, to multicolor editions. This, in all probability, will be true again.

Large-scale maps are not the only need for military purposes. A series of scales from 1:250,000 to 1:1,000,000 are needed for planning purposes. The preparation of these scales does not approach the magnitude in cost of the larger scale series, but is just as important. Much of the staff planning during World War II had to be carried on without any map information or with maps which were seriously out of date. It is highly important that staff planning on an operation be done on maps which are compatible in accuracy with the large-scale maps which the troops are to utilize in combat.

The information produced in the accomplishment of our large-scale program will be incorporated into the production of our planning scales. These planning series will, however, necessarily cover larger and more general areas than the strategic spots previously described.

Throughout my talk I have said "we will" or "the War Department plans" or "we shall." More properly I should probably have put it in terms of the Engineer motto, "Essayons," which means "We shall try," or "Let us try." A lot depends on you people of the technical organizations, the support of societies such as yours and of the public at large. We know we will have your support. We can only hope that, with your evangelistic assistance, we shall also have that of the public.

Thank you very much.

PRESIDENT MILLER: Thank you very much, General Johns.

Our next speaker is Mr. Marshall S. Wright, who is Technical Assistant in the Office of the Secretary of Agriculture. His title is actually longer than that, but Mr. Wright has suggested to me that I abbreviate it. Mr. Wright holds a very important administrative position and has much to do with policy formation in the Department of Agriculture in photographic and mapping activities. He is of course very well known to most of us here and is a unique member of this Society in that he alone has held at one time or another every office in our Society. He is also a Vice-President of the Congress of Surveying and Mapping. I have great pleasure in introducing Mr. Marshall Wright.

MR. MARSHALL S. WRIGHT:\* Mr. President, Fellow Members, Guests: The art and science of photogrammetry plays a very important role in the work of the Department of Agriculture. Few people, beside those most directly affected, have any comprehension or conception of the vast scope and the magnitude of the contribution aerial photography makes toward the fulfilment of the Department's objectives relating to the growing, marketing, and distribution of agricultural products, the protection and management of national forests, agricultural adjustment, conservation, land use, farm tenancy, rural rehabilitation, rural electrification, and other supplementary phases concerned with watershed protection, fire control, soil determinations, soil erosion control practices, and many others.

It must appear obvious, even to the layman, that nothing devised by the ingenuity of man is more ideally suited to a study of the face of the earth than is an aerial photograph; nothing can portray the physiographic and cul-

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tural conditions on the ground, and as they actually exist, including the vegetative and the forest coverage, as well as does a vertical aerial photograph.

You have heard, and you will probably hear much more regarding the use of aerial photographs in the preparation of maps, and admittedly this is the most fascinating adaptation of the science of photogrammetry. Extensive and elaborate formulae have been developed; expensive equipment has been devised and designed and is now in constant use; all for the primary purpose of transforming a picture into a map. This is highly commendable, and unquestionably constitutes the greatest single contribution made to the surveying and mapping profession during the past 200 years.

I believe that the utilization of aerial photographs *alone* or in stereoscopic pairs has been the greatest single factor contributing toward the economic solution of most land-use problems; however, in the evaluation of basic data there is a natural inclination to emphasize extensive and elaborate technical processes and overlook the more simple and utilitarian practices which in the aggregate serve the greatest and the most universal need. By the full utilization of aerial photographs in the solution of such problems it would be possible to save enough money to finance a large regular mapping program.

It may appear from the foregoing statements that I have come to the defense of the lowly single aerial photograph, and that I am leaving it to my contemporaries to explore and elucidate in the realms of higher mathematics as is involved in the science of photogrammetry. That is true, and that is my theme.

The Department of Agriculture is not a map-making organization; it is a map-using agency. It probably uses more maps in peace times than does any other federal agency. This need for maps is so great that at times it has had to make its own. It prefers, however, to spend its appropriated funds on its delegated functions; it is only when basic map information is not available that it resorts to original map making. The need for aerial photography and for topographic maps in the administration of federal land has become so acute in one bureau, namely the Forest Service, that special authority and funds have been made available by Congress for that purpose.

The single lens, vertical aerial photograph, however, or some adaptation thereof, has served the greatest need of all departmental agencies; partly as a substitute for a map, but mostly in a study and determination of many heretofore intangible factors, the procurement of which has had to be determined by actual field study and investigation.

To give some conception of the extent and volume of this work, and the vast and many uses aerial photography serves in the furtherance of departmental activities, I would like to indicate by specific bureaus the extent to which aerial photography plays a dominant role. But first, for those not conversant with the amount and kind of aerial photography executed by the Department, I wish to state that to June 30, 1945, and since the year 1926, the Department has contracted for or executed directly 2,945,000 square miles of vertical photography, at a cost of \$9,014,000, or \$3.06 per square mile. This amount of photography includes approximately 745,000 square miles of rephotography, leaving a net coverage of 2,200,000 square miles, which constitutes 70 percent of the area of the United States. The Department photography excludes a large part of the arid and semi-arid areas in the West, and consequently, the total figure represents practically complete coverage over all the agricultural land in the entire country. This photography, as most of you know, is of the single-lens type, and for the most part is on the scale of 1:20,000. Some extensive areas in the southwestern and middle western portion of the United

States are on the scale of 1:31,680. Now to indicate by specific bureau:

The Field Service Branch of the Production and Marketing Administration, formerly and probably better known as the Agricultural Adjustment Agency, has procured and utilized over 1,750,000 square miles of aerial photography. These photographs, and enlargements therefrom, have been used in county offices throughout the United States in assisting farmers in planning their field operations to increase food and fiber production and institute soil conservation practices. These photographs have also been used as a means of checking conformance with agreed upon practices performed under departmental programs.

In addition to its regular activities, which were greatly curtailed during the War to make its facilities and personnel available to the War and Navy Departments, the photographic laboratories of the Production and Marketing Administration located in Washington, D. C. and in Salt Lake City cooperated with the Bureau of Agricultural Economics of the Department, which in turn was working very closely with the Bureau of the Census of the Department of Commerce, in taking the 1945 Agricultural Census. The laboratories furnished, and helped perfect a procedure to utilize over 250,000 aerial photographs to procure pertinent census data of sample areas covering over one-eighteenth of the land area of the United States. These prepared photographs made it possible to locate and determine with sufficient accuracy particular designated areas for detailed population and agricultural studies. It is reported that their use produced results with greater efficiency, expediency, and accuracy, and at lower costs than had theretofore been obtained by using older and more conventional methods. The relative efficiency of the sampling method in this type of work depends to a great extent on the size of the given area, and the aerial photograph serves as an ideal base for choosing representative areas in rural communities, and in densely populated areas adjacent to cities.

The amount of new aerial photography to be secured in the future by the Production and Marketing Administration will depend to a large extent on the type of agricultural programs which it is determined are necessary during the reconversion period. It is anticipated that it will be necessary to not only secure aerial photography of areas not at present photographed, but to continue a program of rephotographing previously photographed areas as the photography becomes obsolete through changes in field patterns and culture.

Soil Conservation Service. The Cartographic Division thereof is primarily a service organization whose main purpose is to supply the Soil Conservation Service with all basic mapping information needed for the fulfilment of those functions which have to do with the administration of a national program of soil and water conservation and sound land-use practices, including drainage, irrigation, water utilization, land purchase and sale, land development and management, and also flood control. Consequently, it should be readily apparent the tremendous part played by the utilization of aerial photography in the consummation of these objectives.

The Soil Conservation Service utilizes aerial photography extensively in the preparation of maps designed for a particular use. For the purpose of a comprehensive determination of various factors, such as slope and erosion classes, soil types, land-use capabilities as distinguished by seven or eight classifications, it has found in most cases that maps on scales less than four inches to the mile (1:15,840) are too small. In certain drainage areas it frequently becomes necessary to make large scale topographic surveys of comparatively small areas. This type of a map is usually necessary for determining the location and size of a dam and its resultant watershed and reservoir capacity.

During the past few years there has been an ever increasing demand from the field organizations of the Soil Conservation Service for both controlled and uncontrolled mosaic maps, as considerable time is lost in the field in sorting and using individual photographs. By assembling them in mosaic form larger areas can be studied and determinations made of appropriate measures to be effected for proper conservation, irrigation and drainage practices. Investigations are now under way to determine the feasibility of preparing quadrangle sheets with a photographic background, as they should be very helpful to the farm planner, inasmuch as the map will present a pictorial view of the terrain along with planimetric or topographic data. It is realized that in areas of topographic relief, these so-called "photo-maps" will sacrifice some geographic accuracy, but the additional placement identification on such a map will offset this inherent inaccuracy from the standpoint of practical field use.

The Soil Conservation Service has no progressive national mapping program in mind as a post-war project, but will continue to furnish basic mapping information to the soil conservation districts with which it carries on cooperative work.

An extensive study is being initiated to establish or determine some criteria whereby "the law of diminishing returns" will evidence an actual need for re-photography over given areas. It is recognized that there is a certain period in the use of an aerial photograph when the features it portrays no longer represent the conditions on the ground and it would be cheaper to procure new photographs than to continue to use old material and be constantly making or noting changes. This study, it is hoped, will result in formulating some practical means of determining when new photography is warranted.

Division of Soil Survey, Bureau of Plant Industry, Soils, and Agricultural Engineering. A soil survey consists of the classification and the mapping of soils in terms which show all of the important observable characteristics of the soil possessed in any locality, and hence, show which soils are like and which are unlike those found in other localities or on any given farm or tract of land. The usefulness of this kind of a soil classification becomes apparent when it is completed, as it will permit a farmer, for instance, to know whether his soils are like those of experimental fields on which important new farm practices have been tested and found promising; it will tell him whether his soils are like those on farms in other sections of his State or his region on which experience with new crop varieties, tillage methods, or cropping systems has been found successful. The usefulness of a soil survey is not limited to agriculture. Engineering and industrial problems likewise require knowledge of soil characteristics for their solution in many instances. Problems of airport and highway construction location are examples; also as we come to depend more on forest crops to produce our wood supply we shall need a much more accurate understanding of the characteristics of our forest soils.

The availability of aerial photographs provided by agencies of the Department and by other federal agencies, have been of inestimable value in the correct delineation of soil types in the field, and have made a major contribution toward the accuracy of soil maps, and have also greatly expedited the soil mapping program of the bureau.

It is the earnest hope that now, with the end of the War, field activities can be resumed, and can be greatly accelerated, thus make substantial progress toward completing the soil survey of the entire United States, which now covers only about one-half of the agricultural portion of the country.

Forest Service. The Forest Service utilizes aerial photographs for two sep-



arate and distinct purposes: (1) Resource studies; (2) Mapping. Mapping operations, however, are secondary. In a study of the timber resources, both public and private, of the United States, and of the part taken by the utilization of aerial photography, I desire to quote from a report by the Director of the Forest Survey of the Division of Forest Economics:

"We are enthusiastic regarding the use of aerial photographs on the nationwide Forest Survey, for both initial surveys and for keeping information up to date. During the past several years our Northeastern and California Stations have been putting in considerable time developing the technique of using aerial photographs in timber inventory work. Still further research and methodology development is necessary but we have now progressed far enough so that some fairly definite ideas are taking shape.

"In interpreting aerial photographs for Forest Survey purposes we expect to determine at least forest type, tree heights, crown widths, and a density estimate, or tree count. This information would then be supplemented by such ground studies as are necessary to obtain information on species composition and under-story not determinable from the pictures, growth, quality, and reproduction counts. At present there is no consensus as to the scale of aerial photograph or type of picture most satisfactory for timber inventory work. At present our field stations are making a study of pictures of different scales of the same area in order to determine which is most satisfactory for timber inventory purposes. Along with this analysis will go also the focal length of camera and the type of film.

"Preliminary results indicate a leaning toward a scale of 1:15,840, or 4 inches to the mile. This particular scale fits into a variety of uses in forest type mapping and is sufficiently large to permit fairly detailed interpretation of aerial photographs. Preliminary tests in the Northeast indicated that aerial photographs taken on infra-red film using a minus blue No. 12 filter gave a fairly satisfactory differentiation between hardwoods and softwoods and between several species within the softwood group. Most of the aerial photographs now available for timber areas are on the ordinary panchromatic film. Our experience indicates that such pictures, even though used with a filter, do not differentiate satisfactorily between species."

As indicated earlier in this paper, the Forest Service is the only agency in the Department of Agriculture that secures funds directly by appropriation from Congress for the specific purpose of procuring aerial photography and making maps. During the last fiscal year the Forest Service received an appropriation sufficient to secure aerial photography of approximately 25,000 square miles of national forest land. These photographs, when procured, will be used in resource studies, fire detection and suppression work, road location studies, and other diverse forest uses. Subsequently they presumably will be used in the preparation of topographic maps meeting national map accuracy standards. In specific instances, however, it may be found necessary to photograph a given area on two different scales, as large scale photography may be necessary for detailed resource study.

Field control operations are now under way on an area of 3,000 square miles in Arizona, and a topographic map on the published scale of 1:63,360 in standard 15-minute quadrangle units will be prepared by modern stereo-photogrammetric methods, and as such will constitute a contribution toward the completion of a national mapping program.

Additional funds are being requested of Congress for the next fiscal year. These funds, if appropriated, will be used to finance additional aerial photog-

raphy and standard topographic mapping. It is proposed that all horizontal and vertical control will be executed to established standards by the Regional Offices of the Forest Service, and that topographic quadrangles will be prepared meeting national standards.

National forest lands cover approximately one-tenth of the area of the United States. For approximately 300,000 square miles of this area topographic maps are not available, or where available, fail to meet national mapping standards. Aerial photographs are needed for an even larger area because of requirements for resource, as well as map use. It is hoped that the mapping organization of the Forest Service can be enlarged and funds will become available to permit the mapping of these areas at an accelerated rate.

The foregoing statements outline the extent, kind, and future plans of the departmental agencies to execute aerial photography and produce maps and mosaics. There is one other phase of departmental activity, however, that is worthy of mention; in fact, it in itself is a major function in several of the aerial photographic laboratories. It is the sale of photographic reproductions. The Congress of the United States, under Section 387 of Public 430, 75th Congress, approved February 16, 1938, authorized the Secretary to "... furnish reproductions of such aerial or other photographs, mosaics, and maps as have been obtained in connection with the authorized work of the Department to farmers and governmental agencies at the estimated cost of furnishing such reproductions, and to persons other than farmers at such prices (not less than estimated cost of furnishing such reproductions) as the Secretary may determine, the money received from such sales to be deposited in the Treasury to the credit of the appropriation charged with the cost of making such reproductions."

To fulfil a demand from Federal, State, and county agencies, municipalities, public utility corporations, and private agencies for use in mapping, physiographic studies, highway locations, geological studies, and for innumerable other uses the Production and Marketing Administration's photographic laboratories alone have sold over \$800,000 worth of reproductions. The disposition of such material was greatly restricted during the War, but since the War ended, non-federal sales have increased three-fold.

In conclusion, I want to correct any impression I might have unintentionally given that the agencies of the Department of Agriculture are only "picture-using" organizations and are not greatly concerned with the photogrammetric phases of precision measurements and the mathematical and optical techniques involved in the procurement of accurate data from aerial photographs. The trained photogrammetrist readily appreciates the difficulties involved in procuring accurate data, and obtaining area determinations from aerial photographs having a certain amount of tip, tilt, and relief. To him no qualifying statement is necessary; but, for the benefit of the layman I want to re-emphasize the fact that all the involved complexities of unraveling the inherent distortions of an aerial photograph by the exercise of the techniques of photogrammetry are with us always.

It would be an injustice to the photogrammetric technicians of the Department if I did not take this opportunity to inform you that at least three of the most universally accepted methods and instruments used in the process of mapping, namely the Slot Templet, the Overhead Projector, and the Mechanical Arm Templet, were conceived, designed, and patented by individuals in the Department of Agriculture. There are two other instruments in this same category which are not so well known, i.e. the Cook Plotting Instrument conceived, designed and patented by Lt. Comdr. Charles O. Cook, formerly of the

Soil Conservation Service; the K. E. K. Stereoscopic Plotter patented by Messrs. King, Elliott, and Kail of the Forest Service. Additional, but unpatented contributions furthering the science of photogrammetry are the Kail Radial Plotter and the Photo-Camera and Photo-Transit. Most of this latter equipment is on exhibit at this meeting.

Mr. Kelsh of the Soil Conservation Service has done considerable research in the development and manufacture of equipment for the projection of full-size diapositives by an adaptation of the multiplex method, and has amply demonstrated its feasibility and potential possibilities in large scale mapping operations. I thank you.

PRESIDENT MILLER: Thank you very much, Mr. Wright.

Our last speaker on the program this afternoon is Mr. Robert H. Randall. We are now going to hear from the Executive Office of the President, the Bureau of the Budget, in Mr. Randall's person. It is fitting, I think, that Mr. Randall should be the last speaker this afternoon, as the Bureau of the Budget often has the last word. Mr. Randall acts, as a great many of you know, as liaison and coordinator between the federal mapping agencies and the Bureau of the Budget, and as such he is rather an essential person to have in this group of talks, to give one of them. I should like to point out at the same time that Mr. Randall has had a great deal of practical experience of his own in mapping and cartography and can speak in his own right on technical and administrative aspects of this subject. I have very great pleasure in introducing Mr. Randall.

MR. ROBERT H. RANDALL: Mr. President, Gentlemen on the program, and Members and Guests: I am very grateful to our President for assigning the reason which he did assign for my appearance last. As a matter of fact, this rather obvious sneak I did across the front of the room was occasioned by the fact that I got snarled up in my traveling plans as between the annual meetings of the American Society of Civil Engineers and the American Society of Photogrammetry. That is a kind of circumstance that has its advantages. If I had been on time, if I had been able to have gotten here for the morning's session and for the early part of the afternoon's session, I should then have had to give my few remarks in such a fashion that I didn't contradict anything that had been said by any body, by any of the previous speakers, or repeat things that had been said previously by speakers. But as it is, you see, I am just in free-wheeling. I came late, I don't know what has been said, except Marshall Wright's talk, so I have a certain amount of latitude which I shall try to exercise with discretion.

The subject is "Postwar Plans." I take it that that is of interest to two groups represented in this audience. In the first place, there are those who use the products of photogrammetry, and then, of course, for the larger part, there are those of us who make photogrammetric maps, photographs, and everything on down to the final published copies of maps. I think what most of us are really interested in is what will be our personal activities in the postwar period. Those of us who, either in the public service or in private concerns, engage in photogrammetry, those of us who are here representing either of those groups, would like to know anything that there is to be known about the future.

Although, as our President has said, the Bureau of the Budget gets a certain insight into what federal agencies would like to do for the ensuing year, yet it gets that insight after the federal agencies themselves devote a lot of heartfelt study to the problem. So, I suspect that you have heard most of what is going to be actual in the plans for producing maps and charts, and so on, by photogrammetry for the next year or two years, as they have been detailed to you by previous speakers. So, I am not at all sure that I can add anything in particular