technicians during the war. While sufficient equipment was available to do most of the required mapping, trained technicians were scarce and production was in general, slow. This is the principal reason why mosaics, and anaglyphs were often substituted for topographic maps for the carrying out of military operations. There is no evidence that German mapping organizations, in spite of a traditional background of research and development and the complicated instruments produced, has equaled our own country in the actual production of topographic maps through the utilization of modern photogrammetric methods.

Mr. Russell K. Bean was introduced. His paper, which follows, deals with the general aspects of German Photogrammetry and its development.

MR. BEAN: The information given is the result of investigations which were made in Europe shortly after VE Day. This mission was made possible through cooperation of the Geological Survey and the Corps of Engineers, U. S. Army.

Terrestrial Photogrammetry

Terrestrial Photogrammetry, the oldest branch of stereophotogrammetry, was revived during the war years and increasingly used in engineering projects, such as water and power supply, highways, and railroads. It was also used for military map revision in Alpine lands. A new small model of a terrestrial plotter —Klein Autograph—was ready to go into production at the war's end.

Pleon Lens—136° and 148°

Development of the 136°, f = 8 cm., Pleon lens was finished in 1936, but commercial use was barred by military authorities and research on proposed plotting equipment thereby hindered. The 148°, f = 7 cm., lens was developed during the first year of war to replace the German 9 lens camera, which also covered 148°. The very high marginal distortion of this lens is eliminated, to a certain degree, in an elaborate optical converter. Cameras of this type rendered very valuable results, according to reports, in reconnaissance mapping. It was used extensively over vast areas in Africa and Eastern Europe. Contact prints were reported to be useful as an aid to navigation by the Luftwaffe pilots. Both contact and converted prints were extensively used in radial line work, by the slotted template method.

Use of Radar

Apparently radar as an aid to navigation was not used on photographic missions; however, special instrumental methods of navigation were employed instead, in connection with gyro-equipment. Strips as long as 200 kms. were precisely flown quite straight and on parallel courses.

Employment of Rectifiers

Germany made extensive use of rectifiers, particularly during the war years. The large SEG-I type was used for both civil and military purposes. Controlled mosaics to accompany the 1:5,000 sheets of the German Base Map were made. Anaglyphic mosaics were made for military purposes at many scales and of different classes. Reconnaissance mosaics were quickly made, as substitutes for line maps of theaters of operation.

The small SEG-IV type was used more as a field instrument for both controlled and uncontrolled mosaics and for map revisions.

Attempts were to be made to improve the projection optics and the illumination of the rectifiers. The instrument was to be made more automatic, also.

Employment of the Stereoplanigraph

The stereoplanigraph was used to secure aerial triangulation for military mapping of very large areas; for revision and remapping of the 1:25,000 topographic map; for creation of the 1:5,000 "Base Map of Germany," a combined cadastral and topographic map; for large scale precise mapping for engineering and strategic purposes; and for military mapping of all classes.

Various Military Uses of the Stereoplanigraph

War uses to which the steroplanigraph was put included the determination of flying characteristics of aircraft, trajectories of various missiles by the use of photograms taken with special wide angle synchronized phototheodolites or cinetheodolites, and the determination of the impact of heavy artillery and other missiles on concrete and various materials.

Personnel Used for Instrument Operation

Institutions which pioneered the stereoplanigraph as their first-order instrument adhered to the policy of employing well-trained and experienced professionals in surveying, i.e., with a good field or theoretical background. Beginners started as assistants at the coordinatograph, or drawing surface, and advanced gradually through all steps and operations. Later in the war military units used officers, enlisted men, and civilians in the operation of the instruments and personnel of all descriptions as assistants. Output and quality of work were, in some instances, not first class. With manpower decreasing, female help was tried and in several cases found efficient.

The Cartographic Institute of the Hungarian Army used female operators and assistants for stereoplanigraph and multiplex work exclusively.

Order of Procedure in Stereoplanigraph Work

Wide angle (18×18 cms.) negatives were mostly replaced by 30×30 cm. normal angle, f = 20 cms., negatives during the last years of war. This condition was forced through by those wishing photographs for intelligence studies, etc. Many photogrammetrists complained of this as detrimental to efficient results.

For the Base Map of Germany 1:5,000 normal angle photography was used exclusively, the scale of the negative about 1:7,500. Extensive field work using the aerial photographs supplied ample control and identification of essential features. Planimetry was generally plotted on base sheets, topography on overlays. Plotting scale was the same as publishing scale, and reproduction was by various color separation methods.

For the Topographic Map—1:25,000—aerial triangulation was used up to ten pictures; negative scale of normal angle and wide angle photography was between 1:25,000 and 1:30,000.

The camera with 18×18 cm. film, f = 10 cms., Topogon wide angle lens similar to the RMK P-10 known in this country before the war, but with slight improvements, was still their best mapping camera.

Output per Unit of Time

Production figures varied greatly with different German organizations and with other European countries. One plate pair per day was a first approximation applicable to general mapping scales and types of photography, basic requirements being good control, good photographic quality, farsighted planning, and frictionless coordination.

Many European institutions fell short of the above. I was informed that one of the best organizations was the "Turkish Military Mapping Institute," with a regular output of 3 sq. mi. per 8-hour shift of 1:25,000 topographic map made from wide angle photographs having a scale of 1:30,000 to 1:40,000.

Stereoplanigraph Manufactured

Starting with the C/1 to C/4 model in 1923, thirty-two (32) instruments were manufactured through 1936. The C/5, with considerable change, was started in 1937, and one hundred (100) instruments on this model were manufactured through 1943. Some of these, made in the last part of the war, had luminous floating marks, with a choice of several designs of dots, circles, etc. These marks could also be projected in color. There were also some mechanical improvements. Thirty instruments, nearly completed, remained at the Zeiss factory.

A complete redesign of the stereoplanigraph was intended, which would result in a new C/6 model.

Ratio of the Stereoplanigraph to Multiplex

The stereoplanigraph, in the opinion of several German photogrammetrists, should be used to procure, by the extension of control, a sufficient number of pass points to make possible the break-down of strip flights into independent pairs of overlapping photographs. These pairs or single models should then be plotted by multiplex.

With an eight-hour shift output of 10–12 consecutive photographs (including the compensation of closing errors) one Stereoplanigraph would keep 6 to 10 multiplex instruments, comprising two to three projectors each, busy. This would, of course, depend upon plotting scale, amount and kind of relief, and the volume of cultural features.

The Swiss promote a similar theory in that they recommend one Wild Autograph, A-5, to four A-6 plotters. These would cost the same for initial cost as two A-5 instruments. The output of the combination would be two and one-half times that of the two A-5's used alone.

Order of Procedure in Multiplex Work

Multiplex instruments in Germany had a surprisingly small part in peacetime mapping activities. The amount of military work was difficult to ascertain, as this instrument was carried by many units in the field during the war. Wide angle photography prevailed, but diapositives from negatives 30×30 cms. in size and with focal lengths up to 50 cms. were used in the multiplex.

The German multiplex equipment was improved only slightly during the war.

Military Employment of Multiplex

Military applications of multiplex were: aerial triangulation of restricted scope, medium and small scale military mapping, map revision by military field units, establishment of control for rectification, and some application to the building of relief models.

Wide angle projectors, with certain modifications, were used to operate as small rectifiers. Results did not compare favorably with standard equipment.

Normal angle projectors were used as sketchmasters with slight modifications. Special light diffusing and color screens in place of multiplex filters were used for the comfort of the operators' eyes. The design was received very favorably, though brought out late in the war.

Normal angle projectors were used for plotting pairs of obliques having tilt angles of 10° to 20° below the horizon. As in this country, it enjoyed a fair degree of success.

Other devices or adaptations of the multiplex or double projection methods were tried in connection with older devices, such as the "Duplex" and "Multiplag." The optical problems involved offered too much difficulty and were dropped.

German Multiplex Activity and Accuracy

The following is quoted as translated from a German report:

"A review of German multiplex activity in recent years falls short of evidence that there was intelligent planning and adequate exploitation of the possibilities which this instrument offers. This result was largely due to the military nature of the work done with it, particularly to subsequent restrictions put on publication of results and the wartime circumstances which made it imperative to disregard basic requirements of photogrammetric practice to the extent of making diapositives from contact paper prints. Flying heights in excess of 20,000 feet, focal lengths up to 50 cms., base-height ratios down to 1:8, underexposed negatives, excessive tilts, irregular overlaps, poor photographic processing, insufficient or poor control, inability of personnel, red tape, lack of cooperation, and other inadequacies defeated sincere efforts and great opportunities."

In an effort to obtain more information on multiplex, I was told, and again I quote:

"No reliable or helpful information could be given which was better than that accumulated by the Photogrammetric Section of the U. S. Geological Survey."

General Comment:

I found that, in general, Europeans were more interested in the use of multiplex and the progress made in the design than in any other thing American in the photogrammetric field.

Cameras in general were of higher precision than American made cameras. There is a tendency toward glass plate cameras again, mainly due to a desire to feel certain that bothersome errors attributed to film were in the main eliminated.

I found that several scientists of the Zeiss Aerotopograph GMBH were of the belief that the Topogon wide angle lens could be made to be practically distortion free and yet have good resolution. It was believed that this could best be accomplished at some particular focal length, perhaps between 4″ and 5″. This is not at variance with the belief of engineers connected with the manufacture of the Metrogon wide angle lenses in this country.

Camera mounts have geen given quite a lot of consideration in Europe and were apparently due for an intensive study. Gyro control of the mount was experimented with. The compensation of film movement also was studied.

Undoubtedly we in America get a lot more out of a given amount of equipment than most Europeans.

In talking with engineers in England, France, Germany, and Switzerland I found them in accord with each other and with me in the belief that the preciseness with which the aerial photography is carried out must be more carefully engineered in the future. This involves the airplane and its performance or adaptability to requirements, the camera and its mount, satisfactory film, proper exposure and processing of the film, and the precision necessary in

taking the photographs from the correct positions in space so that more economy may be realized in the making of the map. This is in accord with beliefs which I hold and hope to be able to experiment with in the near future.

During several very interesting days spent at the Wild plant at Heerbrugg, Switzerland, and due to the courtesy of the various officials, I was fortunate enough to be able to see the various steps in the manufacture of their surveying and photogrammetric instruments. Although their theodolites need no introduction, I am of the opinion that we would do well in America to investigate thoroughly their A-5 and A-6 plotters as to how they may fit our present or future needs.

The use in Europe of Correctostat, made by Agfa in Germany, as a photographic or map manuscript base offers, I believe, an excellent solution to one of the most bothersome of errors in the processes of producing a map. This material, well known to some, is produced by laminating a sheet of thin tempered aluminum between two sheets of excellent grade thin drawing paper. This forms a thin, flexible medium having the proper qualities for good pencil or pen work and one which has very little absolute shrinkage and practically no differential shrinkage. A sample which I have had in my possession for ten years shows no discoloration due to the adhesive used, even though I have soaked it in fairly hot water and left it there for twenty-four hours.

The application of photgrammetry to fields much wider than those covered by mapping alone enjoys a more prominent place in Europe than in America, but offers an opportunity to photogrammetrists in this hemisphere to "put on their thinking cap" and go to work.

At the conclusion of the formal part of the meeting, John R. Coltharp requested permission of the president to make an announcement from the floor. This being granted, he announced that the custom of the Society in holding semi-annual meetings should be revived and that the Rocky Mountain Society of Photogrammetry recommended Denver as an ideal place for such a meeting to be held this year. Mr. Arthur J. McNair, president of the Rocky Mountain Society extended the remarks by stating that the Society would be only to glad to act as hosts if suitable plans can be worked out. Col. FitzGerald thanked them amid applause from the members, and adjourned the meeting.

COMMENDATION

On 26 February 1946, Rear Admiral G. S. Bryan, Hydrographer, for James Forrestal, Secretary of the Navy, in the presence of the entire personnel of the Hydrographic Office, presented to Mr. Guillermo Medina, the Distinguished Civilian Service Award and Citation in recognition of his outstanding services to the United States Navy while serving as Head Engineer in the Hydrographic Office during World War II. This citation read in part—"For outstanding contributions in which he gave freely of his time and energy, rendering services far and above those ordinarily required or expected in the performance of his regular duties. Mr. Medina is richly deserving of the Navy's highest civilian service award."