it is evident that the omission of many details was necessary. I hope that some of these may be brought out in subsequent discussion.

While experience has shown that in each of the particular examples discussed, aerial photogrammetry has effected a considerable saving in both time and cost, one must be cautious in assuming that this will always be true. Local factors such as climate, extent of area, shortage of staff, political considerations and the nature of the terrain, all play their share in influencing the manner in which the work can be most efficiently carried out. It should be borne in mind that photogrammetry is still a comparatively new tool to the engineering profession, and any attempt by the photogrammetrist to oversell the employment of this method can only result in a loss of confidence by those who do not always appreciate that like all other tools, the aerial camera and the plotting machine have their limitations.

Finally, I express my indebtedness to the Surveyor-General of Ceylon, The Transmission Engineer of the Eastern Division of the British Electricity Authority, and the Director of Surveys of the Sudan Government for permission to publish the results of projects initiated by them, and to which reference has been made in this account.

GLOBAL MAPPING*

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ABSTRACT

From the extremely localized activities of the earliest cartographers, the scope of the mapping industry has expanded until today its operations have assumed a global aspect. Previewed in World War II, confirmed by the Korean War, and emphasized by the recent efforts toward international cooperation, the need for an over-all mapping preparedness program on a world-wide basis has become imperative. As the primary military mapping agency of the United States, the Army Map Service is endeavoring to accomplish such a program by increased productive capacity, an intensified research and development program, participation at national and international conferences, increased collaboration with foreign mapping agencies, and actual operations in far-flung parts of the world.

IN PRESENTING to you a résumé of the Corps of Engineers world-wide mapping efforts, one portion of my remarks will be confined to the current progress in this direction. The other portion will be restricted to those problems incidental to global mapping, which still need resolving, and for which your aid is solicited.

Global mapping is influenced by two requirements—economic and military. United States participation in world-wide mapping efforts coincides with: first, its search for economic resources and world markets; second, the necessity for protecting its citizens, property and interests; third, a need to maintain military security of its mainland and outlying possessions; fourth, a need to service actual or anticipated expeditionary forces; and finally, a duty to implement those official collective actions of the United Nations.

Fulfillment of this complex mapping requirement has been extremely difficult, time consuming and expensive. Many reasons can be cited for the inability of the United States to obtain optimum mapping coverage of those portions of the world which are vital to its interests. A few of these reasons are: The limited season and adverse weather conditions in certain areas of the world (such as the Arctic) for ground surveys and photography; inadequate logistic support because of the lack of communication facilities (as in certain desert or mountainous regions); the difficult terrain characteristics (such as dense forest growths in the tropics or

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tundra, permafrost and glaciers in the Arctic); the lack of sufficient basic ground control, adjusted to a standard datum, from which photogrammetric control surveys could be initiated; and political barriers to certain areas. Needless to say, these factors are more significant now than they were prior to World War II. Our economic, political and military commitments have become more extensive and involved.

Recently military mappers have shown increased interest in the northern approaches to the Western Hemisphere. Strategic defense of this area has become of primary concern to military planners. With this concern has come the urgent need for precise knowledge of those large land masses containing our early warning devices, our listening and weather stations, and our strategic air, navy and army troops' bases. Data on the size, shape and exact geographical positions of these land masses is vital to military planning, as is the location and character of natural land barriers. Relating these features in an accurate and systematic pictorial form is the primary aim of the mapper. Determining the graphical scale for portraying these features; deciding the contour interval to be used for different land formations; and defining the extent to which additional intelligence data, such as names, landmark features, aids to navigation, etc., are to be shown, are additional factors which are governed by the map's military use.

In other parts of the world, implementation of military mapping requirements differ somewhat from that of the Western Hemisphere. Overseas areas where United States troops are stationed, such as Japan, Korea, Germany and Austria, afford many opportunities for cooperative mapping with local agencies. Such facilities are used where practicable for establishing field control, field identification and annotation of data on aerial photographs, and field checks of completed sheets. Military topographic units stationed in those areas assist native mapping agencies in such activities and conduct map compilation, revision, and reproduction to supplement the Army Map Service's production.

In still other countries, especially those with membership in the North Atlantic Treaty Organization, other forms of cooperative mapping effort are employed. In some countries, commercial or military aircraft are procuring aerial photography; in others, local agencies are obtaining field data for ultimate use in map compilation; in still others, local agencies have contracted their services for complete mapping, including photography, field surveys and office compilation.

Certain nations are limited in facilities and/or trained personnel to carry out complete mapping activities. Cooperative efforts are made in such countries in a number of ways. Aerial photography may be flown by United States commercial or military aircraft; local personnel may be trained in mapping procedures and techniques at United States mapping agencies, or conversely, United States technicians may be sent to those countries to act as instructors or advisors in certain specialized mapping fields.

Where the immediate need is reconnaissance for planning purposes, and time precludes obtaining adequate ground control data, electronic equipment is being used. High Precision Shoran trilateration techniques for extension of basic control have been used in some instances to traverse wide desert expanses and to tie outlying islands into a common datum; Shoran grid network photography, with lines spaced at about 50-mile intervals, has been flown in certain isolated areas as a supplement to the high-altitude vertical photography previously obtained; and in still other cases, high-altitude Shoran photography has been flown wherein the Shoran position of the nadir point of each photograph has been determined. This latter technique, when coupled with simultaneously recorded altimeter readings, as well as with the addition of numerous cross flights of similar high altitude photography, appears to have considerable merit.

It may be well here to invite attention to some of the specific contributions made recently by the Army Map Service in the field of mapping. They generally fall into three major categories: (1) Direct contributions to basic scientific knowledge of the earth's size and shape; (2) Technical improvements in measuring long lines or determining positions on the earth's surface; and (3) Joint cooperative efforts to improve the world-wide mapping picture.

In the first category, contributions to scientific knowledge, the following may be cited:

(1) Continued effort to integrate and revise the extensive geodetic triangulation nets with the ultimate goal of devising a best-fitting figure of the earth, which in turn will provide more exact measurements of intercontinental distances.
(2) Precise ground triangulation in areas of the world where significant gaps exist. A cooperative project of this kind was completed recently. It involved closing a 630-mile section of triangulation in East Africa. This section is a part of the 4,000 mile arc, along the 30th meridian between the Cape of Good Hope and Cairo. The arc was extended recently across the Mediterranean by the use of a Hiran connection through the Isle of Crete to a connection with the European Datum. Thus we have a 7,000-mile intercontinental arc running northward from South Africa, through Europe, to the Arctic.
(3) The establishment of a geodetic datum, through the efforts of nations coordinating with the Inter-American Geodetic Survey, for Central and South America and its connection with the North American Datum. This will result in one continuous arc of triangulation from the southern tip of South America to the northern limits of Alaska.

In the second category, technical improvements for measuring long distances on the earth's surface, the following may be cited:

(1) Intensified use of star occultations to determine long distances on the earth. This method depends on accurate timing of the instant when the moon covers a star, as observed from two widely separated stations. The positions of these stations are chosen so that the same feature of the moon's edge cuts off the star's light at both stations. The discrepancy between the observed time and predicted time is noted, and computations are made which yield, for each occultation, a line of position along which the unknown point must lie. At present such operations are being carried out in the Pacific for the purpose of tying various island groups together and eventually tying them to the Asian Mainland and the Tokyo Datum. One result should be a marked improvement in the position of Loran stations with a consequent improvement in the navigation of Pacific waters.
(2) Extensive use of new instruments which facilitate the determination of precise distances and triangulation base lines. An example of this type is the geodimeter—an electronic optical device—which measures the time interval for a light beam to travel to and from a mirror, located at the terminus of the line to be measured. Utilizing this interval, as well as the known constant value of the velocity of light, it is possible to translate the data into a distance measurement—and in a more accurate manner and in less time than by conventional methods. The geodimeter has the further advantage of making it possible to measure distances from one hilltop to another.

In the third category, joint cooperative efforts to improve the world-wide mapping picture, the following may be cited:

(1) Cooperative mapping programs to satisfy North Atlantic Treaty Organization needs. The objectives of these programs are uniformity of map symbols and standards among the participating nations; regular exchange of maps, source materials, reproduction material, geodetic and aerial photographic data; and the exchange of technical personnel for advanced studies and exchange of ideas and techniques. In the same spirit of cooperation, steps are being taken to prepare a set of international standards for maps—standards which affect all phases of map preparation, including requirements for accuracy, common symbolization, and terminology.
(2) Similar cooperative efforts with Latin American countries are being promulgated. Through the Inter-American Geodetic Survey, operating out of the Canal Zone, and with active representatives located in seventeen countries of South and Central America, many advances are being made. Programs thus far

initiated include establishment of basic geodetic and electronic triangulation networks, procurement of low and high altitude photography, and compilation, by stereophotogrammetric means, of certain selected areas.

(3) The least squares adjustment of the triangulation of the European Continent and its reduction to a common geodetic datum.

(4) The processing of thousands of geodetic control stations in Europe and the Far East and the publication of many separate trig lists for these areas.

(5) The conversion of large scale and medium scale maps, in the conversion areas, to the Universal Transverse Mercator (UTM) Grid and the reprinting of stock quantities.

From the foregoing statements, it is apparent that the efforts in carrying out mapping missions in various parts of the world follow no set pattern—they are extraordinarily different in various parts of the world.

It is also apparent that although much is being done to accelerate the world-wide mapping program, a great deal still needs to be accomplished—some of the work to be carried out appears to be relatively simple—some is difficult. At this time I present for your consideration a number of problems of immediate concern to the military mapper.

First, the lack of capabilities for the procurement of vertical ground control data of sufficient accuracy to permit production of 1:25,000 scale topographic maps for all conditions of terrain, by means other than conventional "on-the-ground" surveys.

Second, the lack of uniformity between aerial photographic, aerial triangulation, and stereo-compilation equipment among the various mapping agencies of the world. Such variances prohibit full use of all the mapping capacity in time of emergency. Perhaps the availability of a universal diapositive printer, capable of satisfying the full range of variables, would be the answer.

Third, the apparent lack of uniformity in basic concepts of mapping agencies, especially as they pertain to the maps' purposes, the manner in which maps are produced, the horizontal and vertical accuracies required, the manner of conducting equipment tests, and the nomenclature for procedures and techniques.

Fourth, the incapabilities of certain aerial triangulation and stereocompilation equipment to be used in conjunction with heterogeneous aerial photography flown with cameras of different focal lengths, lens distortions, film or plate format sizes and convergent angles. The solution to this condition will not be met by providing such universality in just the newly manufactured equipment but provision must be made for the economical modification of the large numbers already available to the mapping agencies.

Fifth, the lack of an aerial camera stabilizing mount capable of procuring photography with tips or tilts of less than 1 minute of arc. Convergent or Shoran photography obtained under such conditions and supplemented by automatically recorded altimeter data should result in greater map compilation accuracies.

Sixth, the simultaneous demand for original film, to satisfy mapping and intelligence requirements, points to the necessity of improving duplicating processes. Current processes and materials employed result in products inferior to the original both in photographic quality and dimensional stability.

Seventh, the lack of techniques and procedures for rapidly, economically and, perhaps, automatically translating stereo-compilation data to the lithographic press plate without resorting to intermediate cartographic steps. Perhaps scribing techniques or an electronic-viewing device that records map features on metallic tapes would be the solution. An added feature of the latter method is that the same basic recorded data could be used to prepare maps at different scales.

Eighth, since mapping photography is being flown at higher altitudes, the success of these missions is dependent to a great extent upon overcoming the obstacles imposed by atmospheric conditions. Improved films, filters and lenses must keep pace with man's increasing ability to fly higher.

The ninth problem relates to quickly photo-revising maps. Upon the beginning of hostilities in any area, this phase of map preparation becomes a major one. Increased capability for this operation is a problem deserving immediate attention.

The problems which I have presented need resolving. No individual, no single commercial mapping or equipment manufacturing organization, no single governmental mapping agency, civilian or military, is best able to solve them. It is only through collective effort, as exemplified by the professional interests represented here that we can hope to reach our goal. Perfecting the present photographic and mapping equipment and techniques and satisfying the needs of the global requirement are a challenge. Such a challenge must be met—it was met before by similar groups in World War II—it can be met again by this one. Our stake in peacetime is caring for the common good. Our stake in times of military emergency may well be common survival—of ourselves as well as those democratic traditions we cherish.

NEWS NOTES

Portable Processing Machines

Use of heliarc welding in the production for the Navy of portable photographic processing machines which will handle 70 mm. 5, $5\frac{1}{4}$, $5\frac{1}{2}$, 7 and 9-inch wide film in lengths up to 250 feet has been announced by Alan Gordon, president of Gordon Enterprises, camera manufacturer, North Hollywood, California.

Because of the relatively strong acids and alkalies routinely employed in photographic processing, and because of the damage from shipping and other handling which the equipment may suffer, use of heliarc welding was especially important in manufacturing these portable machines.

The use of inert-gas welding in manufacture of photographic equipment is a recent development. It avoids weakening of the parent metal at the welded seam which occurs when the metal is heated and its chemical and physical properties change because of oxidation. Heliarc welded seams are equal in strength or better than the strength of the parent material.

Gordon Enterprises is a prime source of heliarc welding applications to photographic equipment, having done considerable experimental work in adapting the process to photographic equipment manufacture.

Super Concentrated Liquid Chemicals for Photographic Use

Announcement of superior chemicals for stabilization processing of oscillograph, electrocardiograph and seismographic recording materials has been made by the Photo Concentrates, Inc. of Peekskill, N. Y.

The company recently became associated with the *Oscar Fisher Company* as an adjunct to its operations in the photographic processing equipment field.

In announcing the Association of the two companies, Mr. Kinsler, President of Photo Concentrates and Mr. Fisher, President of Oscar Fisher Company stated that the chain to complete integrated photographic processing is now completed. The use of modern high speed chemicals makes the design of superior processing equipment possible, at the same time that it makes possible the thorough testing and evaluation in modern equipment of modern photo chemicals. The officers believe that superior chemicals, as well as superior equipment, will be the result of this association.

Beverley Devised for Arctic Transport

A tanker configuration of the Blackburn Beverley transport has been devised by Field Aviation Company Limited, of Oshawa, jointly with the English manufacturer, for the continuing supply of Arctic outposts. According to Hunting Associates Limited of Toronto, Ontario, considerable interest in the application of this aircraft to Canadian requirements has been shown.

The Beverley Tanker is particularly well adapted for supplying by air all types of fuel and other items to Arctic stations which can only be supplied by sea for, at the most, one month a year.

The Beverley has the capacity to carry bulky items of spares and maintenance equipment in addition to fuel. These items do not have to be broken down to go in the Beverley, thus saving both manpower and time.