THE AAF'S CONTRIBUTION TO THE ADVANCEMENT OF PHOTOGRAPHIC MAPPING AND CHARTING

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THE 37th anniversary of the AAF was marked 1 August and the 35th anniversary of the purchase of the first military plane 2 August. A Signal Corps order 1 August, 1907, created the Division of Aeronautics, with one captain and two enlisted men assigned to the office.

"This organization has grown to an air force with approximately 2,300,000 officers and men and more than 75,000 planes, including 34,000 of combat types. The first plane, accepted by the Army 35 years ago, weighed 740 pounds empty and 1200 pounds with fuel, water and two passengers. It was powered with a 30-horsepower motor. Following acceptance of this first plane, the first Army flying field was established at College Park, Md., the world's first military airdrome. Gen. Henry H. Arnold, Commanding General of the AAF, was the 14th student assigned for flight training and when the rank of military aviator was established he became one of the first three officers to earn wings."

The ARMY AND NAVY JOURNAL of August 5, 1944, referred to the early days of the Air Corps in the above words in commemoration of the anniversary of that branch of the service. This is of interest because the development of the Air Forces has been accompanied by a corresponding development of photography and photogrammetry which has been stimulated to a considerable extent by the development of military aviation.

Originally, as intimated in the above quotation, the Air Forces was merely a division of the Signal Corps. Recently, as we all know, it has grown from a separate branch to an autonomous position comparable to that of the Army and Navy.

The bombs that are dropped from airplanes have grown since the early days of World War I from objects approximately the size of grapefruit to the block busters with which we are acquainted today. It is therefore not surprising that cameras and other equipment have undergone a similar evolution.

It is the purpose of this article to describe the development of aerial photography as employed by the Air Forces for map and chart making purposes during the past ten years. In order to see the picture in proper perspective, it will be necessary first to consider some of the early phases of photography and flying.

Credit for the first practical work in adapting the camera to surveying probably belongs to Laussedat, who began his work in 1849 under the Engineer Corps of the French Army. He realized the advantage of photographing from the air and began his experiments with a plate camera suspended from kites. At that time Germany, Austria, and Italy followed suit and the art developed more rapidly, for a time, in Europe than in America. For example, Theodor Scheimflug, a captain in the Austrian Army, developed a multiple lens camera which he suspended from a captive balloon.

According to a mimeographed publication of the Geological Survey entitled AERIAL PHOTOGRAPHIC MAPPING BY THE GEOLOGICAL SURVEY, "Available records show that the first known photographs from an airplane was a motion picture taken by Wilbur Wright in a flight over Centocelli, Italy, on April 24, 1909. Wright's motion pictures, however, were not taken for mapping purposes." The article continues, "The earliest record of photographs actually taken and used for mapping is in a paper by Capt. Cesare Tardivo (of the Italian Army), presented September 25, 1913, at the meeting of the International

Society of Photogrammetry held in Vienna. He displayed a mosaic of 1:4000 of the city of Bengazi, Italy."

At the commencement of the first World War the amount of intelligence furnished by the air forces depended largely on what the aviator could see, remember and report. Due to the fact that the camera was accurate and stored information indefinitely, increased use was naturally made of aerial photographs. The majority of these photographs were undoubtedly of the reconnaissance type although some photographs were used for mosaic and mapping purposes.

It is beyond the scope of this article to trace the history of photography in World War I, but its importance as a stimulus to photography should not be underestimated. Major General James E. Fechet, formerly Chief of the Air Corps, writing in issue number 45 of AERONAUTIC stated, for instance, that 56,000 8×10 inch prints were turned out in four days during the Meuse-Argonne offensive.

In this country, meanwhile, Major J. W. Bagley developed the T-1, a trilens camera which was first used at Langley Field in 1917. "The results of these tests," stated AERIAL PHOTOGRAPHIC MAPPING BY THE GEOLOGICAL SURVEY, "served as a basis for a program to photograph several strips of country between aviation fields for the purpose of making aeronautical maps." Later Major Bagley went to France where he continued his work with the T-1 camera for the A.E.F.

After the war, in 1920, the United States Geological Survey began the use of single lens aerial photographs in the preparation of their quadrangle sheets. This program continued up until America's entrance into World War II and it will no doubt be revived after the war is over.

The history of aeronautical charting in the United States, in which aerial photography played an important part, is described briefly in Technical Manual 1-205 entitled "Air Navigation," and unclassified publication, as follows:

"The Air Commerce Act of 1926 provided for the charting of airways and the publication of aviation maps necessary for safety in flying and for the further development of air transportation. At that time there were no suitable maps of the country as a whole, nor even maps which could serve as an adequate base for the addition of aeronautical data. A new type of map, especially designed to meet the needs of a new industry, was urgently required, and the technical work of investigating this field and of compiling and publishing the new maps of the airways was assigned to the United States Coast and Geodetic Survey of the Department of Commerce, with instructions "to provide as adequate charts for air navigation as it now provides for ocean navigation."

"In order to satisfy the most immediate and pressing demands, the first maps published for this purpose by the Coast and Geodetic Survey were strip maps of the principal airways. However, it was realized that strip maps could not long meet the need, and in December 1930 an experimental edition of the first sectional airway map was published."

"The aeronautical chart cannot yet be considered as having reached its final form. Changing conditions of flight (such as higher speeds, longer flights, and higher altitudes) are fairly certain to result in changed methods of navigation, and further changes and improvements in the charts will be required. The chart should not merely keep pace with these advances but should anticipate them."

The article concludes: "Maps in general may be thought of as containing information which is subject to comparatively little change even over a considerable period of time. By way of contrast, the aeronautical charts include

25,000 miles of airways equipped with beacon lights, radio ranges, teletype service, and other related features. Over such an extensive system it is obvious that many changes must occur. New airways are being established and old routes are being rebuilt for more efficient operation; improved equipment is being installed; and aids are even being provided for the navigation of air routes across the oceans. The frequent correction of these charts to show the changes as they occur is a most important function of the Government and is imperative for safety in all forms of cross-country flying."

In about 1926, tri-lens aerial photographs began to be used on a considerable scale for mapping in connection with soil conservation, river and harbor and similar surveys. It was reported that the Air Corps photographed about 22,000 square miles for the War Department and other Federal agencies that year. The following year the first photographic course was opened at the Air Corps Tactical School, Langley Field, Virginia. This course included basic photography camera repair, mosaics and some motion picture work as well as the more general aspects of aerial photography.

The U. S. Army Air Corps began about 1929 to flight check a number of the strip maps which had been made charting the airways in this country. The practice of making flight checks has been continued. Numerous corrections and additions are made as a result of the observer comparing the area covered by a chart with the details seen on the ground from a plane. This process is repeated periodically where possible in order to keep the charts up to date, and all pilots are encouraged to report any corrections which they may observe while in flight.

The history of aeronautical charting by the U.S. Army Air Forces outside of the United States began with the commencement of this decade in 1934 when General Arnold, then a Lieutenant Colonel, led a flight of 10 Martin Bombers from Bolling Field to Fairbanks, Alaska. Among those on that historic mission were Samuel T. Bush (now Major, Chief of the Photo Services Branch of the Photographic Division, A-2). The B-10 was a two-engined craft served by a crew of three consisting of pilot, navigator and photographer. A notable feature of this plane was the fact that some of the instruments were installed in the wings instead of inside as is the uniform practice at the present time. Utilizing the T-3A camera, a 5 lens affair, a portion of Alaska was photographed from the air. Previous to that time Geological Survey had been using a panoramic camera to take photographs from mountain tops in that area. Also, during 1934–35 the entire Tennessee River Watershed, an area of 42,000 sq. miles, was photographed with T-3A cameras and the photographs compiled into 1:24,000 scale planimetric maps by the Geological Survey in cooperation with the Tennessee Valley Authority.

The T-3A was only one of several multi-lens cameras ranging from three to nine lenses. Optical restitution was relied upon to bring the low oblique photographs into proper scale. Furthermore these cameras were heavy, bulky and too delicately adjusted for practical field use. Moreover, there were not enough of such cameras in existence and there were too few personnel trained in their use to obtain photographs as fast as desired. Also the additional laboratory transforming and processing required and the unwieldy method of compilation nullified the advantages of using this type of camera.

This jumble of methods and equipment created experiments which led to the development of Trimetrogon, a system which consists of vertical photos and high obliques which can be mechanically restituted.

The Trimetrogon system of charting was developed jointly by the Army Air Forces and the Geological Survey. This system consists of a camera mount constructed so as to hold three standard 6-inch lens K-17 cameras in such manner that the focal planes have a 60 degree angular relationship and are exposed simultaneously. With each exposure a horizon-to-horizon picture is obtained with a running overlap in the direction of flight, thereby enabling stero vision and three point radial intersections. The trimetrogon system retains sufficient accuracy for charting at scales of 1:80,000 and smaller and has the following time-saving advantages over methods formerly used: flight lines may be spaced farther apart, less precise flying is required, less geographic control points are required and compilation methods are simplified.

The first practical test of the new system was in the summer of 1941 when the 1st Photographic Squadron sent a flight of F-2s to Alaska to equip B-18s with the metrogon cameras. Among those who were on that mission whose names are familiar to photogrammetrists are: Colonel George G. Northrup, Lieutenant Colonels Baron Powers, T. D. Brown, Frank L. Dunn, Frank L. Graves and Harry Eidson. This mission executed trimetrogon photography which resulted in the finest extensive aeronautical charts of this country.

Accordingly, this system opened new horizons and their possibilities have been successfully exploited over the globe. At 20,000 to 30,000 feet altitude the plane, in a single flight, can cover approximately 8 times the area of vertical photography. This arrangement is so simple, rugged and practical that B-24s and B-17s are now out photographing whole continents.

In combat areas, P-38s have also been equipped with the tri-met system as well as two 24" K-17 cameras for pin points (spot photographs for Intelligence). Armed with his cameras the pilot of the P-38 can make his exposures from high altitudes for maps or target approach charts.

The Army Air Corps has conducted extensive aerial and laboratory tests of color photography especially Kodachrome. It is probable that the majority of military observation type aerial photographs will eventually be made in color, although color photography has not yet been utilized for charting purposes.

To reduce the effectiveness of anti-aircraft gun fire and enemy pursuit aircraft, equipment for very high altitude photography has been developed. This development was at first retarded due to the difficulties encountered in obtaining telephoto lenses of domestic manufacture. However, the situation has changed and lenses approaching the army requirements are being manufactured in the United States.

Reports from Army Air Corps tests show that clear large scale photographs have been made above 35,000 feet. A picture of a gasoline filling station, taken at 27,000 feet with a 40-inch telephoto camera showed the high and low gasoline pumps very clearly.

In addition to color photography and high altitude photography Air Corps experiments and experiences have developed night photography, quick work photography, infra-red photography, portable laboratories, and improved sensitized materials.

A German general is quoted as stating before this war started that the next war would be won by the side with the best aerial photography. We are inclined to agree with that statement and to anticipate the outcome with confidence because we feel that the organization and aerial photographic equipment of this country is not surpassed by any other country.

Some of the developments resulting from the present war cannot be dis-

cussed in detail for security reasons. However, it can be stated in a general way that enormous strides have been made in aerial photography within the past ten years, especially when one considers the comparatively small number of people who were devoting their time and attention to this subject and the small amount of money that was appropriated to encourage this advancement, but bombs educate vigorously and considering the number of people pursuing this type of work and the large appropriations that are being allotted to this type of endeavor at the present time, it is anticipated that the development within the next decade will far overshadow the sizeable achievements of the past.