AERIAL PHOTOGRAPHY FOR INDIANA.

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Aviation in general is making marvelous progress marked by a series of spectacular achievements attended by wide publicity. The public is becoming "air-minded" and the present generation is "born to the air" and takes flying for granted. However, most of us can remember the days when "Darius Green and his flying machine" was one of the popular recitations at the Friday afternoon exercises at the little old school and we naturally hesitate at each new scheme of enthusiasts.

It is the purpose of this paper to discuss one of the least advertised phases of aviation; namely, aerial photography—with special emphasis on the status of this work in Indiana and to suggest possibilities of this development in the future.

Aerial photographs are in every periodical these days, illustrating articles and advertising different things. Most of these pictures are obliques because they appeal to the eye of earth dwellers more than do vertical pictures which really constitute the most extensive and valuable product of aerial photography. Vertical pictures are used chiefly in various kinds of mapping, as in connection with standard topographic surveys, location of power lines, roads, railroads, rights-of-way of all kinds, reservoir surveys, flood control, drainage, city planning and zoning, traffic studies, timber cruising, tax appraisal, oil exploration, home sites, geological and ecological studies. You need look no farther than the 1926 issue of Proceedings of the Indiana Academy of Science for a good reference on a use of aerial photography.[1] Several extensive bibliographies on aerial photography have been compiled.[2]

Over 50,000 square miles of standard topographic surveys have been made by the U. S. Geological Survey with the aid of aerial photos. New York City and Los Angeles have been covered by pictures. One process has been perfected by which topographic maps can be made direct from aerial photos.[3] After comparing two maps of the same territory, one made by this photo process and the other by standard methods, the chief topographic engineer of the U. S. Geological Survey wrote that they agreed fairly well but the "most marked difference is due to the marked superiority of the photographic method in refinement of

[1] Aeroplane Photography and Ecological Mapping by Stanley A. Cain, Proc. Ind. Acad. Sci. Vol. 36, 1926, pp. 269-272.

[2] Bulletins of the Fairchild Aerial Surveys, Incorporated, 270 West 38th Street, New York City: A list of references on aerial surveying by the library of the Bureau of Railway Economics; U. S. Department of Commerce: A bibliography prepared by the Engineers Corps library and published in Professional Memoirs, Vol. 10, 421-436 and 560-590 and 855-884.; Aircraft Year Book.

[3] Paper 1606, Aeroplane Topographic Surveys by George T. Bergen, p. 627, Vol. 90. Trans. Amer. Soc. Civ. Eng. (June, 1927).

"Proc. Ind. Acad. Sci., vol. 37, 1927 (1928)."

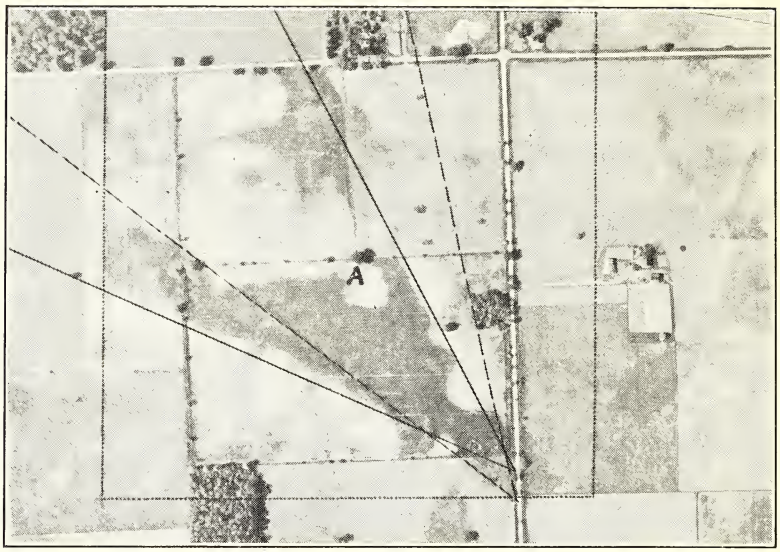

Fig. 1—Aerial photograph of land located about two miles north of Purdue University. The dotted square shows area covered by figure 2. The angle between solid lines shows area in figure 3. The angle between dashed lines shows area in figure 4. The letter A locates the same large tree in figures 1, 2, 3 and 4. Photograph by U. S. Army Air Service, May 20, 1926.

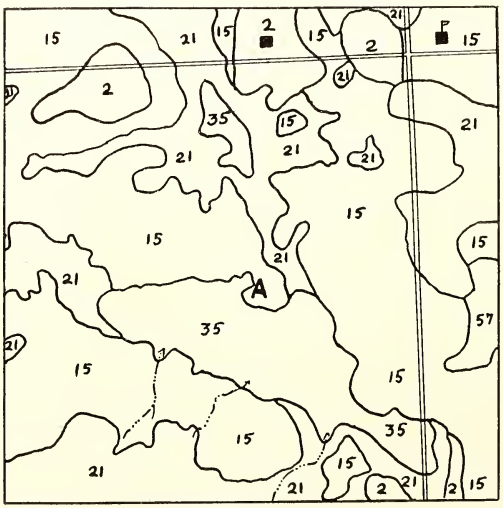

Fig. 2.—Soil map based on aerial photo (figure 1) and field studies.

Fig. 3—Photograph, June 20, 1926, of land located within solid line angle on figure 1. Note how the growth of wheat has concealed the light and dark soil areas which are so visible in figure 1.

detail. This is particularly obvious in such features as drainage lines and also applies to contours."

The title of one article is, "Air Surveying 15,000 Square Miles of Forest in Burma,"[1] It seems that this country to which we send missionaries has photographed an area nearly half as large as our State while we apparently have aerial pictures of only a few hundred square miles.

As far as I can learn, our largest aerial survey is about 100 square miles which were photographed in Martin and Lawrence counties for the State Highway Commission to aid in the location of a state road.

Fig. 4—Photograph taken in November, 1927, showing land located within dashed line angle on figure 1. The plowed field shows the land in best possible condition for terrestrial mapping of the soils. Note how quickly the visibility of soil conditions fades out in the distance; also how little can be seen in corn fields even at short range.

[1] Flight, Vol. 17, pp. 826-827, Dec. 17, 1925.

Some 30 square miles in Harrison County have been mapped for commercial purposes. About 30 square miles were photographed by the Army Air Service near Lafayette to help the U. S. Geological Survey make a special topographic map for the Purdue Military Department. A similar area was mapped at Culver. Transmission line strips were photographed near Fort Wayne, Marion, South Bend and Muncie. The Bacon's Swamp area of less than one square mile was photographed for ecological studies. As there are four firms in Indiana and many more in adjoining states which report aerial photography as one of their activities, there must be a number of other areas mapped in Indiana and I would like to request at this time detailed information from anyone who knows about any aerial work that has been done or is being considered.

The interest of my department in aerial photography arose out of the needs of soil survey. Dirt is too common to be an object of interest to most folks, but soil surveyors are devoted to the interests of "Pedologie" or soil science, which is as distinct from agronomy as botany is, although, like botany, it makes contacts with agronomy and practical agriculture in many ways. The soil map, which many might consider the most conspicuous product of soil survey, is simply a graphic record of where different soils occur and is usually made by rapid and simple methods. However, when we once enter the map making game, we assume a heavy responsibility for accuracy and reliability. On one hand, we have high standards set by the board controlling all government maps; on the other hand, we find a map which "might be" 99 per cent perfect is likely to be condemned by some citizen if a mistake is made on his property. The only standard permissible in mapping is perfection comparable to that found in dictionaries. Thus, our soil students in soil survey ought to be expert cartographers. Soil surveyors often find map making taking most of their time and energy to the detriment of soil studies. Gathering soil data in the field is a form of research work in which no one supervising the work has a chance to review original data without considerable labor in reaching the exact spot on the earth's surface where some problem may occur. For our work, we regard aerial photos as a means by which an inspector or any person can actually see the surface indications in any locality and check the work of field men. Pictures give us accuracy of detail and reliability not possible in any other way and at the same time allow us to cover the ground more rapidly. Pictures would avoid such errors as those due to local magnetic attraction, mistakes in measurements and especially in location of features which ordinarily are sketched by eye between points actually located by instruments. In many states, soil survey maps are supplemented by elaborate systems of notes relative to farm conditions. These could be largely replaced by photos on file at experiment stations which would show a wealth of detail about lay-out of farms, buildings, fences, crops, woodlands, erosion and streams, which can not be shown on published maps.

Figure 1 is a good example of conditions prevailing in the "black and white" soil region of central Indiana. This aerial picture shows the roads, fence lines, land lines, etc., which are used in constructing

a base map. It shows trees, houses and many other landmarks extremely useful in locating any feature which should be mapped. It even outlines perfectly many soil boundaries even under cover of crops, although there are other soil boundaries shown on the soil map in figure 2 which are not shown by the aerial photo, but must be determined by field studies as to character of subsoils, reaction, depth to lime, etc. Figure 3 shows how difficult it would be for a soil surveyor to locate the striking color changes in the soils which show so plainly in figure 1. With a set of pictures taken under uniformly good conditions the map will have a more uniform degree of accuracy than is possible if part of

Fig. 5—West Lafayette and Purdue University. Photo by U. S. Army Air Service.

the land is mapped when plowed as in figure 4 and part under heavy cover of corn, wheat, hay, etc.

In soil survey work the mapping of towns is often very costly of time and difficult to do accurately with plane table outfits. Figure 5 shows how plainly and accurately all the details of a town are outlined in aerial photos.

In strong contrast with the conditions of central Indiana is the limestone belt which is illustrated by figure 6. Here is an undulating plain, thickly dotted with sinkholes, some containing water as at A, and some dry as at B because of subterranean drainage. The road system is rather irregular because of the uneven topography. Several orchards

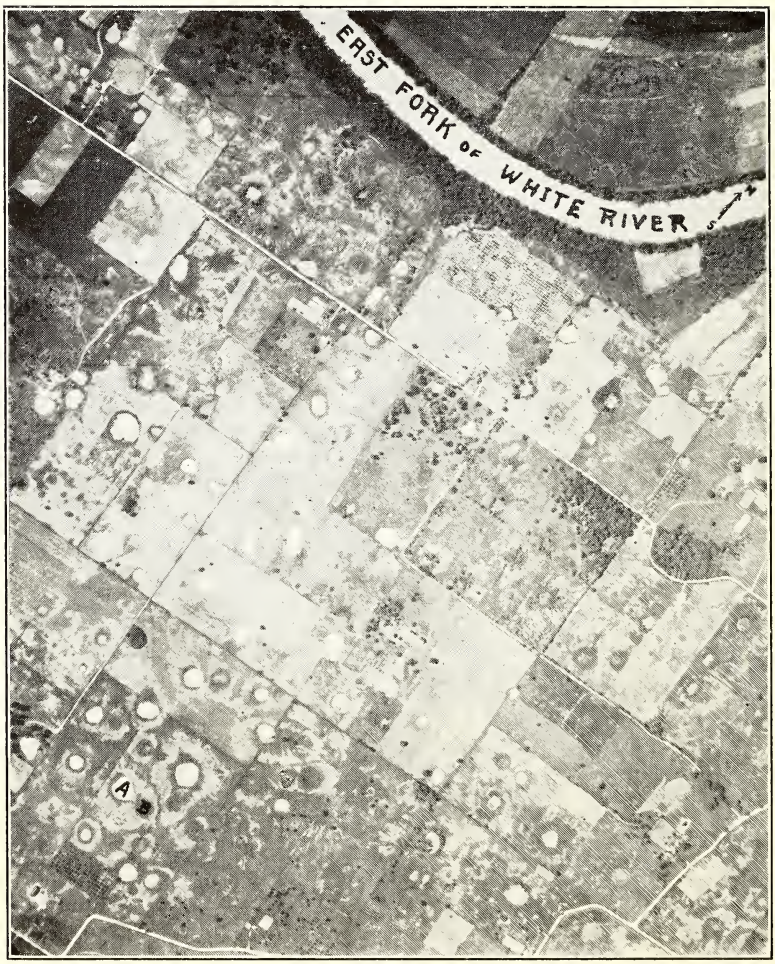

Fig. 6—Aerial photograph of limestone "sinkhole" country about five miles southwest of Bedford. Photo by Bowman Park Aero Co., of Louisville, Ky.

are to be seen and the bluffs along the White River are wooded. Around the "sinks" or "swallow holes" over most of the photo are numerous sharply etched areas where the "yellow clay" soil has eroded, but in the upper left-hand corner the smoother, almost blurred, appearance shows where sandy lands are found, while in the upper right-hand corner of the picture are overflow bottoms of the river.

Figure 7 shows an area lying along the state road between Bedford and Oolitic. The meanders of Salt Creek, railroad and race track are plainly shown. It is not obvious to the eye, however, that the race track is in a flat valley floor many feet below the rugged, wooded hills rising from the state road bridge across Salt Creek. In cases like this

Fig. 7—Aerial photograph of Salt Creek Valley between Bedford and Oolitic. Photo by Bowman Park Aero Co., Louisville, Ky.

the mirror stereoscope would be of great help in reading the photographs. This instrument is a simple device as shown in figure 8.

Through the courtesy of the Indiana State Highway Commission, we have obtained prints from the aerial photos taken in Martin and Lawrence counties. With them we have checked soil survey work already done in Lawrence County and have carried on experimental soil survey work in Martin County this fall. The results confirm our previous experience with photos taken by the U. S. Army Air Service at Purdue and prove to us the value and need of such pictures.

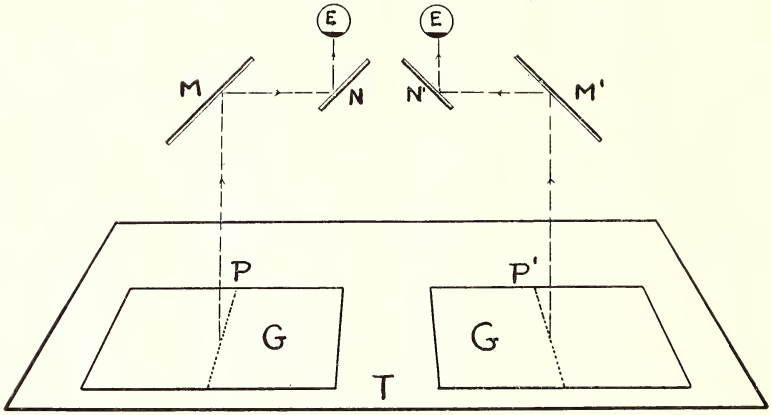

Fig. 8—Diagram of mirror stereoscope.

Two aerial pictures, P and P¹, taken from viewpoints about one-half mile apart but with area G in both pictures representing the same land, are laid on a table, T. Their images in mirrors M and M¹, (which are face down) are reflected to mirrors N and N¹ (which are face up) and thence to the eyes E E of an observer. The pictures are moved on the table until the images of similar points coincide in the eyes, and stereoscopic vision of area G is attained.

As a matter of fact, definite study of the aerial photography question was begun several years ago and plans were matured to use the pictures in the soil survey of a whole county in the spring of 1927. The U. S. Bureau of Chemistry and Soils, with whom Purdue co-operates, requested the U. S. Army Air Service to photograph Rush County. Favorable action was expected on this request. However, the Mississippi flood conditions drew all available army planes away and in the meantime the federal board controlling policies of government aviation decided that the Army, Navy and Commerce air services "would do no work for anyone, including federal departments, until they had exhausted the resources and facilities of commercial aeroplane corporations." Proposals were then sent out and five firms bid on the Rush County job. The bids ranged from $2,700 to $9,000 for 409 square miles. As these all exceeded the funds available for such use, no bid could be accepted and the Army Air Service has again been requested to do this work.

The best season for pictures of this kind is in April and May when the trees are in leaf and when much land is plowed and no land is covered with heavy growth of crops. As pictures are taken from elevations of two or three miles, perfectly clear, cloudless days are necessary. A county can be mapped in about two days of actual flying. Army air survey charges were based on expenses of its men, flying expenses and cost of photographic materials. The estimate for these for Rush County was $1,400. The Army Air Service carries all overhead, and has no selling costs like commercial firms. Commercial interests argue that our government has a broad policy not to compete with private industry and consider that making photos for government surveys is a legitimate field for private aerial photographers. Some other people have a theory that government economy demands that different departments should help each other out where it will save money for any tax-supported enterprise. The conflict between these two ideas is apparently one for the public at large and the authorities in high places to decide.

Soil survey is a relatively inexpensive kind of work and the cost of aerial photographs must be rather low if we are to use them. Specifications for any aerial photographic job may vary greatly, especially in regard to overlap, scale and total area to be mapped, so that the cost may vary from hundreds of dollars a square mile down to a very low figure. The value of pictures for some corporations may be very high, and merely as a matter of personal interest or curiosity all of us could pay as much for aerial pictures of our town or farm as we would for views of our house or face. When you consider that the ground photographer in safety snaps a view with a camera costing a few hundred dollars and note what he charges for his pictures, you will see that the aerial photographer, with a $5,000 camera and a $10,000 plane, risking life and limb two miles above terra firma, seldom over-charges for his product. Consider also that aerial photos of an entire county can be obtained for the cost of 500 feet of concrete road and they will not seem very expensive.

Soil survey can use the most inexpensive form of aerial photos—those with very little overlap—but in some cases it would be beneficial to have pictures, such as the engineers usually desire, which have greater overlap, so that we could use the mirror stereoscope. This is simply a system of four mirrors arranged so that a person can observe two overlapping pictures as one and obtain a vivid vision of the topographic variations. This overcomes the most disappointing feature of vertical pictures; namely, the monotonous flat appearance even in hilly country. Anyone looking straight down from an aeroplane has the same impression of a landscape.

We may expect in the future even higher standards of accuracy in all kinds of surveys. A set of aerial photos and good base maps made from them could serve a number of government surveys, such as topographic, geological and soil surveys, and aid in forestry studies, flood control and location of roads. Considering the enduring qualities of really good work and the economy due to large scale operations, the

complete aerial photographic survey would be the best possible foundation for different kinds of public work. In addition the negatives would be a photo library from which additional prints could be purchased by anyone at much less than the cost of the first set and thus be a saving and a service to the public in general. With pictures easily available, uses not thought of now would surely be found for them. The people of Indiana can well afford to make a thorough study of the possibilities of aerial photography, and facts already established should convince most people that a state aerial map would be practical, beneficial and fundamental to all kinds of surveys.