MAPPING FOR TURNPIKE LOCATION AND DESIGN*

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ABSTRACT

The paper deals with the experiences of the Jack Ammann Company in handling mapping projects, and information regarding the use of such maps. As an example, a time table is given on one emergency job which required the completion of topographic maps at a scale of 1″ = 200′, showing 5-foot contours of an area approximately 13 miles long and one mile wide. Instructions to proceed were received on the 18th of the month and the completed maps were required to be shipped on the 31st of the same month. In the course of operation, engineers found a better location for the road about one mile south of its original location, and rephotography became necessary. Despite this delay, delivery was still required on the 31st. Similar experiences are cited for the Kansas Turnpike project.

THE history of roads and turnpikes is related to the centralization of population in powerful cities, which they served for military purposes, and for the collection of supplies and tribute. In Persia, between 500 B. C. and 400 B. C., all provinces were connected with the capital, Susa, by roads. One of these roads was 1,500 miles long. The Greeks, who believed in the independence of the city-state did relatively little road building.

The Roman roads are famous. In Italy, and in every region that the Romans conquered, they built roads so durable that parts of them still remain in service. The Roman roads were generally straight, regardless of grades. Highway engineers today criticize the Roman roads for their steep grades and their total disregard of economy of material and labor. In France, Napoleon built good roads for military purposes. In England, the Industrial Revolution necessitated the construction of good roads. In the region between Mexico and Peru, the roads were long and comparable to the Roman roads in quality; they were in use when Columbus discovered America.

In the United States road building began about 1800. The U. S. Government saw the need for a good highway to the West and, between 1806 and 1839, surveyors and laborers built a stone surface road which was called the National Turnpike. The name comes from the turnpikes or tollgates built along the way; travelers paid a tax or toll to pass from one gate to the next. The National Turnpike led from Maryland westward to Terre Haute, Indiana. It was straight and direct compared with the usual crude "cow path" roads of the day, and it helped greatly in the early settlement of Ohio and Indiana. This road is well known today as U. S. No. 40. About this time, other turnpikes were built by private capital.

Turnpikes continued to be of great importance until about 1850. Afterwards, for a short period of time, interest centered on canals and railroads. In about 1890, the bicycle created a new interest in good roads. A short time later, this interest was greatly increased by the development of automobiles and trucks which require good roads to be efficient.

In about 1900, administrators and legislators sat down around a map with highway engineers and said, "Here is the pattern of roads we want, so that good roads will connect every town and city. Where no such roads exist now, let us plan to build them." Engineers began experimenting with new materials and methods of construction. The federal government and the State governments began taxing the owners of automobiles and States and counties began issuing bonds for road building. Large sums of money were raised. Highway engineering became an important profession; soon strong and more lasting kinds of roads were developed. By 1910, the "good roads" program was in full swing.

Since 1916, the U. S. Government has made available to the States, some of its income, to help construct a national

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system of primary roads. In an amazing era of modern road building, hundreds of thousands of miles of concrete, asphalt, tar and other kinds of durable roads have been built with money paid by automobile users. Today, the United States has some three million miles of roads of all kinds, though a great many of these are still of unsatisfactory standard. In fact, according to one classification, only about $\frac{1}{5}$ of the roads in the United States today are hard surfaced and only 1/10 are rated as first class roads.

Modern road building all over the world has hardly began. Many areas have only mud roads. Roads wear out and must be repaired every few years. Thousands of stretches of highway need widening and straightening. Other roads are too crowded, too steep and too dangerous for present-day automobiles. Still others do not go to the right places or the general location is wrong. Much of the road system in the world, like Topsy, just grew. So hundreds of millions of dollars must be spent every year for straighter, smoother, wider, and faster highways that will serve the latest designs of automobiles and trucks.

It is hoped that President Eisenhower's road program, together with the State and private turnpike program, will provide an adequate road system for the United States. In other parts of the world the amount of building new roads and improving existing roads will increase during this period.

One all exclusive item must be given detailed consideration in modernizing existing highways and building new ones. This item is cost. It includes such items as proper location, design, and construction. This item cannot be given due consideration unless based upon adequate map information. The required information ranges in type from reconnaissance to that necessary for detailed design. It is extremely unfortunate that the United States is not entirely covered with adequate quadrangle maps, as such maps are most satisfactory for reconnaissance and general study. In every case that I know of, where such maps have been available, highway engineers have pin pointed their locations within one mile. Similarly, I know of but few cases where relocation surveys have not been required when quadrangle maps were not available for preliminary locations.

The value of quadrangle maps was proven in the location of the Kansas Turnpike. A portion of the area was covered by rather old quadrangle maps, while the only existing maps of the remainder of the area were county highway maps, which, of course, do not show contours. No difficulty was encountered on the portion where quadrangle maps were available and the final location was well within the area covered by the engineering map prepared at a scale of $1''=200'$ and showing $5'$ contours. Unfortunately, this was not the case for the other portion. Shortly after the aerial photography was completed, it was found that a relocation was necessary at two different points. This necessitated our returning a plane to rephotograph these areas. Later, after the topographic maps had been completed, it was found that a better location was possible at another area; this required mapping the alternate location. In spite of all this extra work of relocation, I believe that we may have established some kind of a record on this job. The entire line assigned to us and consisting of 125 linear miles, was mapped within 88 days after the date we received notice to proceed. This included aerial photography, field control, photogrammetric plotting, finished drafting and editing.

Based on our experience, it seems impossible to make a clear cut statement regarding the type of map information required for highway and turnpike location and design, as this depends somewhat upon the density of development and the nature of the topography of the area. Map information already in existence must be evaluated and used to the extent possible. In some cases, a broad area should be photographed in order that photographs, and possibly a mosaic, may be carefully studied and two or more alternate locations made. For these cases, it is sometimes desirable to have topographic maps made of all of these alternate locations. At other times sufficient information is already in existence to pin point a location within one mile, and accordingly the engineering type maps are required of only a single location.

It is hard to understand why a country such as the United States, that is so progressive along most lines, is so backward in regard to maps. The Federal Government has been attempting to complete the quadrangle mapping of the United States for more than 70 years and still only about 25 or possibly 30 per cent of the area is satisfactorily mapped at this time. It is my opinion, that while the technical staff of the Federal Mapping Agencies are probably at least as efficient as any branch of the Federal Government, the administrators of the government have fallen down on the job very badly. No question exists regarding our country's need for maps. Everyone agrees that maps of the entire United States and its possessions are a necessity. Yet, there has been failure to obtain appropriations for the rapid completion of much needed quadrangle mapping. Unless funds are made available for mapping in advance of, or during the early stages of the forthcoming highway construction program, I assure you that many additional dollars will join the millions currently being wasted because of the lack of adequate map information.

A great many people, including some very well known engineering firms, are still not convinced that reliable topographic maps can be made by photogrammetric methods. The old time engineer certainly has as much sales resistance as any one in the world. However, once they are sold, they become our industry's best salesman.

A firm of engineers called upon us last December 20 to produce a topographic map showing 5′ contours at the scale of $\frac{1}{5}''=200'$ and covering an area 1 mile wide and about 14 miles long. The order was received on December 20 and the maps were required to be delivered not later than December 31. Unfortunately, only county highway maps were available for the area. By telephone on December 20, we were given a detailed description of the area to be mapped. On December 21 we secured the aerial photography and flew the film to our plant in San Antonio, Texas. About the time that the film was developed, another telephone call was received from our client asking whether we had completed the photography. I was quite pleased to advise that the film was being developed at that time. We were advised that a better location could possibly be made just south of the one originally specified, and that one of the client's engineers was leaving to fly over the area and would be at our office that night. We had the photographs laid out for his inspection when he arrived. Sure enough, our photography did not cover the area where they believed a better location could be made. The next morning we sent out a plane to photograph the new area. This was December 22nd, and we then had a total of 9 days to produce maps of the 14 square mile area. A field survey party left for the area as soon as the pilot reported that the photography had been completed. Photographs showing control requirements were flown to the field party on the same day that photography was accomplished. Field operations continued from daylight to dark until the field work was completed and as each section of the control was completed, it was immediately flown to the plant. The photogrammetric and drafting departments operated on a three-shift basis. The job was delivered on schedule; however, several of our employees had a delayed Christmas.

I believe that I can speak for the entire private photogrammetric industry when I recommend to map users that they invite a mapping engineer to work with them in the early planning stages of their projects. Plans can be made to utilize all reliable existing data and new map work scheduled to best fit into the over-all project. In addition, it is strongly recommended that use be discontinued of long detailed complicated specifications that are not understood by the contracting agency. Map users should confine their specifications to the detail to be shown on the map, scale, contour interval, accuracy, sheet size, the date that such map work is to be completed, and how and when payment will be made. The procedures, methods, and types of equipment to be used in preparing topographic maps, should be the responsibility of the mapping engineer. The specifications currently being used by some organizations confuse both the contracting agency and the mapping engineers, and, at times, greatly increase the cost and require considerable more time than if mapping engineers are given complete freedom to select equipment, methods, and procedures most suitable for the individual job.

It has been found by many organizations that the best way to get their mapping done is to negotiate a contract with a reliable organization on a professional services basis. I would like to leave this thought with both federal and private organizations.