The reproduction negatives shall have the following information indicated:

1. The centerline of the selected and surveyed route, positioned approximately in the center of the 24-in. dimension, with notations as to centerline stationing, degree of curvature on portions of centerline on curve, and a north point;
2. A dotted line indication of the entire property ownership both sides of centerline, and of all property adjacent to or bisected by the centerline;
3. The right-of-way line, as established, both sides of centerline,
4. The name of each property owner, or owners involved,
5. The specific acreage involved in the right-of-way taking, the separation, and the residue;
6. Any adjacent land survey section corners falling within the coverage specified, both sides of centerline, with all four sections indicated in a small circle;
7. Appropriate designation of all county lines, and all State and county roads, streams, and ditches; and
8. An appropriate title designation on each reproduction.

Summary

Photogrammetry has been employed on five road projects in which all planimetry and spot measured cross-section position and elevation points have been furnished to design squads. None of these jobs has yet progressed to the point of being placed under contract. Other stereoscopic instrument measurement work has been performed on borrow pits, for interchanges, and for a small amount of route location survey and design work.

The major portion of the aerial work, however, leads to preparation of photographic mosaics for route location by the Planning and Location Departments. Photographic indexes and stereoscopic print coverage are always provided. Oblique, public interest photography is also taken as required for the public relations department.

FUNCTION AND TECHNIQUES OF THE PHOTOGRAMMETRY SECTION, KANSAS STATE HIGHWAY COMMISSION

In 1957, a committee of five engineers was formed by the State Highway Engineer of Kansas and given the responsibility of reviewing reports of visitations made to States having organizations utilizing photogrammetric equipment, making inquiry and investigations, and finally submitting a report suggesting steps to be taken by the Highway Commission of Kansas with regard to the use of such equipment within its organization. The results of this action found the first section of the Department of Electronic Computer, Aerial Surveys and Photogrammetry organized in late 1957 with the training of personnel taken from the various existing departments in a special programing school. Electronic data processing equipment was ordered. Late in 1958, the second section was started. Again personnel were taken from existing departments for training in photogrammetry and its allied functions.

Since this time considerable growth has occurred. An organization chart of the department is shown in Figure 4. It should be noted that dual roles are being assumed by several individuals. The assistant to the head of the Photogrammetry Section (Supervisor of Aerial Surveys and Photogrammetry) is also the pilot of the plane. The Supervisor of the Photogrammetry Laboratory is the aerial cameraman. Until recently, the head of the Computer Section was also listed as a pilot and both photographers in the Photogrammetry Laboratory are alternate aerial cameramen. The system of dual roles has proven very effective in the organization of the department.

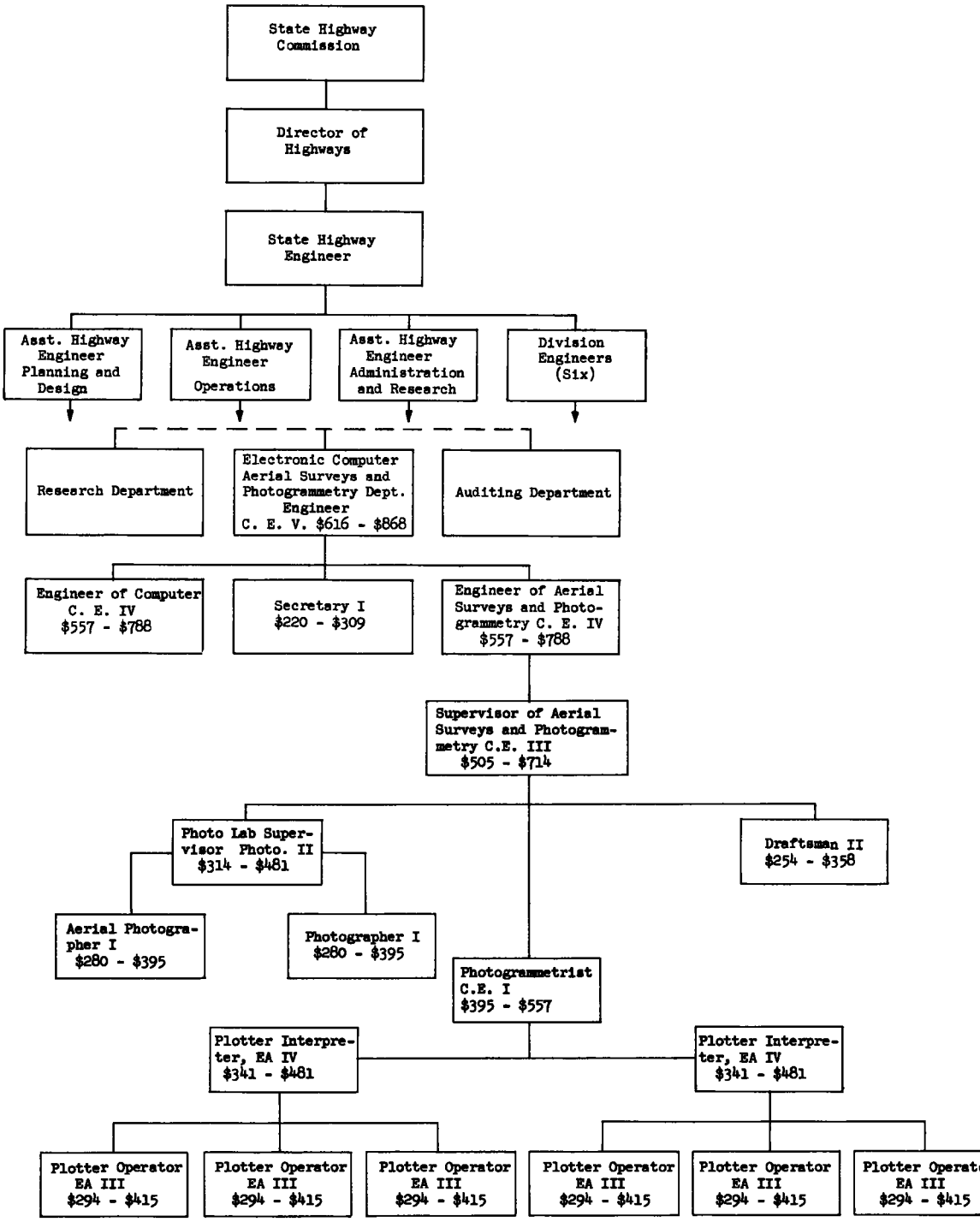


Figure 4. Organization of State Highway Commission of Kansas, pertaining to the Photogrammetry Section, with salary ranges effective July 1, 1962.

TABLE 1

USE OF STATE-OWNED AIRCRAFT[a]

Year	Photogrammetry		Personnel Trans.		Total		Costs ($)	
	Hr	%	Hr	%	Hr	%	Dept.[b]	Oper[c]
				(a) Yearly Total				
1959	151.0	55 33	121.9	44.67	272 9	-	2,020.20	2,020.20
1960	178.8	57 07	134.5	42.93	313 5	-	1,502.40	4,225.50
1961	275.7	93.84	18.1	6.16	293 8	-	1,411 20	3,969.00
Total	605.5	68 80	274.5	31.20	880.0	-	-	-
				(b) Monthly Averaged				
1959[e]	12 58	55 32	10 16	44.68	22 74	100.0	-	-
1960	14 90	57 07	11 21	42.93	26.11	100 0	-	-
1961	22 98	93 83	1.51	6.17	24.49	100 0	-	-

[a]For period April 1, 1959 to Dec. 31, 1961.
[b]Rates for 1959, 1960, and 1961 are $7.40, $4.80, and $4.80, respectively.
[c]Rates for 1959, 1960, and 1961 are $7.40, $13.50, and $13.50, respectively.
[d]Total average use = 880.0/33 mo = 26.66 > hr/mo.
[e]For 9 mo.

Aerial Photography

In April 1959, Kansas purchased a Cessna-182 aircraft, modified for a Wild RC-8, 6-in. focal length camera. Since that date, the aircraft has flown 880.0 hr (Table 1). It is used for personnel transportation as well as for photography. The cost of the aircraft, auto-pilot, radio equipment, and modification was $22,736.59 and the cost of the Wild RC-8 camera was $17,150. Immediately before the purchase of this equipment, a total of $13,581 was expended for photography on a contract basis. Several previous projects (by contract) for mapping using photogrammetry did not prove successful, and the process within the Commission was initiated under an air of distrust of the system and is proceeding at a cautious pace. The first projects were small, experimental and limited in scope. The results were not successful in the area of accuracy but formed the stepping stones to much better work being performed at the present time.

A review of the operation to early 1962 indicates that the actual operation costs of the aircraft are less than the total allowed by rate. The rate does not include the cost of the hangar and insurance for the aircraft, but does include all other costs that can be applied directly to its operation. The rate of depreciation is set to reduce the original cost of the equipment to one-half of its original value in 10 yr with a monthly operation of 25 hr.

The present practice is to photograph all major projects before beginning design and preparation of highway construction plans, again after construction has been completed, and in some cases every several months or years after completion. Several scales have been used; however, the present practice is to fly all planning photography at a flight height of 6,000 ft giving contact prints a scale of 1,000 ft to 1 in., and all design photography at a flight height of 1,500 ft giving contact prints a scale of 250 ft to 1 in. Mapping projects usually involve these same scales. There is occasion to use photography having a scale of 400 ft to 1 in.; for determination of highway construction cost estimates, some projects are flown at heights of 3,000 and 12,000 ft. The section is, at the present time, attempting to photograph all cities, State institutions and parks during routine aerial photography flights. A card index file has been developed along with a set of maps showing the coverage of photography within each county. These maps are reproduced and distributed on a quarterly basis to all users of the photography. A master is kept current in the section at all times. The section also maintains a complete file of all oblique photography taken. These are single photographs and are usually taken to show a specific feature. They are used extensively for public relations, progress reports, public hearings and similar uses. Over 20,000 photographs have been taken, and 511 areas have been covered, varying from strips taken along the proposed improvement to the mapping of areas. Over 20 percent of the towns and cities have been photographed, with most of the photographs taken for this purpose within the last 6 mo.

The section is currently photographing 16 drainage areas in cooperation with the U. S. Geological Survey. Rainfall and runoff data are being accumulated. The photography is being used to determine the drainage area to within 0.5 percent of its true value. Various land-use and cover factors will be determined from the photography and will be correlated with the runoff data to produce factors for hydraulic computations which will be more reliable than those used at the present time. Each of the drainage areas includes a gaging station. The photography for this project is to be completed before the end of the fiscal year.

Several proposals are being considered to initiate a project for the photographing of the entire State on a 5-yr plan. This photography will be used primarily for the study of land use, materials investigations, the location of all sources of materials and for preconstruction photography of all highway projects. A secondary use of this photography will be by the Planning Department in the 5-yr map revision program. Post-construction enlargements for legal cases would also originate from this photography, as well as long-range planning of projects, establishing route locations, and determining drainage areas.

The principal months for flying to take aerial photography in Kansas are March, April, and May in spring; and September, October, and November in fall. The sparse tree cover in the western portion of the State allows photography during any season when snow does not cover the ground. Actually, some aerial photography flying has occurred during winter months when there was little snow cover. There is, therefore, the possiblity of year-round activity. If possible, all flights are planned with several areas indicated as primary photographic missions and several areas as alternate photographic missions. The total mission planned is actually more than could be covered in one day. If the weather prevents activity in one area, alternatives are considered. Through this process, the section has made only two flights since early in 1959 when no photography was obtained. Charges are computed on a prorated basis and the cost of photography for any one project is, therefore, reduced within the total operation.

Photographic Processing

All aerial film is developed and printed in the section's Photographic Processing Laboratory. This laboratory was started and actually in operation before the section was obtaining its own photography. A Wild Aerial Film Developing Kit and a Wild Aerial Film Dryer were purchased at a cost of $2,220. A copy camera was constructed which can use either a 47.5- 30-, 19-, or 9.75-in. focal length lens. A contact paper and glass plate photographic printer was also constructed by the personnel of the section at a cost of around $150. Equipment such as a print dryer, two sets of Color Tran Linelights, Nu-Arc Vacuum Frame, timers, safe lights, and other items were purchased. The total cost of the laboratory equipment including the aerial camera, office equipment, and furniture was $29,827. Although some items have been added since these purchases, the basic equipment still remains. The addition of an automatic dodging printer and a rectifying enlarger is being considered.

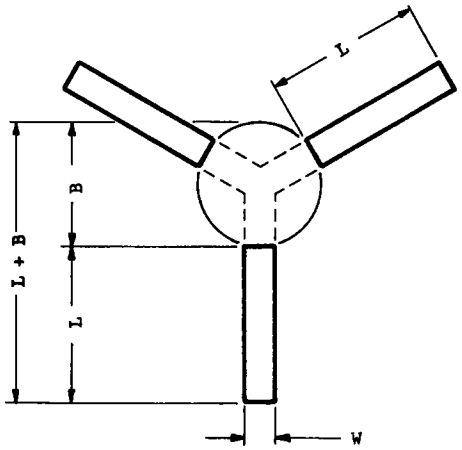
All negatives are properly numbered according to geographic location within Kansas, date of photography, and flight height. A cross-index arrangement and file system locate a set of prints and the roll of film easily. The system was designed to fit with other systems currently in use in other departments of the Highway Commission.

Over 50 percent of the operation of the photographic laboratory is service production of plans and photographs for other departments. One of the important services performed is the production of the negatives and negative overlays used in printing county maps of Kansas. Perfect matching is required on this photography because the maps are produced in color and the overlays must register with the base map. These maps are produced by the Planning Department, reproduced by the Photogrammetric Laboratory, and printed at the State's plant.

Ground Control

Kansas uses both a picture point control and a target marking of control procedure. All surveys are made by the regular Design Department's survey crews or by the resi-

For targets made of lime, plastic, or similar material.



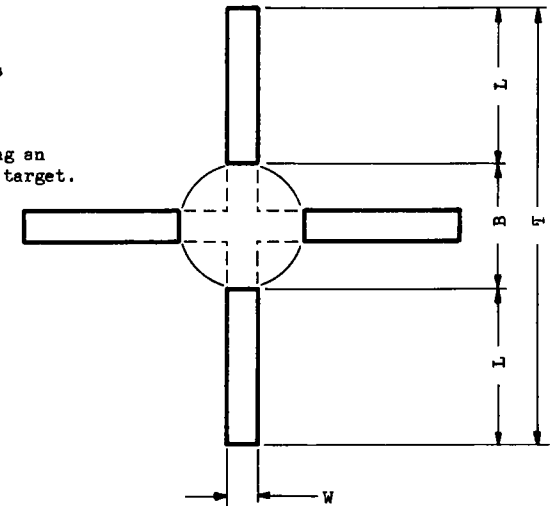
Typical target for marking pass points of known elevation

TARGET DIMENSIONS

Flight Height (feet)	L (feet)	B (feet)	W (inches)
900	1½	1	3
1200	2	1	4
1500	2¼	1½	5
1800	2½	2	6

Figure 5

A target for horizontal control points, the legs of which are constructed of lime to the dimensions T, L, and W. The center portion at the control point has a diameter B which is not limed, giving an open effect to the cross target.



Plastic strips having the width W and length L are available. This target, when constructed of plastic strips, is used on all station markers of horizontal control and may be used on points of vertical control.

TARGET DIMENSIONS

Flight Height (feet)	T (feet)	L (feet)	B (feet)	W (inches)
900	4	1½	1	3
1200	5	2	1	4
1500	6	2¼	1½	5
1800	7	2½	2	6

Figure 6

dent engineer. When a survey crew was not available from these sources, a crew made up primarily of photogrammetric instrument operators has been used. Usually a stereoscopic instrument operator is sent to assist a crew, if the survey for ground control is the first survey of this type that the crew has attempted. The usual method of control is that of using a baseline or centerline as the horizontal control and setting elevation pass points at an appropriate distance from each side of the line for vertical control. A profile of the line is also measured. A manual was produced by the section to guide field survey crews in control surveys. Pages from this manual are shown in Figures 5 and 6.

Some research was conducted by the section to determine a good procedure for the setting of targets. The size and material of the target were the primary interest of this research. Lime has been used for some targeting. Current practice, however, is use of Firestone Velon plastic sheeting, 0.003 in. thick (Fig. 7). Cost per target using this material is about $0.15. The target itself consists of four strips, 6 in. wide and 3 ft long, laid in a cross having an open center of about 18 in. The use of an open "Y" for points of elevation has proven quite successful.

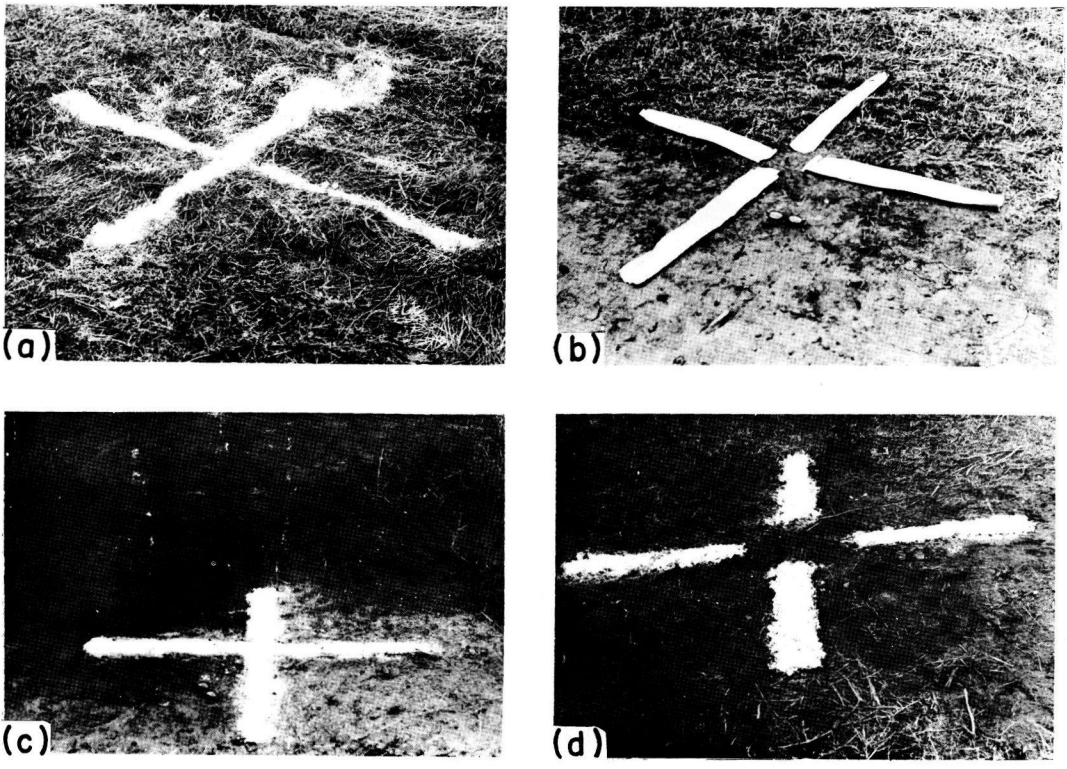


Figure 7. Some targets used for placement on markers of control points in Kansas research projects to determine a good material and proper procedure for setting targets. (a) Very rough X limed target marker; target used with good success; open cross, however, better target. (b) Typical target made of canvas, using four strips. Two strips may be used, however, by darkening center portion with dirt or paint. (c) Typical closed cross constructed of lime by using care in placing lime to general size and shape suggested for photography taken from a flight height 1,500 ft. (d) Typical open center cross made of lime and having same characteristics as closed cross. This cross seems to have best characteristics for pass points at which elevation is measured for leveling stereoscopic models.

Compilation Section

Compilation is accomplished with four 5:1 projection ratio Kelsh stereoscopic plotters. Two of the plotters are the three-projector type. Eight plotter operators are utilized by the section. This insures full plotter usage, provides the ability to send a plotter operator to the field to supervise a survey, and allows for leave time, normal setup procedures, note checking, and data gathering which precedes and follows the working of a stereoscopic model on the plotter.

Most design data comes from the plotter in the form of a topographic strip map, profile and cross-sections. The cross-sections and profile data are recorded by use of recording machines. This information is later placed into note form, reproduced directly by the key punch section onto cards, or plotted, as the project demands. A cross-section measuring and recording device is on order which will directly produce the information in card form for electronic processing.

Many topographic maps are produced by the section for purposes such as highway centerline study and drainage structure location. The map scale varies from 40 to 100 ft to 1 in. The most common scale is 50 ft to 1 in., with a 2-ft contour interval. Many routes are mapped or profiled for the purpose of estimating quantities.

The alignment problem in Kansas, with its many existing roads, is not a problem of quantities as much as one of existing topographic features. Urban areas are often compiled as planimetric maps with contours being measured and delineated only in critical areas. Before the addition of the second two stereoscopic plotters, the section was operating on a split shift basis using the plotters 12 hr a day. The section has had the Kelsh instruments in operation continuously, except for two short periods when lack of ground control or photography delayed their utilization.

The Compilation Section, after three trial projects, is also measuring and recording the cross-sections from which payment quantities are computed. Many projects are closed with the contractor accepting the design quantities for payment. In the cases where this acceptance is not forthcoming, cross-sections for computation of pay quantities are measured photogrammetrically. The Photogrammetric Section has been used for this purpose on five such projects. The reaction to such use cannot be determined at this time, but with the continuance of this procedure, all of the difficulties should be eliminated and this will be a regular function of the Section on many projects.

Because of the close control of the designer assigned to the project and the section there has been no need during the past year to reset stereoscopic models in the precision instruments. The problems of centerline alternatives have been resolved early and although the section is often called on to produce data for alternatives, only one alternative highway route area is mapped in detail.

General

There has been little use made of the State plane coordinate system by the Section, probably because application of the system is not required by law in Kansas. Research in the use of strip cameras has been made. Color photography has been tried on several projects and further research in this area is expected. Much use of photographic enlargements for public hearings and in the condemnation cases of rights-of-way has been made. The use of models has been studied. It is hoped use of the State plane coordinate system will become an important part of all highway surveying and plans in the future.