

# Photogrammetry and Highway Law

MORRIS M. ABRAMS

U. S. Bureau of Public Roads

•THE INCREASINGLY large number of land measurement transactions for land purchases, various government programs, etc., has been accompanied by the application of new scientific techniques. One of these measurement techniques is the art and science of photogrammetry, the calculation of vertical and horizontal distances from measurements made by use of photographs. As the use of techniques associated with this process becomes more widespread, photogrammetry impinges upon established legal criteria in some instances. Chief among such criteria is the use or adaptability of photogrammetric evidence in administrative or judicial proceedings.

Photogrammetric evidence may be considered as a form of demonstrative evidence. Such evidence, though lacking substantive value, can be the most effective medium through which the trial attorney may express his client's case to the court. Many lawyers who are active in trial work and whose task it often is to convince a jury or commission of the legal and equitable rights of their client generally agree with the old adage that "one picture is worth a thousand words." In some jurisdictions demonstrative evidence which was properly admitted during the trial may be called for by the jury when they are deliberating upon their verdict in the jury room. Physical or material evidence will convince a jury of the alleged facts of a case much more readily than does the most efficient orator or the most "honest looking" witness who will testify. Consequently, the effect of demonstrative evidence is worthy of the attention of every trial attorney.

The major purpose of this report is to indicate some of the ramifications of the use of photogrammetry in legal and quasi-legal proceedings, in administrative determinations of a legal nature, and to indicate trends in the statutory and case law illustrating recognition of the reliability of photogrammetrically made measurements in the courts and elsewhere. Highway engineers and legal counsel will then understand the boundaries, in a legal sense, of photogrammetry and will be aware of new developments that have implications for highway personnel.

Highway engineers, city planners, land-use specialists, and various survey and defense activities have utilized photogrammetric techniques with varying degrees of regularity. It was in pre-World War II Italy (1931), however, that systematic application of photogrammetric methods to cadastral or land surveys was first achieved. By 1939, this became the regular means of producing cadastral maps in Switzerland. In France, photogrammetric methods have been used for the delineation of properties and determination of boundaries in large-scale maps for many decades.

The United States cadastral survey techniques have lagged behind those in other countries, for it was not until 1937 that the first complete standard quadrangle was mapped by Fairchild for the Tennessee Valley Authority. The results of this experiment were indicative of some of the later uses of this technique (1). For while the results differed from those of ordinary topographic maps, the aerial results were correct in every instance of disagreement with maps compiled from conventional plane table surveys.

Most progress in developing uses of aerial photography in the United States as a tool in surveying and mapping has occurred in the last 25 years. Since its establishment in 1935, the Maps and Survey Division of the Tennessee Valley Authority has

utilized aerial photographs in nearly all of its mapping activities. The TVA's use of aerial photographs in property surveys has been employed on a wholesale basis because it has involved relatively large areas of land (2). The TVA, from 1933 to 1952, for example, made cadastral surveys of more than 2,000,000 acres of privately-owned land representing some 40,000 individual ownerships in the Valley area. Aerial photography was used in practically all of these surveys. Later, as the topographic program of TVA progressed, manuscripts showing fence lines, wood lines, hedgerows, streams, and other features likely to represent property lines were shown; facsimile copies of the manuscript were made into plane table sheets and used as a base for property surveys.

In Canada, the purpose of the legal survey has been to define and mark boundaries of properties on the ground but has not been used to prepare large-scale maps (3). As an experiment, the Alnwich Indian Reservation was surveyed by ordinary field methods and by photogrammetric methods in 1958 and compared in both cost and accuracy. In order to perform the survey by photogrammetric methods, it was still necessary to establish property corners in the field. It was found that, for short distances, photogrammetry was not as good as a field survey but was considered adequate.

The situation in Switzerland is unique (4). There is a complete absence of flight problems because all of the photography is performed by Swiss Federal Government organizations. The government takes care of supervision and coordination of the various projects and setting up of rules, has technical supervision of photogrammetric projects and their control, and holds examinations for cadastral surveyors. For control point determination, the photogrammetrist has at his disposal an excellent network of triangulation points throughout the country and does not have to make a fresh start for each project.

Although photogrammetry was used in conjunction with many aspects of planning and engineering highways in the United States, perhaps the greatest impetus to photogrammetry was given by the Federal Highway Act of 1956, providing for the accelerated completion of the 41,000-mile Interstate Highway System. In recognition of its potential and its accuracy, Section 121 of the Act was prescribed to foster the use of photogrammetry in mapping.<sup>1</sup> When one considers the enormous problem involved in the development of various topographic measures, the laying out of rights-of-way, and the fact that 750,000 parcels of land will have been acquired by the completion of the Interstate program, one can obtain a better appreciation of the need to adopt accurate and rapid measurement techniques which have the possibility of reducing cost to Federal and State Governments and to the community at large.

It should be pointed out that few instances have arisen which have culminated in court actions where the issue to be decided hinged directly upon the admissibility or validity of aerial photographs or maps compiled by photogrammetric techniques. It is reasonable to assume, however, that such court actions will increase proportionately to the number of instances in which photogrammetry is utilized. The legislature may, by proper legislative provision, minimize the burden of increased litigations and attempt to clarify certain elements of doubt which might arise among prospective litigants due to the prevailing statutory void in the subject of photogrammetry.

### Photogrammetry in Highway Design and Development

Before discussing the legal implications of photogrammetric measurement, it might be well to describe briefly how this method has been used in highway construction. In the location and design phase, photogrammetry has proven particularly valuable. A general reconnaissance survey is first made in order to select terminal points between which a continuity of design is indicated. This entails detailed study of existing maps to ascertain type of terrain, populated areas, bodies of water, and other

<sup>1</sup>Federal-Aid Highway Act of 1956 ch. 462, P.L. 627 § 121, Mapping. In carrying out the provisions of this title, the Secretary of Commerce may, whenever practicable, authorize the use of photogrammetric methods in mapping, and the utilization of commercial enterprise for such purposes.

features which may have an influence on selection of a route and subsequent design of the highway. After a general route is selected, photographs are made with precision aerial cameras. The pictures are taken from a predetermined aircraft flight height in order to secure coverage of the route alternatives which may require study and comparison. A wealth of information can be gathered from detailed examination and interpretation of these photographs. With a three-dimensional viewer, the topography and land use features can be studied in detail, contours may be measured and delineated and stream and river crossings selected. Photogrammetrists then compile topographic maps by use of special stereoscopic plotting instruments which require only a few vertical and horizontal control points. The instruments are also used to extend the control. Contours on the topographic maps can be measured and delineated at 5- and 10-ft intervals or, for special and detailed design purposes or in urban areas, at 2- and 1-ft intervals. Finally, with the selected route band appropriately mapped and the highway location design completed, the map sheets are given to the land negotiators who are now in a position to proceed with permits and title searching (5).

Another benefit derived from aerial photography and photogrammetry is in the appraisal area. In the initial stages of highway engineering, appraisals are usually made for cost estimation and comparison purposes. More often negotiations are made with the aid of aerial photographs, photographic mosaics, and maps during or subsequent to completion of the preliminary survey and preparation of construction plans. This type of presentation presents a clear and concise plan to the parties involved in the negotiations (6).

#### Other Uses of Aerial Photography

The use of aerial photographs for cadastral surveying is but one of the many ways in which aerial photography is utilized. It has advanced to such a degree that it is no longer a matter of what can be obtained in the way of planimetric detail, but more a matter of deciding what should and should not be shown. It is possible, when detailing with a 6-in. accuracy to show such things as individual steps on houses, projections from buildings such as window air conditioners, and even the positions of switches in railroad yards will be shown as open or closed (7). With such clarity of detail, the utility of aerial photographs is extended immeasurably.

One of the most obvious advantages of photogrammetry in cadastral surveying is the determination of locations of natural features such as streams, rivers, shore lines, ridges, and swamp lines. Rivers nearly always become natural property boundary lines and are quite troublesome when their courses change. Shore lines confront the cadastral surveyor with problems of riparian rights, and the laws controlling riparian rights differ from state to state. Photogrammetry will not only give the present location of the river but will also reveal data that will enable the surveyor to chart and sometimes date each change of course (8). This is important to a land surveyor particularly if his survey is being contested in court.

An extremely important use of aerial photographs which has not been developed to its fullest extent is in the preservation of man-made monuments. Because all conveyances must somehow be related to known monument positions, certainty of location is endangered if the monument is destroyed. One means of preserving this evidence is by aerial photography. Very often the photograph itself is of more value to the property surveyor than the measurements made from it. The many uses of a photographic history of land include the following:

1. Identification. The Forest Service, Bureau of Land Management, U. S. Geological Survey, ties the location of a found corner or other boundary evidence to other monuments on the ground. Reference ties to three or more points that are easily seen on a photograph will reference the corner to all images on the photograph. This forms a permanent record for location on the ground long after all man-made references have disappeared.
2. Land-use development. Aerial photographs may be used to reveal direction of city growth, rural growth, population density, urban concentration, population, zoning,

data, and culture where ground information is otherwise unobtainable or unavailable or where there is a need to bring available material up to date.

3. Use of old photographs. After a road has been obliterated, or a fence removed, traces may still be seen on a photograph even though no evidence appears on the ground. A comparison of an old photograph with a new one indicates some of the changes. It is apparent that an old photograph can be more valuable than an old map because there is no danger of a surveying or drafting blunder. Accordingly, the aerial photographer can build up a library of perpetual visual evidence with a degree of accuracy otherwise unobtainable.

4. Riparian evidence. Comparison of old and new photographs will show the action of water with some certainty, e.g., accretion and dereliction. The photographs will evidence shallow areas as well as relative beach and shore lines. The location of shore lines at the original survey or time of conveyance is essential information for determining riparian rights.

5. Evidence undetectable from the ground. Pipelines and field drains may be valuable title evidence but can become completely invisible from the ground. Their locations are usually evident from aerial photographs even when the lines are abandoned for many years. Infrared photography will reveal the subtlest change in the character of the land.

6. Detection of encroachments. A building wall or corner may appear to be over a property line; the extent of the overhang is clearly illustrated in an aerial photograph.

7. Identification of lost tracts. Tracts which are described by metes and bounds sometimes have insufficient title identity. If the parcels are plotted to the same scale as an aerial photograph and if the shape is tried like a jigsaw puzzle until a similar pattern on the photograph is discovered, title identity can often be determined.

8. Location of monuments. Search for ancient cornerstones, landmarks, and section corners can be aided by a thorough study of an aerial photograph. Faint field lines can be projected, and their intersection will localize the area to be searched (9).

Photographs of any type have been admitted into trial and into administrative proceedings as a means of providing a representation of the particular property, direction of growth, or in particular, of some facet applicable to the case involving highway construction, zoning, land changes, land values, and highway location. The need for any type of representation arises from the need to illustrate some contentious point clearly to the agency, court, and/or the jury.

In the law, a model, map, or photograph is of course considered to be demonstrative in that it serves merely as a visual aid to the court or jury, especially in comprehending the verbal testimony of a witness.

The unique value of photogrammetry lies in providing visual explanations and a means of accurate measurement of visual subject matter.<sup>2</sup> Demonstrative evidence such as this has no probative value in itself and hence is distinguished from substantive evidence which goes beyond a mere aid to understanding. An excellent example of this point was discussed in *Barnes v. North Carolina State Highway Commission*, 250 N. C. 378, 109 SE2d 219 (1959), where maps of a registered civil engineer, showing a residential subdivision that could have been placed on land previously taken by eminent domain and also showing the reduced number of lots after the taking, were properly admitted as evidence. The maps were used to illustrate and explain testimony previously given by an expert realtor who testified that the property before and after taking was adaptable to residential subdivision. Although the maps were not admissible as substantive evidence to show a practical subdivision, they were nevertheless admitted for a more definitive explanation of an expert witness' testimony.

#### Foundation for Admissibility

Prior to the admission of any aid during a trial, technical procedural rules prevail; thus, a proper foundation must be laid. Demonstrative evidence must be identified

<sup>2</sup> *Smith v. Ohio Oil Co.*, 10 Ill. App.2d 67, 134 NE2d 526 (1956).



by a witness and verified as being an accurate and reliable representation. Maps prepared for testimonial purposes are of a circumstantial nature, and the question of sufficiency of the testimony offered as a foundation for them is addressed to the discretion of the court. They may be excluded where the court finds that, notwithstanding their relevance and competency, the probative value of the exhibit is outweighed by the risk of undue influence, confusion, or waste of time entailed in its use. Where the qualifying testimony is sufficient for a map and the accuracy of the map is then disputed, the question of accuracy must be answered by the jury.

In administrative proceedings, zoning hearings, county commissioners' courts, and many others, of course, these technical rules may not apply or do so in various degrees.

Certain generally accepted circumstances tend to give foundation for the admission in evidence of a map.<sup>3</sup>

1. The map must be prepared according to scale. In addition, any variance between horizontal and vertical scale would perhaps mislead the jury.

2. It must be verified by a witness as being a reliable and correct representation of the area in issue. In most kinds of evidentiary presentations, courts generally favor what has been termed the "best evidence" rule. Thus, if a particular document is to be used to prove a point, then that document (and not a copy) is to be preferred. In the case of a surveyor's plat, however, this rule does not apply. In an action against a city to recover for damage to the plaintiff's property caused by the construction of a viaduct, plaintiff called a witness who produced a plat made by him of the lots and surrounding area. The witness testified that it was a correct plat according to a survey originally made by him. But the plat had been made by him by copying the lot lines and dimensions from the original plan on record in the recorder's office. An objection was made that, under the best evidence rule, the original plat should be produced. Admission of the copy was upheld. The court said:

The object was to show the jury the location of the property by the surveyor, who had measured it. It would have been competent for him while upon the stand to have made a plat of the property as he found it for the inspection and information for the jury.<sup>4</sup>

3. The map must be of such a nature as to be explanatory of verbal testimony. Where a witness testifies that the land is adaptable to the erection of certain buildings, a map of the land with the supposed buildings depicted thereon is admissible, supported by his testimony, for the limited purpose of showing such adaptability.<sup>5</sup> But even though it is verified as correct by the surveyor, the plat is not admissible unless it is somehow related to relevant landmarks and thus, as it were, attached to the soil.<sup>6</sup> But when the survey or plat is of official origin and conforms to the code section pertaining thereto, it is admissible as presumptive evidence of the facts.<sup>7</sup> Thus, the courts have taken judicial notice of topographic maps made by the U.S. Geological Survey.<sup>8</sup>

4. The map must be of such a nature as not to mislead the jury or cause confusion or undue influence. Formal survey maps are the cause of much misunderstanding by counsel in controversies over land. A plat produced by an expert surveyor and supported by his testimony that it is correct, especially if it purports to show boundaries in favor of the party who called him, challenges objection because of its seeming legal effect. Unless some statutory authorization, official recognition, admission by the opposing party, or documentary reference to it gives it such effect, it is admissible only as any other diagrammatic medium may be, to illustrate the testimony of the

<sup>3</sup>Foundation for admission of map or diagram, see, 7 Am. Jur. Proof of Facts, Maps, Diagrams, and Models, Proof I (1961).

<sup>4</sup>Chicago v. LeWayne, 119 F. 662 (7 Cir. 1902).

<sup>5</sup>Campbell v. City of New Haven, 101 Conn. 173, 125 Atl. 650 (1924).

<sup>6</sup>Hageman v. Bernhardt, 162 N.C. 381, 78 SE 209 (1913).

<sup>7</sup>Durden v. Kerby, 41 SE2d 131 (Ga. 1947).

<sup>8</sup>Union Transportation Co. v. Sacramento County, 42 Cal.2d 335, 267 P.2d 10 (1954).

surveyor who made it. If the surveyor testifies that the plat correctly represents the location of the objects marked thereon and the measurements made by him of distance, it is rendered admissible as part of his testimony.<sup>9</sup>

5. The witness must be qualified to testify as to the accuracy of the proposed map. It is not an objection, though subject to the court's discretion, that the witness is not skilled in the making of maps.<sup>10</sup> He must have had observation of the land in question, must collect his observations, and must correctly express his observation and recollection. It must appear that there is a witness who has competent knowledge, and the map is affirmed by him to represent it.<sup>11</sup> An owner with no qualifications as a surveyor or engineer may support an issue as to what land is in his adverse possession by measuring his fences, making a diagram of them, and producing and testifying to it in court.<sup>12</sup> In a condemnation proceeding by a railroad company, the owner of the property was permitted to introduce in evidence, as part of his testimony, a map or diagram of his property made by him, showing the location of his various improvements—his house, barn, etc.—and the location of the railroad across the land relative to these improvements. He was also permitted to testify by referring to the drawing.<sup>13</sup>

6. The nature of the testimony must be such that reference to a map is necessary to the understanding of the testimony by the jury. In a condemnation proceeding, it was held that the trial court did not err in admitting in evidence a copy of a plat of several blocks of a city including the property in question, where the plat was admitted for the sole purpose of showing the location of the property in reference to the streets. It was admitted on the theory that the plat was nothing more than a verified pictorial representation of matters about which the witness had testified, and a desirable expedience by which to illustrate the witness' testimony as to the location of the land in question.<sup>14</sup>

The rules of law dealing with photographs differ from those rules dealing with maps because the situation and surrounding circumstances are subject to change. Photographs, to be admissible as evidence, must have been taken at the time of the transaction or before the situation and circumstances have undergone a change. Frequently, photographs have been held inadmissible on the ground that they were taken at too remote a time and conditions had changed.<sup>15</sup>

There is no distinction between aerial and other types of photographs insofar as their admissibility is concerned, and no case has been found which admitted or excluded a photograph on the sole ground that it was taken from the air.<sup>16</sup> The basic elements of authentication are the same for pictures taken from airplanes as for ordinary photographs although emphasis may differ.<sup>17</sup> Aerial photography presents problems that are not encountered on the ground; the qualifications of the photographer and the quality of his equipment can be expected to play a greater role in admissibility because it is more difficult to make useful and accurate photographs from airplanes.<sup>18</sup> In addition, courts often require that aerial photographs possess some additional advantages over ground-level photographs of a scene in order to be admissible. On principle there is no reason photographs taken from airplanes should not be admitted in evidence under the same rules governing all photographs provided they are relevant to some issue in the case and verified as correct representations of the scene they

<sup>9</sup>Seidenschlag v. Town of Antioch, 207 Ill. 280, 69 NE 949 (1904).

<sup>10</sup>Redman v. Cooper, 160 SW2d 318 (Tex. Civ. App. 1942).

<sup>11</sup>Wigmore, Evidence, § 793 (3rd ed. 1940).

<sup>12</sup>Ibid.

<sup>13</sup>Chicago K. and W.R.R. v. O'Dill, 41 Kan. 736, 21 Pac. 778 (1889).

<sup>14</sup>Aycock v. Fulton County, 95 Ga. App. 541, 98 SE2d 133 (1957).

<sup>15</sup>Chandler v. Russell, 164 Va. 318, 180 SE 313 (1935).

<sup>16</sup>20 Am. Jur. § 727 (Cum. Supp. 1962); 57 A.L.R. 2d p. 1352, § 1351 (1958).

<sup>17</sup>Scott, Photographic Evidence, § 628 (1942).

<sup>18</sup>9 Am. Jur. Proof of Facts, Photos as Evidence, Proof 6, p. 199 (1961); Scott, Photographic Evidence, p. 191 (1942).

portray.<sup>19</sup> When the prerequisites of relevancy and verification are present, the question of admissibility rests upon the discretion of the trial court.

A California district court of appeals, commenting on the admissibility of land-level photographs, in a 1959 case, said:

In ruling upon the admissibility of photographs the trial judge had two primary duties, one, to determine whether the photograph is a reasonable representation of that which it is alleged to portray, and second, whether the use of the photograph would aid the jurors in their determination of the facts of the case or serve to mislead them.<sup>20</sup>

Very accurate maps for use as evidence in real property controversies can be compiled from properly prepared aerial vertical photographs. But this being a highly specialized form of photography, the photographs to be used must be made by a photographer skilled in taking aerial photographs for mapping by photogrammetric methods, the airplane must be piloted by a man skilled in piloting a plane on photography missions undertaken for mapping purposes, and the maps must be compiled from the photograph by someone trained in photogrammetric instrument operation and map compilation.<sup>21</sup> The photographs are also valuable assets in negotiation. The parcel can be studied prior to contact with the owner and compared to the parcels and oriented to existing roads, the proposed construction, streams, and other features. Damages and enhancements as assessed during the appraisal process may be examined as well as neighborhood characteristics and the general terrain involved (7).

This is well illustrated in *Orange County Water District v. Riverside*, 173 Cal. App. 2d 137, 343 P. 2d 450 (1959) where, in an action by a county water district for declaration of water rights of cities to take water from the district river system, admission of a map compiled by use of aerial photographs was held not to be a prejudicial error where the effect was purely cumulative. The expert who prepared the map was present to verify and attest the validity of the map, and the jury was not present. Another case, which was appealed in 1945 in an action by the plaintiff to perpetually enjoin the defendant and his successors from using a certain ditch, admitted a tracing from an aerial photograph. The court based its decision upon cases dealing with the discretion of the trial court to admit maps and charts as competent evidence to illustrate relative locations and objects as an aid to the jury.<sup>22</sup>

Whether an aerial photograph should be admitted as evidence depends a great deal on the circumstances of the individual case. For example, aerial photographs showing condemned property and the neighborhood surrounding it were admissible as evidence where they were properly identified and where they accurately portrayed the condition on the ground.<sup>23</sup> Such photographs were qualified for admission by testimony of a registered professional engineer employed by the condemning city, who was familiar with the property in question.<sup>24</sup> Aerial photographs were considered admissible where they showed the location of the land, roads, and buildings involved from a high altitude, and witnesses testified that the area "looked about the same" as the photographs showed.<sup>25</sup> It is for the trial court to determine whether a photograph offered is a preliminary question of fact to be decided by the trial judge.<sup>26</sup>

A leading case of the subject of admissibility of aerial photographs is *Department of Pub. Works & Bldgs. v. Chicago Title & Trust Co.*, 408 Ill. 41, 95 NE2d 903 (1950),

<sup>19</sup>*United New Jersey R. & Canal Co. v. Golden*, 104 N.J.L. 385, 140 Atl. 450 (1928); *Chandler v. Russell*, 164 Va. 318, 180 SE 313 (1935).

<sup>20</sup>*Anello v. Southern Pacific Co.*, 344 P. 2d 843 (Cal. Dist. Ct. App. 1959).

<sup>21</sup>*Scott*, *Photographic Evidence* § 628 (1942).

<sup>22</sup>*Williams v. Neddo*, 66 Idaho 551, 163 P.2d 306 (1945).

<sup>23</sup>*Frankfurt v. Dullas*, 299 SW2d 722 (Tex. Civ. App. 1957).

<sup>24</sup>See also, 3 Wigmore, *Evidence* § 793 (3rd ed. 1940), as to competency of witness.

<sup>25</sup>*Trachta v. Iowa State Highway Comm'n.*, 249 Iowa 374, 86 NW2d 849 (1957).

<sup>26</sup>*Howe v. City of Boston*, 41 NE2d 1 (1942); *Hyde v. Town of Swanton*, 72 Vt. 242, 47 Atl. 790 (1900); *Adams v. State*, 28 Fla. 511, 10 So. 106 (1891).

where the Department filed a petition to condemn certain land for park purposes. The court entered judgment directing the petitioners to pay a certain amount to the county treasurer for the benefit of the property owners as full compensation and the owners appealed, contending that the court erred in allowing three topographic maps made from aerial photographs as exhibits to show what portion of appellant's property was under water, what portions might be subject to flood, and what portion was on or above the feasible building plane. The Supreme Court of Illinois ruled that plats, photographs, drawings, and diagrams that illustrate the subject matter of the testimony may be received into evidence for the purpose of showing a particular situation, explaining the testimony, or enabling the jury to apply the testimony more intelligently to the facts shown; but the particular photographs involved were held inadmissible on the basis of the trial judge's discretion.<sup>27</sup>

Aerial photographs taken from the files of the U. S. Corps of Engineers to show improvements on land or a lack thereof have been held admissible as evidence in Louisiana where the plaintiff produced an expert witness to testify to the validity of the photographs.<sup>28</sup> This was the only case uncovered during the study concerning admissibility of aerial photography in which the court cited a statute in support of its reasoning. However, the statute cited deals entirely with the admissibility of Federal enactments, regulations, or documents as evidence but does not mention photographs.<sup>29</sup>

Photographs used as a comparison for similar conditions have been admitted also. In an action to condemn land for the purpose of extending a municipal airport, the defendant landowner objected to the admission into evidence of a photograph of a municipal airport in another city on the ground that it was immaterial and irrelevant and that there was no evidence by the photographer that he took it correctly. The court held the photograph admissible where the witness testified that he formerly was an aviator and had, over a long period of time, flown in and out of the airport photographed, that the photograph was a true and correct picture of the airport, and that it reflected the true condition on the ground.<sup>30</sup>

Because the admission of aerial photographs is a matter within the trial court's discretion, there are a number of cases in which such photographs have been held inadmissible. The courts have ruled that they were inadmissible when there was ample evidence previously submitted to give the jury a proper perspective of the site,<sup>31</sup> where the photograph was not accurate (not representative) in that it failed to show the complete condition of the land,<sup>32</sup> the photograph was not sufficiently verified,<sup>33</sup> the accuracy was not properly and sufficiently shown,<sup>34</sup> and where the photographs have not been verified or authenticated by some other evidence before they are admitted.<sup>35</sup>

In a few actions aerial photographs have been excluded from evidence, at the discretion of the court, where other evidence gave a sufficiently accurate picture. In *Buchanan v. McHurdle*,<sup>36</sup> the court stated:

The aerial pictures would have thrown little, if any light upon the essential facts, in addition to that disclosed by the other evidence —certainly not enough to work a reversal and retrial of this cause.

<sup>27</sup> "While such exhibits (aerial photographs) might properly have been admitted under the rule of the Smith case . . . , it was still a matter within the discretion of the court, and its failure to do so is not such an error as to warrant reversal of the judgment." *Department of Pub. Works & Bldgs. v. Chicago Title and Trust Co.*, 408 Ill. 41, 95 NE2d. 903 (1950).

<sup>28</sup> *Airway Homes, Inc. v. Boe*, 140 So.2d 264 (La. Ct. App. 1962).

<sup>29</sup> L.S.A. - R.S. - 13:3713 (1951).

<sup>30</sup> *Wise v. Abilene*, 141 SW2d 400, 9 A.L.R.2d 928 (Tex. Civ. App. 1940).

<sup>31</sup> *Galt v. Dept. of Pub. Works & Bldgs.*, (71 Sup. Ct. 804, 341 U.S. 931). (Ill. 1951, certs. denied.) Reported below: 408 Ill. 41, 95 NE2d 903 (1950).

<sup>32</sup> *Chandler v. Russell*, 164 Va. 318, 180 SE 313 (1935).

<sup>33</sup> *United New Jersey R. and Constr. Co. v. Golden*, 104 N.J.L. 385, 140 Atl. 450 (1928).

<sup>34</sup> *Department of Pub. Works and Bldgs. v. Chicago Title and Trust Co.*, 408 Ill. 41,

95 NE2d 903 (1950); *Chandler v. Russell*, 164 Va. 318, 180 SE 313 (1935).

<sup>35</sup> *Moore v. McConnell*, 105 Ga. App. 758, 125 SE2d 675 (1962).

<sup>36</sup> 209 Miss. 722, 48 So. 2d 354 (1950).



It is evident, however, that with a proper foundation an aerial photograph can be admitted as demonstrative evidence in much the same manner as a map or an ordinary photograph. Care must be exercised in having an expert prepare and verify the aerial photograph in court to avoid any possible exclusion.<sup>37</sup>

In 1962, the Photogrammetry and Aerial Surveys Committee of the Highway Research Board prepared and circulated a questionnaire (6) to state highway departments and Federal agencies to determine the utilization of aerial surveying in each of the principal highway engineering stages. Of the replies received from 47 states, only 17 states reported use of aerial photographs for cadastral purposes, and nearly one-third of the states use aerial photographs for appraising and negotiating for rights-of-way. Less than 10 percent of the states use aerial photographs for preparation of deeds, however (6).

Other questionnaires (10) to state highway departments show that 47 states use some form of photogrammetric techniques in their highway programs.

### Legislative Reform and Judicial Recognition

With respect to admissibility as evidence, the products of photogrammetry are treated almost universally by the courts as any other photograph or stereoscopic model. There has been to our knowledge little effort to lay guidelines for the development of uniform rules for photogrammetrically made measurements as cadastral data or to recognize the technical ability of the photogrammetric methods to meet and even surpass the various accuracy and minimum standard requirements presently demanded of cadastral surveys by the state title associations and the judiciary.

A majority if not all of the states statutorily define land surveying and the surveyor under some title such as professions and occupations. Accordingly they institute licensing and registration requirements for the professions and occupations regulated. The courts generally rely on these statutory provisions as providing a reliable level of competence. Consequently, the products of the land surveyor or professional engineer are recognized judicially as the work of an expert and thus receive a certain air of veracity. Some courts have already extended judicial notice to topographic maps prepared by the U. S. Geological Survey.<sup>38</sup> Yet these statutes, regulating everything from pediatricians to morticians, have not recognized the newer techniques of surveying and land measurement as described in this paper.

California appears to be the only state which does statutorily recognize photogrammetry. The statutory change in California began in 1961 when the land surveying definition was amended by adding the words, "or photogrammetry," to paragraph "(d)" of Section 726.<sup>39</sup> Two additional sections, subsequently added, read as follows:

§ 8730.5. Preparation and delivery of topographic maps produced by photogrammetric process; licensing.

This chapter does not require licensing to prepare and deliver topographic maps produced by the photogrammetric process or data connected therewith under contract with an individual, firm, corporation, association, or public agency if the following conditions exist:

<sup>37</sup> For other cases involving verification, see, *Adams v. State*, 28 Fla. 511, 10 So. 106 (1891); *United New Jersey R. and Canal Co. v. Golden*, 104 N.J.L. 385, 140 Atl. 450 (1928); *Moore v. McConnell*, 105 Ga. App. 758, 125 SE 2d 675 (1962); 3 *Wignore*, Evidence § 794 (3d ed. 1940).

<sup>38</sup> *Union Transportation Company v. Sacramento County*, 42 Cal.2d 335, 267 P.2d 10 (1954).

<sup>39</sup> Cal. Code Ann. § 8726 (Cum. P.P. 1962), Amend., Stats. 1961, c.2225, p. 4579 § 1.

"§ 8726 Land Surveying defined a person practices land surveying within the meaning of this chapter who, either in a public or private capacity, does or offers to do any one of the following: (d) determines the configuration or contour of the earth's surface or the position of fixed objects thereon or related thereto, by means of measuring lines and angles, and applying the principles of trigonometry or photogrammetry." [Emphasis added.]

- (a) Field surveys to be done under the contract are performed by registered civil engineers or licensed land surveyors.
- (b) A registered civil engineer or licensed land surveyor is the official of the individual, firm, corporation, association, or public agency responsible for the approval of the performance under the contract, or the work is to be delivered to a registered civil engineer or licensed land surveyor.

§ 8730.6. Termination of licensing exemption.

After June 30, 1962, the exemption from licensing provided in Section 8730.5 shall apply to only those persons who hold a certificate of exemption issued by the board. The board shall receive applications for certificates of exemption filed on or before June 30, 1962, but not after that date. A certificate of exemption may be issued to any person who shows to the satisfaction of the board that he has had six years or more of professional level photogrammetric mapping experience. The certificate shall be on a form prescribed by the board and shall be accompanied by the application fee prescribed by this chapter for land surveyor's license.

As a result of these statutory changes California clearly intends that photogrammetry be recognized as a method of measurement for calculating land dimensional data. Before these specific statutory provisions were enacted California recognized the work of the photogrammetrist, but not on the same plane as the work of the registered land surveyor or civil engineer. In 1954 the Attorney General of California rendered the opinion that topographical maps prepared by aerial mapping firms under contract with the Department of Public Works, for use by the Division of Highways and Division of Water Resources, did not necessitate the services of a licensed surveyor, because the service rendered by the aerial mapping firm did not constitute land surveying as defined in Sections 8726 and 8627 (as of 1954).<sup>40</sup>

Section 8727, as enacted in 1954, except certain surveys from the provision of Section 8726. Aerial photography and photogrammetry were among the excepted categories. This section was changed in 1959, however, and the categories of aerial photography and photogrammetry were removed.

A similar point came up in *Hill v. Kirkwood*,<sup>41</sup> a 1958 taxpayer's suit to enjoin payment on a certain contract. It held that a contract requiring a company performing aerial survey work to furnish maps prepared by a process known as photogrammetry was not illegal because the company engaged in the work was not registered as a civil engineer or licensed as a land surveyor even though the mapping did require use of conventional land surveying methods for the ascertainment of ground control data because this work did not constitute land surveying as [then] defined by Sections 8726 and 8727. The subsequent statutory changes, however, tend to indicate that the same factual situation today would require a different holding.

Idaho also has interpreted the service of photogrammetry as not being within the state's statutory definition of land surveying.<sup>42</sup> Idaho has a statute,<sup>43</sup> as do a great majority of states that defines land surveying in terms similar to those used by California but not including the word photogrammetry. The general terms in which most of these statutes are drafted perhaps would permit judicial interpretation to include photogrammetry as a method of measurement (within the meaning of the statute) if the court desired to so construe the present statutes. It could be well argued, however, that such interpretation would be burdensome upon the litigative process. The alternative solution appears to lie within the command of the legislature, for proper legislation could eliminate the majority of doubt. Photogrammetric techniques in their pres-

<sup>40</sup>23 Ops. Cal. Atty. Gen. 86 (1954).

<sup>41</sup>161 C.A.2d 346, 326 P.2d 599 (1958).

<sup>42</sup>*Aero Service Corp. (Western) v. Benson*, 374 P.2d 282 (Idaho 1962).

<sup>43</sup>Idaho C.54-1202 (1957).

ent state, as compared to conventional land surveying techniques, lend themselves to statutory recognition and regulation with equal definitiveness.

The changes made by California are indicative of a trend which may possibly result in the adoption or amendment of licensing and registration regulations including examinations directed toward evaluating the capability of photogrammetric instrumentation and techniques and setting a standard level of ability and competence for the photogrammetrist.

### Conclusion and Forecast

It is apparent that photogrammetry has greatly advanced in the United States since its beginnings a few decades ago. Some of the advantages and improvements which have been made through its use are improved accuracy of cadastral surveys, an increase in planimetric detail, a minimizing of costly omissions, reduction in time, elimination of cumulative type errors, elimination of delays in schedules due to weather, and an increase in size of the area mapped to include adjoining properties without trespassing or significantly increasing the cost of the survey. Despite the recent technological advances in the perfection of high-speed cameras, the use of photogrammetry in litigation is relatively rare. It is probable, however, that with increasing public interest and lowering of expense together with easier and more accurate methods of using aerial photographs, the use of aerial photographs as evidence will become more extensive.

When the TVA needed maps of an area within which it was working, it was proved through use that photogrammetry could be a useful tool in compiling small-scale maps of large areas. Since then, mapping has been a major application of photogrammetry for small surveys but large-scale detail work by photogrammetric methods was not readily accepted until proven feasible, economical, and reliable. Only in recent years has acceptance of the use of photogrammetry by the design engineer, land surveyor, landscape architect, city planner, and municipal engineer occurred. Much of the credit for demonstrating to the design engineer and surveyor the capability and accuracy obtainable from photogrammetric surveys must go to the design survey maps compiled in conjunction with the greatly expanded highway program of the past decade.

The question of admissibility is based upon the discretion of the trial judge in any given litigation. The criteria upon which that discretion generally hinges may be concisely stated as reasonable accuracy, proper verification, and relevancy. Accuracy is a relative matter and, with modern development in aerial photography, photogrammetry supersedes the requirements set for the admission of land-level photographs as demonstrative evidence. The proper verification of an aerial photograph generally can be supplied by the testimony of the expert engaged in the taking of the photograph or by one who can attest to the veracity with which the given photograph reflects the actual subject. The requirement of relevancy may be satisfied by showing that the photographs are beneficial to the proper understanding of the subject under litigation.

The question of cost is diminishing as technical developments increase the accuracy of the equipment and measurement and decrease the time factor (11).

In the field of eminent domain in particular, evidence in the form of aerial photographs has great potential. Aerial oblique photographs can clearly show aspects and features which could not be as effectively shown to the jury or special commissioners in eminent domain proceedings and zoning hearings by any other means. Vertical exposures may be used to show comparable properties, but generally they are not as readily understood by laymen as the oblique view. Photographs with overlays or with the artist's conception of the completed facility, perspectively fit into bordering photographic details, can show benefits to property remainders to offset claims of excessive damages in severance suits. A valuable use can be made of photographs showing in perspective the completed highway construction and abutting property development that is comparable to the area in question. In partial takings where the project is in operation before eminent domain proceedings are completed, photographs of the completed project can be most effective, particularly in determining if enhancement in value has taken place in the area by reason of the highway construction (7).



In many suburban and rural areas, maps compiled at a scale of 40 feet to 1 inch are considered acceptable for use in right-of-way development when the properties involved are large tracts (7).

Consequently, it is reasonable to assume that the use of photogrammetry will steadily increase in such areas as planning, surveying, designing, and procuring rights-of-way for highway development as its possibilities become evident and as the legislatures recognize the need for statutory revision to provide for the acceptance of photogrammetry as a metrical science.

In the words of another in concluding a discussion of photogrammetry:

More recent developments in the area of photography such as photogrammetry ... also promise to assume favored positions as illustrative aids in establishing market value. There is no reason to believe that the courts will require anything more for their admissibility into evidence than is required for the admission of courtroom exhibits in general--that they be relevant and verified as accurate.

Assuredly the primary objective of awarding just compensation in a proceeding in eminent domain, and the general objective of accomplishing justice, requires the continued use, encouragement and further development of illustrative assistance in the varied forms of demonstrative evidence. For, in this dynamic age, we must, to borrow a phrase from "Alice in Wonderland," "... run awfully fast to stand still." (12)

#### REFERENCES

1. Eliel, L. T., "One Hundred Years of Photogrammetry." *Photogrammetric Engineering*, p. 359 (June 1959).
2. Frierson, R. E., "The Use of Aerial Photography in Property Surveys." *Surveying and Mapping*, p. 70 (April-June 1948).
3. Blachut, T. J., "Use of Photogrammetry on a Legal Survey at Alnwich." *Canadian Surveyor*, p. 336 (July 1959).
4. Pastorelli, A., "Large Scale Photogrammetry and Economy of Precision Photogrammetry in Switzerland." *Photogrammetria*, 11(3)(1954-55).
5. Johnson, H. E., "Aerial Surveys Aid Land Acquisition." *Right of Way*, p. 35 (Feb. 1959).
6. "Results of 1962 Questionnaire on Use of Aerial Surveys." *HRB Res. News* 6, 50 pp. (June 1963). Pryor, W. T., "Evaluation of Aerial Photography and Mapping in Highway Development." 9th Pan Amer. Highway Cong., Doc. 20 (1963).
7. Huff, T. S., and Christian, A. H., "Photogrammetry." *Acquisition for Right-of-Way*, AASHO, p. 196 (1962).
8. King, I. E., "Advantages of Photogrammetry in Cadastral Surveying." *Surveying and Mapping*, p. 97 (March 1962).
9. Brown, C. M., and Eldridge, W. H., "Evidence and Procedure for Boundary Location." 313 pp., J. Wiley, New York (1962). Pryor, W. T., "Highway Engineering Applications of Photogrammetry." *Photogrammetric Eng.*, p. 523 (June 1954).
10. Avera, H. Q., "Photogrammetry and the Small Land Surveyor." *Photogrammetric Eng.*, p. 96 (Jan. 1963).
11. "Increased Use of Photogrammetric Service Saves Department Upwards of One Million Dollars." *Hy-Lighter* (Michigan State Highway Pub.), p. 4 (Sept. 1958). Clarke, L. E., "Photogrammetry in Preparing Right of Way Maps and Deeds." *Texas Highways*, 7(8):3 (Aug. 1960). Goodwin, W. A., "Aerial Photographs and Some of Their Application to Highway Engineering." Presented at 2nd Ann. Oklahoma Joint Highway Eng. Conf., p. 35 (1959). Lowe, T. M., Jr., "Photogrammetry for the Highway Engineer." *Proc. of the 2nd Ann. Alabama Joint Highway Eng. Conf.*, p. 41 (Mar. 1954). Segelke, V., "Use of Photogrammetry



- for Highway Land Acquisition Purposes." HRB Bull. 314, pp. 78-81 (1961).
12. Hadley, G. C., "Demonstrative Evidence in Eminent Domain Proceedings." Inst. on Eminent Domain, p. 132 (1960).