THE STATUS OF SURVEYING AND MAPPING IN THE UNITED STATES

Final Report by the Task Committee on Status of Surveying and Mapping, Surveying and Mapping Division, American Society of Civil Engineers

October 14, 1958

Endorsed by Executive Committee of Surveying & Mapping Division as Amended: October 15, 1958

A - General Background of the Problem

In the past decade, certain problems relating to the professional status of its surveying-mapping members prompted the American Society of Civil Engineers in 1954 to inaugurate a study of surveying and mapping activities in the United States. A Task Committee on Status of Surveying and Mapping was appointed to report on two questions:

a. Which parts or activities of surveying and mapping are professional, and which are not?
b. Which parts or activities of surveying and mapping are engineering, and which are not?

These two questions have been under close scrutiny now for nearly four years, and herein are presented the results of various phases of the study.

Ethical Considerations

The problems that prompted the action mentioned above were typically these:

a. Certain federal surveying-mapping agencies (e.g., Corps Corps of Engineers) and state and municipal bodies were seeking to contract for the hire of surveying personnel on a competitive-price basis, a practice that many ASCE members reported as violating the ASCE code of ethics;
b. Contracts for preparation of topographic maps by use of photogrammetry were frequently awarded to corporations on a competetive-price basis, again suggested as a violation of ethics.

Other problems of a minor nature and similar thereto, not the least being the recurrent question of admitting land (property) surveyors to engineering license or to engineering societies, added weight in favor of the study.

Committee Personnel

The Task Committee is composed of three members: representing federal mapping agencies, Mr. George D. Whitmore, Chief Topographic Engineer of the U. S. Geological Survey, Washington; representing private practice (or industry), Mr. Alfred O. Quinn, Chief Engineer of Aero Service Corporation, Philadelphia; and representing engineering education, Brother B. Austin Barry, Associate Professor of Civil Engineering at Manhattan College, New York, as Chairman.

B - First Report (1955): What in Surveying is Professional

At the start, it was found necessary to ascertain a good definition of the term professional. In its first report* the Task Committee cited four distinguished authorities and noted that, among other attributes, these are primarily the distinguishing marks of a profession (or of professional work):

a. It is of a high intellectual nature;
b. It must require the exercise of judgment and is not subject to standardization;
c. It must satisfy an important social need;
d. It has a body of advanced knowledge (science) and an art (skill) not commonly possessed by the general public.
e. Its practitioners are usually prepared on the college or university level in a specialized intellectual technique (as well as in general areas of learning);
f. Its members must have a motive of service, assume relations of confidence, and accept individual responsibility;
g. There must be some social recognition and regulation of the profession.

On the basis of these characteristics, all categories of surveying-mapping activity were studied and the individual job classifications were designated as professional-level, technician-level, or preprofessional-level in nature. Definitions were also included for each professional title in the attached classification chart (Appendix D). In each case, the professional person is distinguished from the technician, who usually works under the direction of a professional.

Professional vs. Technician

The tenets used for the differentiation throughout the study are as follows:

Professional Level: Work that involves the exercise of professional judgment, frequently based on knowledge acquired through higher learning, generally non-routine in character. The term implies one who can plan, perform, and/or direct all such operations in the category; this person is responsible for work performed by those under him.

Technician Level: Work that is primarily routine, of a technical nature, often demanding a higher degree of skill, done under the direction of a professional person who is responsible for its outcome. Such work is preprofessional when [redacted] performed by a professional trainee who, having completed courses of specialized intellectual instruction and study, is seeking to attain professional status.

It might be appropriate to state that such a differentiation between professional and technician had not previously been made, but that its acceptance upon publication was unanimous, indicating that such is a very natural pattern of human behavior. Similarly, while no comprehensive classification of surveying-mapping activities had ever been published, the six categories shown met with general approval as well. The Task Committee submits this Classification Chart as part of its present final report. (See Appendix D.)

* First report: "Professional Aspects of Surveying and Mapping" dated October 24, 1955; published as Paper #921, Journal of Surveying and Mapping Division of ASCE, Vol. 82, No. SU1, March 1956.

C - Interim Report (1956): What in Surveying is Engineering *

Having completed the initial phase of the study, it became necessary to determine which of the six categories of activity are properly engineering activity. In October 1956, the Task Committee (Interim Report) listed its findings, as follows:

1. Land or Property Surveying (Cadastral) was stated to be separate and distinct from engineering, as determined from the official pronouncements of two groups:
   a. In 1948, the statement of the National Council of State Boards of Engineering Examiners (NCSBEE). (See Appendix A.)
   b. In 1952, the resolution of the National Society of Professional Engineers (NSPE). (See Appendix B.)
2. Engineering Surveys (for Design and Construction), because widely recognized as engineering, were identified as engineering;
3. Geodetic Surveying, Geodetic Engineering, or Geodesy was listed as engineering work in nearly its entire scope;
4. Cartographic Surveying, Cartographic Engineering, or Map and Chart Surveying was called engineering because so determined by the NCSBEE, the NSPE, and by a 1952 statement of the ASCE Board of Direction, as also because so adjudged generally by various state boards of engineering registration. (See Appendices A, B, and C.)
5. Aerial Survey Services (adjunct services not necessarily linked to photogrammetric mapping) were listed as non-engineering;
6. Cartography (map compilation from other than original surveys, map finishing, map reproduction) was listed as non-engineering.

Reaction of the Profession

Efforts to publicize these findings widely resulted in many responses from all parts of the United States. The land surveying statement caused by far the greatest discussion, with many groups and individuals strongly endorsing the stated view and with just as many others objecting thereto with equal vigor. Many analyses were made by land surveying groups, state and regional, but no general agreement was found to exist among them.

At this point, the American Congress on Surveying and Mapping (ACSM) became greatly interested and attempted to act as spokesman for land surveyors throughout the nation. At the suggestion of ACSM, Mr. Victor H. Ghent, land surveyor from Virginia, became an associate member of the Task Committee to act as ACSM liaison and to offer counsel in the deliberations. Mr. Ghent's aid is hereby gratefully acknowledged.

* "Interim Report of the Task Committee on Status of Surveying and Mapping" of October 18, 1956, published in Civil Engineering of March 1957.

D - Second Interim Report (1957): Modification re Land Surveying

With a fairly unified opinion across the country concerning the categories II through VI, but with a general lack of accord on category I, Land or Property Surveying (Cadastral), the report of October 1957 (Second Interim Report) of the Task Committee* was a restatement of its October 1956 findings, with a single exception. The change, concerning category I, was this statement:

> We find that more than half of the profession (including a national committee of surveying teachers) believe that Category I (Land Surveying-Cadastral) should continue to be regarded as a branch of civil engineering... We must therefore retract the recommendation of 1956 that land surveying be regarded as an activity separate and distinct from engineering.

With an unsettled question of such magnitude facing it, the Task Committee immediately presented (in form of an Appendix attached to the Second Interim Report) a partially developed thesis that would "retain" land surveying as a part of engineering. There began simultaneously a severe scrutiny by the Task Committee of all the reasons for retaining any part of surveying within the domain of engineering, especially for retaining land (property) surveying. The present report is the result of this scrutiny.

* "Second Interim Report of the Task Committee on Status of Surveying and Mapping" of October 18, 1957, not published but rather widely distributed by the Task Committee.

E - Findings of the Present Report

Primary and basic attention was given to the fundamental question, "Does the practice of Surveying and Mapping as defined and categorized by the Committee constitute the practice of Professional Engineering?" Two facets of the problem were seen to be important: (1) recognition by the engineering profession, and (2) recognition by the legally constituted bodies, i.e., the various state laws and boards of professional licensing.

A review of the registration laws for professional engineers in the country indicates that a uniform and clear-cut decision has not been made. Some states, such as Pennsylvania, specifically include surveying (and mapping) as a part of the basic definitions of professional engineering practice; others have no reference to surveying-mapping in their laws; and in still other states, opinions by Attorney Generals have excluded all or parts of the Surveying profession from engineering and the requirement for licensing.

Since a lack of uniformity of state laws and rulings exists, the Task Committee felt that the basic definition and resolution of the professional status of surveying and mapping should emanate from the engineering profession itself. When the engineers have placed surveying and mapping in its proper professional position, a positive statement can be made to the licensing boards to attain legal recognition.

As a result of thorough deliberation and widespread consultation during the past year, the Task Committee feels that it is ready to present in this final report, certain findings on matters not covered in the prior interim reports. The findings are followed by a series of conclusions, and concomitant recommendations. The recommendations collectively constitute, in effect, a policy position for ASCE as principal spokesman for the civil engineering profession, as well as a program of action for state registration boards, engineering schools, ASCE's Surveying and Mapping Division, other professional societies, and individual engineers and surveyors throughout the country.

Basic Considerations

From a fundamental point of view, the practice of engineering includes the use and recognition of the properties of matter and the sources of power in nature to provide tools, structures, machines, and conveniences useful to man. This broad scope of activity demands the professional services of persons schooled and skilled in the basic laws of nature and materials to successfully apply engineering principles. The Committee concludes that the application of the engineering concepts of mathematics, astronomy, mechanics, physics, and human management as practiced by persons engaged in activities defined in categories I, II, III, and IV of this report constitutes the practice of professional engineering. The investigation, planning, design, and responsible supervision of surveying operations, the construction of surveying equipment and/or systems, and the location, delimitation, and delineation of natural and physical features on the surface of the earth fulfill the requirements for engineering practice. The exercise of these responsibilities does require higher and professional education which the Committee believes must be satisfied by the completion of an engineering curriculum in a college or school having adequate equipment, resources, and professional instructors to provide at least a four-year program.

Re Land Surveying

The place in engineering of our category I, Land Surveying (Property, Cadastral), is the subject of greatest controversy throughout the country and of greatest concern to this committee. The principal facts relevant to the matter seem to be:

1. A substantial majority of the civil engineering profession throughout the United States firmly believe categories II, III, and IV to be engineering.

2. However, with regard to category I, probably a majority of the profession feel that property surveying should be considered engineering and be "retained" within the branch of civil engineering. Many others believe that this category of work, while admittedly fully professional in nature, should be splintered off from engineering and be allowed to form into a separate professional group.

3. Probably a majority of private-practice property surveyors are also licensed (registered) as professional engineers, which seems to work out very well in practice, as both capabilities are required on many projects and, in any case, they tend to be complementary activities.

4. Others in private practice not so dually licensed usually find it necessary, in order to stay in business, to combine property surveying with certain auxiliary jobs that are generally considered to be engineering, e.g., subdivision development and construction layout.

The Task Committee believes, so far as the surveying and measurement sciences are concerned, that property surveying in the future will necessarily become increasingly more precise and complex, and will necessarily utilize geodetic, photogrammetric, electronic, and other advanced procedures. The Committee feels that the measurements made to ascertain the size and shape of the earth, as well as those to ascertain a distance between two points three hundred feet apart, are part of the same science. Similarly, surveying for the topographic plan for a 2-acre plot is part of the same science as mapping an entire State, although the specific techniques be different.

The Task Committee therefore advocates that the practice of property surveying, (usually referred to as land surveying in state registration acts), be considered to be an integral part of the surveying and mapping complex, and consequently of engineering. As a corollary, the Task Committee also advocates that a basic engineering education, preferably with some emphasis in the surveying and mapping sciences, should be prerequisite for all land surveyors of the future, as it should be also prerequisite for those who specialize in any other categories of surveying and mapping.

While admitting that property surveying and survey engineering are thus basically akin, identified in fact, the Task Committee here points out an additional important requirement for an engineer engaged in property surveying: a knowledge of property law and of local conditions. As has been established, all who wish to practice property surveying should be basically engineers (and should be equipped with the B. C. E degree or equivalent) because of the similarity of the knowledge and tools needed for both, and there should be no need for a separate L.S. examination and registration law.

It is most important, however, for all to recognize the peculiar nature of property surveying, which demands a specialized knowledge of property law and of local conditions. Because of the particular conditions that exist in many states in regard to land surveyors, platting laws, recording laws, etc., it is felt that each state must work out for itself the most practical methods of transition from land surveyor and professional engineer licenses to the single professional engineer license.

We envision that in the future it will be imperative that engineers be very careful, therefore, in judging their own competency to practice property surveying. This will require a renewed sense of ethics within the profession, but we are strong in the belief that without such a proper ethical basis a profession cannot exist.

Re Photogrammetry

In view of the past controversies regarding the place of photogrammetry in topographic surveying and mapping, and in engineering, it is felt desirable to repeat here in some detail the views of the Task Committee on this matter.

It is the Committee's judgment that the use of photogrammetry involved in making a topographic plan or map, for example, is engineering work. However, certain adjunct aerial survey services (e.g., obtaining aerial photographs, etc.) in themselves are regarded as non-engineering. The findings of the Task Committee regarding photogrammetric activity are simply stated in the Interim Report: "The photogrammetric methods of Categories I, II, III, and IV are engineering procedures by reason of their being operations of an engineering project, e.g., the preparation of a topographic map."

Certain difficulties seem to surround this concept of photogrammetry as a procedure, for some persons would have the method divorced from engineering and become a profession by itself.

It is the view of this Committee that the topographic plan or map, aside from its inherent value as an engineering instrument when completed, is itself a project that is engineered in its construction. The basic elements of lineal and angular measurements, and the selection of the proper instruments and procedures for each of the succession of operations beginning with horizontal and vertical control, must be commensurate with the purposes of the product. As the concept of measurement evaluation is essentially the basis of engineering, we hold that the topographic plan or map, whether or not produced mainly by means of photogrammetric surveying (or any other surveying method yet to be devised) rather than traditional ground surveys, is an engineered accomplishment.

Furthermore, it should be noted that a topographic plan or map is an engineering instrument, a basis on which engineering design is to be based, and that production of such topographic plan or map is undertaken for the value it will have for engineering planning and design for such as highways, dams, reservoirs, irrigation systems, drainage systems, industrial sites, subdivisions, etc. Vast sums of design and construction money will be expended on the basis of the map's information. Only in the measure that the plan is reliable can it be of any use, and it is manifestly impossible for the user to check the entire map for reliability without inordinate expenditure of time and effort. The reliability therefore is something that must be worked into the

map by professionally accepted methods, competent and informed personnel, precision equipment, and (primarily) engineering planning and supervision at every stage of the process. It would be unwise to entrust the basic mapping of terrain and culture at any useful engineering scale to persons lacking a sense of plotting accuracy and of the implications of map error (and blunder).

It is well to remember that the use of aerial photographs in the surveying and mapping field has brought about the development of the science of photogrammetry. The original service offered by private practitioners was almost exclusively that of taking aerial photographs (classified as non-engineering) and it became common practice to obtain this service through competitive bidding. Later, when photogrammetric survey operations were added, competitive bidding was continued even when highly accurate, detailed surveys and topographic plans and maps were a major part of the contract. The continuance of the competitive bidding practice also can be attributed to the relative newness of the photogrammetric methods (though European countries have utilized the basic principles for many decades), and the consequent reluctance of the public and of public bodies to risk money on untried procedures. The Committee is confident that persons who specialize in photogrammetric surveying procedures will welcome a clarification of their status and the recognition of their work as professional engineering, and that this should ultimately eliminate the practice of competitive bidding from this activity.

Re New Umbrella Term

The Task Committee believes that Categories II, III, and IV clearly form the content of the "earth-measuring" sciences. We find, further, that Category I, Land Surveying (cadastral) falls into this concept and, as recommended herein, should henceforth demand that its practitioners be engineers with specialized additional training and background. Thus we find that this field may well include geodesy, topography, hydrography, photogrammetry, engineering and construction surveying, property surveying, and the like.

Heretofore much reliance has been placed on the term "surveying and mapping" as an overall designation, although the term "cartography" was also used for a few years by Government agencies under instructions of the U. S. Civil Service Commission. We find that "surveying and mapping" as a designation is not only cumbersome, but falls short of conveying the proper meaning. The term "cartography" never found full acceptance among surveying-mapping practitioners in the United States.

The Task Committee therefore has attempted to find an appropriate name for the entire content of these "earth-measuring" sciences, a term which would serve to denote the entire field of Categories I, II, III, and IV. To date no agreement has been reached on a new umbrella term but the most appropriate names seem to be these three:

1. Survey Engineering, as proposed in an early report, meets with favor by many.
2. Geodetic Engineering, is the name acceptable to many others, although its basic weakness as a designation for the entire field stems from its being already the designation of one of the parts of the whole. European practice might be pointed to as a precedent for its use, however.
3. Geometronic Engineering, a term coined by Walter S. Dix, A.M., Am. Soc. C. E., and Secretary of A.C.S.M., meets with considerable favor by many persons although it is so new and untried that its use in this sense must be regarded as highly tentative.

The Task Committee offers these three terms for consideration without advocating any, recommending, however, that an umbrella designation is needed and should be used in referring to the work of the first four categories. Throughout the remainder of this report the term survey engineering is generally used, though such use is intended to be without prejudice to either of the other terms or to any other acceptable designation.

Re Education

In the deeper study of surveying and mapping during the past year, two significant and pertinent trends have become apparent to the Task Committee:

1. Engineering as a profession is beginning, more than ever since its inception 150 years ago, to emerge clearly as a scientifically-oriented profession. No longer is it based primarily upon the art (the how-to-do), but is now assuredly founded on the principles of science. Educational institutions are rightly showing the way in this emergence of the new concept of engineering.
2. Surveying, concurrently, may be losing its place in the civil engineering curriculum, probably because:
   a) in the past elementary surveying has been taught mainly as an art, or how-to-do course, the type of course now being eliminated in many schools; and
   b) unfortunately there is now not sufficient time available in a 4-year degree program to include the variety of subjects currently required in advanced surveying and mapping courses.

We find that educational facilities for geodetic surveying (Category III) and cartographic (topographic and hydrographic) surveying-mapping (Category IV), though recognized widely as being engineering, have been neglected in the United States to a serious degree. There are only a few engineering schools where the work is taught in the undergraduate curriculum despite today's drastic need for scientific manpower in these two fields specifically. Since the educational facilities for housing the body of professional knowledge are essential to making a profession, we believe that in this instance the lack of sufficient courses in surveying-mapping subjects is a serious impairment of the profession.

Perhaps worse off from the educational standpoint is property surveying, for preparation therefor is not generally regarded as an obligation of the colleges and universities. The legal aspects of property surveying are of the greatest importance, and surely warrant at the least an elective course in a few schools.

We take this occasion to sound a warning that we may soon be caught up in a shortage of intellectually competent persons able to carry on the necessary, even vital, function of geodesy, photogrammetry, topography-hydrography, and cadastral surveying on a professional level.

We believe that the present usual method of studying these important sciences, mainly self study while on in-service training assignments, will only result in shrinking the body of knowledge, in losing potentially high-caliber persons in the field, in stifling research in a vital science, and in lowering the stature of a professional field.

Specifically, where should such a body of knowledge be housed? Although a few persons would prefer to see the field of surveying and mapping splintered from engineering and be given a fresh start in the colleges of arts and sciences, it seems clear that a large majority of the civil engineering profession would much prefer that the engineering schools continue to be identified with all of the surveying and mapping sciences, on the grounds that in content and method they are most nearly engineering (as opposed to being simple or basic science). Some educators have included the geodetic sciences among the recognized engineering sciences.

The Task Committee believes that the engineering schools are the proper place for the study of the surveying and mapping, or geodetic sciences, especially in view of the enlightened shift of emphasis now current in these schools throughout the nation towards science-oriented curricula, plus the added factor of new knowledge of the geoid. The decrease of emphasis on the art of surveying in engineering curricula is not at all inimical to this recommendation; in fact, such decrease may be the very means of providing time for courses in geodetic, photogrammetric, cadastral, topographic and other such fields.

Actually the operation, care, and adjustments of surveying instruments should be handled as the work of technicians and we commend the colleges that give specialized training and/or two-year college programs for such work. However, engineers' responsibilities are more properly defined as the planning, direction and design of surveying and mapping operations.

The Committee agrees that the teaching of the highly specialized aspects of the survey (geodetic or geometronic) engineering field should be restricted to a relatively few universities. However, a course in basic surveying should be included in the curricula of all civil engineering colleges to provide fundamental concepts of geodetic relations, mensuration through the application of surveying techniques, the theory of errors, and the advantages, disadvantages, and restriction of various methods and techniques used in surveying and mapping practice.

F - Conclusions and Recommendations

The following conclusions and recommendations are presented by the Task Committee for approval and action by the Surveying and Mapping Division and for appropriate action by the Society's Board of Direction:

1. That the overall definition of the field of surveying and mapping comprising six principal categories: a) land surveying; b) engineering surveying; c) geodetic surveying; d) cartographic surveying; e) aerial survey services; and f) cartography, all as shown in detail in the attached classification chart (Appendix D) be accepted, and that the difference between professional-level duties and technician-level duties as proposed in the classification chart be recognized.
2. That the first four of the six main categories comprising the overall field of surveying and mapping should continue to be regarded as engineering, these being land or property surveying, engineering surveying, geodetic surveying, and cartographic surveying; that these four categories should be considered as comprising the field of survey engineering (or geodetic engineering, or geometronic engineering), which in turn should be regarded as a branch of civil engineering; and that all State Registration Boards, engineering societies, and similar professional groups should recognize professional-level experience in this field as professional engineering experience.
3. That, with regard to education in this field,
   a) All fully accredited civil engineering curricula should include adequate instruction in basic surveying by qualified personnel.
   b) Some of the engineering schools throughout the country should provide an elective sequence of surveying and mapping subjects, available in the junior and senior years, totalling 16 to 20 semester hour credits, that would comprise, in effect, a major in

survey engineering (or geodetic engineering or geometronic engineering) within the B. C. E. degree, or alternatively, a B.S. degree in such engineering;

c) That at least one engineering school should offer graduate degree programs in the major specialties of the survey engineering field, such as: land surveying, geodetic, cartographic, and photogrammetric engineering;

d) That all employers of professional-level surveying and mapping personnel be encouraged to assist those schools that are willing to establish the educational programs listed in (b) and (c) above, by recommending promising students for enrollment, by offering part-time employment to the students, and by employing graduates of such programs.

4. That at some appropriate time in the future, those who wish to engage in the practice of land surveying and related engineering work should first be required to qualify for a professional engineer (P. E.) license, and that ultimately the right to practice land surveying in any given area would be a moral right based on professional competence and the engineers' code of ethics, rather than a legal right based on separate registration for land surveying; and that all State Registration Boards be encouraged by all concerned to move toward the goal herein envisioned as rapidly as circumstances permit.

5. That all national, state, and local societies or associations of engineers and surveyors be encouraged to cooperate for the purpose of bringing about as rapidly as may be practicable, the ultimate situations contemplated in several of the above items.

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The Task Committee gratefully acknowledges the great assistance given by very many individuals and organizations who contributed their views and suggestions during the course of this study and in the formulation of this report. We urge them and all who are interested in the profession to work toward the furtherance of the report's objectives as a means of strengthening the profession in the critical years of the decades just ahead.

Respectfully submitted,

Task Committee on Status of Surveying and Mapping

Alfred O. Quinn
George D. Whitmore
Brother B. Austin Barry, Chairman

Reference D

CLASSIFICATION CHART FOR SURVEYING AND MAPPING

	Professional Level***	Technician or Pre-Professional Level****
I. Land or Property Surveying (Cadastral)		
A. Property and Boundary Surveys*	Land Surveyor	Instrumentman
B. Subdivision Surveys and Plats*		Computer
C. Public Lands Surveys*		Draftsman
D. Surveys for Plans and Plats*		Tapeman
1. Architectural (Building-Site) Surveys		Rodman
2. Tax Maps		
II. Engineering Surveys (for Design and Construction)		
A. Design Data Surveys (including Route Surveys)*	Survey Engineer	Instrumentman
1. Control, Horizontal and Vertical		Computer
2. Culture and Topography		Draftsman
3. Profiles and Cross-Sections		Tapeman
B. Construction Surveys*		Rodman
1. Layout Surveys		
2. Quantity and Measurement Surveys		
3. "As-Built" Surveys		
a. Utility Surveys		
C. Mine Surveys		
III. Geodetic Surveying, Geodetic Engineering, or Geodesy (not to be confused with precise plane surveying)		
A. Control Surveys, First- and Second-Order Accuracy**	Geodetic Surveyor or Geodetic Engineer Mathematician	Instrumentman
1. Horizontal: triangulation, traverse, and electronic trilateration		Observer
2. Vertical: spirit and trigonometric leveling		Computer
B. Geodetic Astronomy		Gravimetric Operator
C. Gravity Surveys, Magnetic Declination Surveys, Figure-of-the-Earth Studies		Recorder
		Signalman
		Tapeman
		Rodman
IV. Cartographic Surveying, Cartographic Engineering, or Map and Chart Surveying (surveys for constructing original maps and similar products)		
A. Control Surveys, Third- and Fourth-Order Accuracy**	Topographic Engineer Hydrographic Engineer	Plane-Table Operator
1. Horizontal		Instrumentman
2. Vertical		Observer
B. Topographic-Planimetric Surveys and Maps*	Photogrammetric Engineer Survey Engineer (Control) Geodetic Surveyor or Geodetic Engineer	Computer
1. Photogrammetric Aero-Triangulation		Recorder
2. Mapping Surveys		Draftsman
a. Ground-Survey Methods		Tapeman
b. Photogrammetric Methods		Rodman
3. Field-Edit Surveys of Photogrammetric Compilations		Stereo-Plotter Operator
C. Hydrographic Surveys**		Observer
1. Soundings: fathometer, hand-lead, sounding pole		Recorder
2. Sounding Fixes: three-point, electronic		Computer
3. Wire-Drag Surveys		Draftsman
4. Tidal and Current Surveys		Leadsman
V. Aerial Survey Services		
A. Aerial Photography	Photogrammetrist Photo-Interpreter Electronic Engineer Mathematician Geophysicist	Photographer
1. Photo-Interpretation		Photo-lab Technician
B. Electrical Measurements for distances and position fixes (shoran, etc.)		Photo Analyst
C. Airborne Magnetometer Surveys		Computer
D. Radar-Altimeter Profiles and Elevations		Electronic Technician
		Magnetometer Operator
		Radar-altimeter Operator
VI. Cartography (not requiring original surveys)		
A. Map Design	Cartographer Geographer Map Editor	Map Compiler
B. Compilation derived from existing source data		Mosaicker
1. Evaluation of Maps and Other Source Data		Modeler
2. Nautical and Aeronautical Charts, Topographic and Planimetric Maps, Special-Purpose Maps, etc.		Engraver
3. Photomaps and Mosaics		Lithographer
4. Relief Maps and Models		
5. Radar-Prediction Charts		
C. Map Editing		
D. Map Reproduction		
1. Engraving or equivalent		
2. Lithography		

* Photogrammetric procedures used when applicable on these and other activities.

** Electronic measuring procedures used when applicable on these and other activities.

*** See definitions following this outline. Titles listed are intended to be illustrative, not inclusive.

**** Including some which are normally skilled craftsmen but which sometimes, by reason of special training, are properly considered technicians, e.g., rodman, tapeman, leadsman, signalman, etc.

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Definition of Professional Positions

As a guide to the terms used for designating the several professional positions in the preceding outline, it is thought advisable here to include certain definitions. These accord generally with the accepted definitions given in the ASCE Manual No. 34, "Definitions of Surveying, Mapping, and Related Terms" 1954, but are altered somewhat to describe more clearly the particular job function envisioned in this outline.

Land or Property Surveyor determines location of land boundaries; prepares maps showing shapes and areas of land; divides land into smaller tracts, including layout of roads and streets and rights-of-way for same to give access to smaller tracts; prepares official plats or maps of such land subdivisions; prepares and interprets land descriptions for incorporation in deeds, leases, etc.

Survey Engineer obtains information for planning or developing an engineering project and estimating its cost, often recording such information in form of an engineering map or plat.

Geodetic Surveyor (or Engineer) plans, performs, or supervises high-accuracy surveys as well as the computations and adjustments thereof, including such as triangulation, traverse, precise leveling, and astronomic observations, such surveys being of a magnitude that the required accuracy and precision can be obtained only through processes that involve figure and size of the earth.

Survey Engineer (Control) plans, performs, or supervises surveys and computations of horizontal and vertical measurements involving complex network adjustments, etc.

Topographic Engineer plans, performs, or supervises the construction of topographic maps of any scale, contour interval, or accuracy specification, including all surveying procedures and calculations required for such map construction; determines when and whether ground or photogrammetric surveys or various combinations thereof shall be used.

Photogrammetric Engineer or Photogrammetrist plans, performs, or supervises use of photogrammetric instruments and techniques in conjunction with various aspects of surveying, mapping, resource surveys, and the design of photo-interpretation systems.

Cartographer plans construction and compilation of charts and maps of small scale; assembles, evaluates, selects, and directs plotting of data therefor.

Map Editor performs many functions of the cartographer; especially designs form and content of maps; designs criteria for symbolization and nomenclature; reviews manuscript maps as to accuracy, completeness, correctness, and conformity with established standards.

The titles mathematician, electronic engineer, geographer, geophysicist, etc., are not defined here specifically, since they are primarily titles of persons in allied professions whose work only incidentally is in the field of surveying and mapping.