

# A NEW ERA IN SURVEYING AND MAPPING CURRICULA\* A CHALLENGE AND AN OPPORTUNITY

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IT OFTEN has been stated that the newspapers of this country print for the most part what their subscribers wish to read. In a similar manner, the educational institutions, reacting much more slowly, present courses and subject matter which their customers, both students and employers of graduates, demand. On occasion these educational institutions, pioneering with new developments scarcely past the laboratory stage and sensing the future needs of both students and employers, will take the lead in making these developments available through courses prior to the creation of a public demand.

This paper is directed at a situation which presently exists in which the traditional leadership of educational institutions is lacking. I shall present a few ideas on the contributing causes to this situation, and also a few suggestions which constitute a challenge to engineering education. I trust that in some small way these remarks will assist in stimulating a realization of the problem as well as the opportunity which exists for engineering education to become a real factor in what is now a proven science.

## SHORTCOMINGS IN ENGINEERING EDUCATION

Knowledge and the ability to think and use that knowledge are the prime purposes of all education. Education may be acquired by formal courses presented in our educational institutions, by reading and self-teaching, by experience, or by any combination of these means. In this particular instance the development of photogrammetry and precise surveying has been accomplished generally in spite of, rather than with the help of, our many engineering educational institutions.

There is no corresponding example in the entire field of engineering education where actual practice has so far outstripped the instructional phase as in the case of mapping with its attendant control surveys. There are, as is the case with most generalizations, a few outstanding exceptions to this statement, but they are all too few.

The traditional conservatism of the engineer apparently has been carried to the extreme in the civil engineering departments of the colleges and universities of our country. Present procedures as practiced in our principal map-making agencies are ignored, either because of the traditional lack of interest by most engineering faculties in surveying and mapping, ignorance of the developments in these fields, or both.

Administrators in engineering education in the United States are fast approaching the point at which they will be forced to make certain decisions and take definite actions with regard to the surveying and mapping portions of their education programs. These decisions and actions are long overdue. Upon these decisions and actions will depend the future position of these universities and colleges in the educational field with reference to these and related subjects.

Let us examine for a moment the attitude just referred to as "the traditional lack of interest by most engineering faculties in surveying and mapping." We all know and admit that the attitude is general, but what we should be interested

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in is the cause for that attitude, and the manner in which it might be corrected.

Traditionally, surveying and mapping are usually a part of the civil engineering curriculum of our engineering educational institutions, and were perhaps the earliest expressions of engineering skill. Since the time when man as an individual first claimed certain land as his own, boundaries have been an important item in our economic and social structure. Boundaries between tribes, and later nations, were determined by war, treaties, or both. Maps became essential when men developed intensively the land to which they held title. Maps also permitted them to travel over the land and navigate the seas, and to these now has been added navigation by air. So, man has long been accustomed to maps and charts of a sort. Perhaps this assumed familiarity has bred contempt.

Surveying and mapping for many centuries advanced slowly, but all the while the desirability for accuracy was recognized. Gradually, contributions were made which brought surveying out of the compass, and mapping out of the rough-sketch, stage. Finally we reached, some years ago, the era of the transit, level, and plane-table. For some unknown reason this apparently was accepted as the zenith of the surveying and mapping developments. For 40 or 50 years developments and improvements to equipment and procedures were relatively unimportant, certainly not revolutionary. The surveying courses which were taught to our grandfathers and fathers are essentially the same as are taught in the majority of our engineering schools today and, in many instances, I do not doubt that the same equipment is still used.

The courses became stereotyped and standardized and consisted, for the most part, of applied trigonometry plus instrumentation. So "dry rot" set in and the more ambitious members of civil engineering faculties, looking for new fields to conquer, turned to structures, hydraulics, water supply, sewage disposal, and many other fields in which the apparent ultimate had not been reached.

This lack of interest in surveying and mapping is attributable to three distinct attitudes on the part of the teaching profession. These attitudes have been carried over also into the older professional societies.

First, there is the distaste for field work. Due to limitations of curricula, teaching personnel, and suitable places to conduct the field work connected with surveying and mapping courses, there is, over the country as a whole, quite a conglomeration of solutions to this problem. This results in some instances in surveying instruction being conducted on the campus under extremes of weather conditions and, due to the small size of some campuses, this activity, by necessity takes upon itself a merry-go-round quality. It has been the attitude in many instances that, since surveying and mapping field work involved this outdoor exposure to the elements, the teaching of courses of this type should be delegated to the newer and younger members of the staff, enabling the higher ranking members of the faculty to conduct other courses of such a nature that professional dignity could be more readily maintained.

The second is the attitude that mental activity required in the solution of problems is stereotyped to a large extent. It is doubtful if clear, logical, and orderly thinking is required to any greater degree in any other courses of the curriculum than is required in thorough, comprehensive courses in both photogrammetry and precise surveying, with their attendant mathematical bases.

Finally, there is the generally prevalent attitude that, in order to achieve success or prominence, the teaching of subjects having some mysterious aura of professional respectability is always preferred to those involving surveying and mapping. Surveying and mapping courses have for years occupied the unhappy "step-child" relationship to the rest of the family of courses included in the

normal curriculum. The reasons for this may be due to quite a number of different contributing causes: first, the fact that in years gone by and up to the present time, surveying was and is practiced as a trade by individuals with background limited to practical experience; and second, that the dividing line between the professional white collar worker and the field man—in field surveying—was rather uncertain, if it existed at all.

Then, too, in the early days the low value of land did not warrant expenditures for surveys of high accuracy, with the possible exception of those made by our Federal Government. This led, through the years, to the development of two groups of people undertaking the problems of surveying and mapping from entirely different viewpoints: one with precision paramount, compatible with the equipment and procedures available; the other with precision relegated to a less important consideration and, guided by economic considerations, with results of varying accuracy, dependent upon property values and land use. For many years there was no attempt to correlate these two entirely separate lines of thought, and in fact in many sections of our country today, this dual viewpoint still obtains.

In Europe, however, where concentrations of population made land use important, research went on. But here in the United States only a few hardy pioneers dared to insist that there must be a better and more accurate way of producing maps economically. World War I, with its attendant development of the airplane and aerial cameras gave, impetus in Europe to the use of photographs taken from the air. This suggested the possibilities which, although followed up at once by some of the European nations through subsidies, were ignored for some time here in the United States. Again, there were exceptions to this general attitude but, for the most part, the educational institutions wrapped their robes of complacency about them; and, if they were not content with existing equipment and procedures, at least they made no real effort to overcome the technical problems or to contribute to the development.

Certain few commercial, educational, and governmental organizations which included among their staffs individuals who believed improvements could and should be made, kept alive the small spark of interest on this continent. Gradually, with the improvement of cameras, film, planes, and stereoscopic equipment, the principal map making agencies of the Federal Government accepted and began to utilize photogrammetric processes for the production of maps. With this expansion of photogrammetric mapping over large areas, accurate control surveys were necessary to produce accurate maps. Today we have a situation where the informed realize that both mapping and control surveys are subject to still further radical changes which may even revolutionize the present new mapping procedures.

Electronics has just begun to enter the mapping field. Photogrammetry is still developing. The combination of future developments in both these fields may result, sooner than many may realize, in still more accurate maps, produced in less time and at a fraction of the cost of present day methods.

Photogrammetry is not new to the profession. Precise surveying, which provides the essential control for photogrammetry, is not new to those who have been using it for some decades. Up to the present time the development of photogrammetry and precise control surveys have been interdependent and must continue that way until such time as future developments might change that relationship.

Precise surveys, in addition to being essential to accurate photogrammetric maps, have many other practical applications. In many states we now have

adopted State Plane Coordinate Systems to enable all surveys made within the state to use these systems as a means of checking and strengthening their own surveys. Yet, if we are entirely frank, we shall have to admit that not 10 percent of the registered surveyors, in the states which have adopted State Plane Coordinate Systems, understand the fundamentals involved in these systems well enough to use them. And equally important, the majority of graduating civil engineering classes in this and recent years, are, for the most part, no better prepared.

#### A NEED FOR TRAINED MEN

The mapping agencies of this and other governments of the western hemisphere need trained men. These trained men are not presently available from our engineering schools. No one could imagine a recent electrical engineering graduate without a fundamental knowledge of radio, or a young mechanical engineer without the fundamental knowledge of Diesel engines. Yet, today, we accept, complacently or not as the case may be, civil engineering graduates without a basic knowledge of the fundamentals of photogrammetry and precise surveying.

To what extent can engineering educational institutions take their share of this development and help to meet these existing needs? The first thing that most of them should do is to bring their present courses in surveying and mapping up to date. They owe that obligation to their students, their graduates, and their own established reputations. Every institution is dependent entirely or in part on public or private funds, in addition to tuition fees. No institution is satisfying its obligation to those who support it, if it permits men to graduate in any field without a knowledge of the basic fundamentals of procedures and equipment in current use in that field.

I recently had occasion to make a trip, contacting various governmental mapping agencies and certain educational institutions both here in the United States and in Canada. Here are some of the observations made to me:

(a) One large governmental organization, having need of men for precise control surveys, stated that they were hiring non-engineers who had specialized in mathematics because, since they had to train them anyway, it was easier for them to give instrumentation instruction than it was to give the mathematical background, in which *most engineering graduates were not too proficient*.

(b) One of our outstanding instrument companies was seriously considering giving courses at its plant in the use and handling of new, modern equipment.

(c) Jobs are available and going begging, at good salaries even for these times, for persons adequately trained in both precise surveying and photogrammetry and competent to organize and conduct large mapping programs and to train additional employees.

(d) Faculties of engineering schools are in need of experienced men as instructors in both photogrammetric and precise surveying fields.

As precise surveying comes more and more into common use, it ceases to lay claim to the Coast and Geodetic Survey and other mapping agencies as its sole users. State, county, and municipal engineers and surveyors are beginning to realize that here is another tool of their profession. Photogrammetry is no longer used solely by the governmental agencies who developed it, but is being accepted by state, county, and municipal agencies for all sorts of operations. Each new user of photogrammetry and precise surveying widens still further the field, develops the possibility of new applications, and further increases the demand for trained personnel.

#### RECOMMENDATIONS FOR CURRICULA CHANGES

To simplify the presentation of suggestions regarding the surveying and mapping curricula, the following questions and answers are proposed. The

answers, in your opinion, may be debatable and, if so, so much the better, for by debating them you are forced to think of alternatives.

1. *What should be done with the present surveying and mapping courses in our curricula?*

All surveying and mapping courses should be thoroughly examined as to content, procedures, and equipment used, with the idea in mind of modernizing wherever possible. We should eliminate procedures that have been superseded unless they are presented as background and for historical interest. The emphasis should be on those portions which are applicable to present-day conditions. Once having done this, we must keep the entire group of surveying and mapping courses up to date by periodic revision. We must bring the surveying equipment up to date by adding more modern and precise instruments. Suggestions for improving instruments should be sent to the manufacturer so that he knows what improvements are needed.

2. *What might be considered a minimum requirement for a basic course in photogrammetry to include fundamentals only?*

I would recommend two courses, although, depending upon the length of course and number of hours, it might be combined into one. (a) The first would deal primarily with aerial photography and would include a study of mapping cameras, camera mountings, lens distortions, focal length of lenses, mapping film, paper, enlargements and reductions, scale of photographs, tip and tilt of photographs; the preparation of controlled and uncontrolled mosaics; the use of graphical and template methods of supplementing control; the use of photographs for engineering purposes, including tax maps, for reconnaissance surveys for roads, railroads, and power lines, for water power and resources, for flood control, subdivisions, etc.; and the use of simple mirror stereoscopes for examining air photographs, with or without magnification, and the preparation of planimetric maps. (b) The second course might include the simpler photogrammetric instruments, the plotting of precise control, and the preparation of a simple topographic sheet made with the less expensive photogrammetric equipment; an explanation of the principles of the more complex and costly photogrammetric equipment, illustrated by photographs and diagrams; and an inspection trip to one of the governmental mapping agencies using the latest photogrammetric equipment, wherever this is possible.

3. *What might be considered a minimum requirement for a course in precise surveying to include the basic fundamentals?*

Such a course should include thorough and practical instruction in least squares; a working knowledge of coordinates as provided for by the state-wide coordinate systems; a basic knowledge of what might be termed surveying astronomy to familiarize the students with the heavenly bodies which are generally utilized in the determination of latitude, longitude, true north, and time; and a familiarization and practice course with the actual use of precision instruments including theodolites, tilting levels, and precise taping equipment. I would recommend that this subject be divided into two courses, but this is again dependent upon the length of course and hours available.

4. *Are these recommended courses of graduate or undergraduate caliber?*

The recommended courses are *undergraduate and basic*. It is not recommended that institutions attempt to give graduate work in either the fields of photogrammetry or precise surveying unless they have the financial resources and trained personnel to include the latest equipment, which, ordinarily, is too

expensive to justify the demand at any one institution. Basic fundamentals should be taught, giving the student a solid foundation and understanding upon which to add specialization should the occasion arise.

*5. How can the faculty member keep up with the latest developments in surveying and mapping?*

Every faculty member concerned with the teaching of surveying and mapping should affiliate himself with those national organizations that are concerned with their development. He probably belongs to the Society for the Promotion of Engineering Education, due to the fact that he is in the teaching profession; he may be a member of the American Society of Civil Engineers; he should also, from the standpoint of his interest and responsibility in teaching surveying and mapping subjects, become a member of both the American Congress on Surveying and Mapping and the American Society of Photogrammetry. He should read carefully both of the publications of these organizations. He should make every attempt to attend conferences and meetings on surveying and mapping whenever this is possible, and should visit the plants of our governmental map-producing agencies as well as our outstanding commercial organizations doing this work.

*6. What can be done for the practicing engineer, surveyor, and graduate of some years back who is not familiar with photogrammetry or precise surveying?*

This constitutes a national problem and one which I believe can be solved only by real cooperation. I suggest that the organizations I have just mentioned, co-sponsor an annual surveying and mapping conference in each of our states, in cooperation with the engineering schools, governmental agencies, and commercial concerns of the state, and with the federal mapping agencies. These annual conferences of 1 or 2 days' duration should be designed for the purpose of acquainting state, county, municipal, and private surveyors and engineers with the developments in surveying and mapping as well as providing for an interchange of technical knowledge. Second, I suggest that regional conferences, including groups of states, be co-sponsored by the same national organizations and held every 2 or 3 years in each region. These sponsored state and regional meetings, combined with the annual meetings of each of the sponsoring organizations, should go far in assisting the men already in the profession who can use photogrammetry and precise surveying, but who have had no formal education in these fields.

#### SPANISH SHOULD BE ADDED

The development of natural resources in this hemisphere as well as elsewhere, due to the economic liabilities imposed on the various nations as a result of the war, has become of prime importance to the survival and continued well-being of any nation. The intelligent development of natural resources can be accomplished economically only when adequate maps are available of the area concerned, for the purpose of study and preliminary planning. Speaking just of this hemisphere alone, the 21 American Republics plus the Dominion of Canada present a mapping project which a few years back would have staggered the imagination. There are years of work ahead in the preparation of adequate base maps for all of these countries, not to mention the revision work which must be done periodically in order to bring these base maps up to date. The fact that in the 22 countries mentioned, English and Spanish are spoken in 20 of them, with Portugese in one, and French in another, might indicate also to the engineering educator the great desirability of adding Spanish to the curriculum or possibly

making it a prerequisite for entrance to any recognized engineering school.

With the rapid development of aviation, radio, and communications, resulting in the shrinking of the earth's surface from a time and travel standpoint, it is becoming quite evident that more and more the relationship of any two countries is not dependent entirely upon the efforts of the various state departments and foreign secretaries. It is increasingly apparent that the professional man who may be employed in another country, either temporarily or permanently, must be considered as an "unofficial ambassador" of his own country while he is there.

This, then, is the challenge to the engineering educators. What they do about it is for them—and you—to decide. The opportunity is still there and I ask that you and the organizations you represent cooperate with and help them. Our engineering schools are an important part of our engineering profession. Let us keep that relationship in the field of surveying and mapping, also.

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## NEWS FROM THE PRESIDENT

THE Board of Direction met on May 26th and again on August 13th to carry on the business of the Society. Our Society is fortunate in that it has elected Directors who take a very conscientious attitude toward the responsibilities of their position. The attendance at Directors' Meetings is always very good. It is my practice to invite out of town members to attend Directors' Meetings and to express their opinions on various subjects. I do this in an attempt to inject into our administration of the Society the viewpoint of members who live remote from Washington.

The membership drive under the direction of Mr. William H. Meyer, Jr. is proceeding at a pace which is most gratifying to me. We have already increased the membership by almost forty percent. I do hope that we can keep the ball rolling. It may be optimistic to think in terms of 100% increase, but I would like every member to keep that very desirable objective in mind. It certainly should not be too hard for every member to get a member this year. After all, if a number of individuals can each alone sign up ten new members and if one member in particular can sign up thirty-two new members, it certainly should not be too much of a job for each person to find one new member. Let's all get behind the drive with renewed effort for the remainder of the year, and really push our membership up to the top.

At the August 13th meeting of the Board of Direction, the final material for settling the whole matter of member classification was completed. This material will be sent out to the membership very shortly. I urgently suggest that you read all of the material carefully and make your decision based upon the material presented. After all, it must be remembered that every member had an opportunity to study the provisions of the new Constitution during the summer of 1946 when the matter was put to a vote. It was the failure of the members to read and understand the paragraphs and clauses of the new Constitution which gave rise to the confusion at the 1947 annual meeting and the submission of the petition which must now be acted upon.

Also, at the August 13th Directors' meeting the general policy for the revision of the Manual of Photogrammetry was passed upon. The Publication Committee is now in a position to put the Manual Revision Committee to work on this most important project. It is hard to say when the revised Manual of Photogrammetry can be expected. However, with hard work and aggressive leadership, the publication should appear at the end of 1948 or early in 1949.