The Land Surveyor of the Future

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YESTERDAY, *today* was tomorrow. *Tomorrow* is the future. There will always be a tomorrow—always the future. Today, therefore, is part of that future in which tomorrow's surveyor will be *The Land Surveyor of the Future.*

Secretary of State for the United States, Dean Rusk, has said, "The pace of events is so fast today—unless we can keep sights on tomorrow we cannot expect to keep touch with today." And to that I say, we need also to keep a sight on yesterday to be really in touch with today, or tomorrow, or tomorrow's tomorrow.

To project intelligently into the future, one needs a very clear picture of today as the point of departure—a good backsight on yesterday for direction into tomorrow.

This audience of professional surveyors well understands that a surveyor must know fully where he stands before traversing to somewhere else, and that a backsight is necessary to control foresighting, if he wants to know where he is really going.

We could not probe space today if those before us had not probed the geological and archaeological past. Even as we probe for the moon, the Mohole project probes to the interior depths of earth itself.

Past, present, future—all are bound together, sometimes in smooth transition, sometimes with gaps between. Looking into the future of the surveying profession is not different. Before we can project into the future, we need to know where we are now, and we need to know by what paths we arrived.

By what paths did surveying and the surveyor arrive?

A brief backsight into the past indicates that if the Sphinx could talk we would know more facts about the history of surveying. We do learn, however, from historians and scholars, that Babylonian survey maps antedating 2000 B.C. show many sections of land composed of irregular polygons subdivided into right triangles, rectangles, and trapezoids, whose dimensions and areas are indicated.

From China—the *Chou-pei*—the oldest known Chinese document on surveying dates back to the second millenium B.C.

The history of mathematics records flooding along the Nile, that washed away survey marks each season, was cause to create geometry, by sheer necessity, to find ways to locate and re-establish those ancient landmarks. The name geometry, taken from the Greek, in fact means *earth measure.*

From the earliest measuring sticks and simple sighting and plumbing devices of the Babylonians, Chinese, Hindus, and Egyptians, surveying and the surveyor came. And in pace with surveying came mathematics, the means for the surveying computations.

The reed or rod measure of a Pharaoh's fields traces down through the pages of history to the rod measure you surveyors here tonight know so well. The harpedonaptae or "rope stretchers" of those surveys along the Nile, so long ago, are quite comparable to the chainmen and tapemen of recent years.

Whether notes and records were on papyrus or were scribed on the clay plaques of yesterday, the computing—by arithmetic, algebra, or geometry; in Greek, Egyptian, Arabic, or Hindu—is comparable to the way George Washington, Thomas Jefferson, Abe Lincoln, and even you and I have computed until today.

From the ancient water-level, the groma, the surveyor's cross, and the Grecian star; from the astrolabe, the square, and quadrant; from the backstaff and the Jacobstaff; and from the compass, still used today, we have come. Our spirit levels, our theodolites and transits, our plumb bobs and clinometers, our sextants and alidades are comparable today.

From the users of the *chords of circles* of Hipparchus of Nicaea more than 1000 years B.C.; from the "Opus Palatinum" of Rheticus, a 10-place, 10-second table of the natural functions, of the late 1500's; and from the 15-place sines of Pitiscus in the early 1600's we have come. In comparison, there are some of us today who have used and remember Crelle's tables for computers; Gurdon's famous traverse tables, for latitude, departure, and distance; the tables of logarithms; and Emma Gifford's natural tangents for seconds of arc, which, even with a residual error in early editions that was later adjusted by Andoyer, were adequate for most of our work not requiring ultra precision. Then came slide rules and hand-cranked, desk calculators, and motor driven calculating machines—all in use today.

Certain periods in our civilization have had influence to accelerate development and improvement of surveying from time to time. From the beginning through the time of Abraham, the Bible records the *measuring*

and the *laying out* of lands and temples. The following are some of the *stepping stones* in the history of surveying progress, from 3000 B.C., to 1900 A.D.

3000 years B.C.—Babylonian and Egyptian surveys.

Late B.C. and early A.D., introduced the Roman Empire Surveys under Emperors Caesar and Agustus.

In the Middle Ages, still for wars on land and sea; and for commerce, boundary records, and taxes; continued improvement of instruments, methods, mathematics, and records. From this came the *Grundbücher* of the continental European countries and the *Doomsday Book* recording the surveys of English lands by William the Conqueror in 1085-1086.

In 1492, Columbus discovered America, at just about the time of great development in learning and culture, especially the arts and sciences including mathematics, navigation, and surveying; a period we know as the Renaissance.

On this new continent of America there followed: St. Augustine in 1565, Jamestown in 1607, and then the Pilgrims to Plymouth in 1620.

Then the early Colonial surveys until the Revolution, when General George Washington brought European trained surveyors to be military engineers for the Continental Army. After the winning of independence, these military surveyors and engineers carried on as the forerunners of the Army Corps of Engineers we know today.

In due time followed Thomas Jefferson's proposal for a Rectangular System of Surveys for the Public Lands; the Land Ordinance of 1785; and the Act of 1796. A civil Surveyor General, Rufus Putnam, was appointed in 1797 to serve under the Department of the Interior. In 1812 this function was named the General Land Office, which later, in 1942, became the Bureau of Land Management we know today.

By the 1850's the transition from military engineering to civil engineering was having its effect, and the American Society of Civil Engineers was founded in 1852—the first of the engineering "founder societies" in this country. It was these early civil engineers who did the surveying to open the highways and railroads to the West.

In 1878, the Coast Survey, created in 1807, was renamed the Coast and Geodetic Survey and was charged with extending precise control surveys into the interior of the United States.

In 1879, the Geological Survey was established to survey and map the land resources of the United States.

Other Federal agencies made surveys of one kind or another, as many of them still do today.

From these land inventory and resource surveys, and the land record or cadastral surveys, surveying and mapping in the United States was to come of age during the nineteenth century.*

Into the Twentieth Century

The turn of the century, 1900 A.D., saw some of our American cities growing into municipal areas with typically associated urban density problems. By 1920 planning commissions were progressively being established, sometimes with the city and surrounding county administrations in cooperation. I remember that Pittsburgh, Pennsylvania, had such a planning commission with offices in the City-County Building.

Urban planning created a need for precise, large-scale surveys and maps to bridge the gap between preliminary reconnaissance from U.S.G.S. quadrangle maps and the more exacting, detailed planning requirements. These large-scale surveys and maps required the extension of local control for coordinate systems, from the more widely spaced U.S.C. & G.S. geodetic control system. Pioneering in this field at that time, a company of geodetic and topographic engineers and map specialists was organized by R. H. Randall in Toledo, Ohio, to become established and well recognized as experts in precise surveying and mapping for municipalities. Another private firm in the mapping field at that time was W. N. Brown of Washington, D. C. Both of these names are well known in the history of the American Congress on Surveying and Mapping.

Leaders in these city-survey programs were influential in forming the Surveying and Mapping Division of the American Society of Civil Engineers in 1926. The Division was to give to the surveying profession the ASCE Manual No. 10, *Technical Procedure for City Surveys* in 1934, and Manual No. 15, *Definitions of Surveying, Mapping, and Related Terms* in 1938.

It was also in the late 1920's and early 1930's, during the great, national, economic depression, that we saw the collapse of just about every kind of private survey enterprise and the creation of CWA, PWA, WPA, FERA, and eventually TVA. At this time colleges, professors, and students found themselves in much the same boat. This caused a mixing—a melting pot, so to speak—of professionals and educators from all fields of surveying and mapping, and from all parts of the United States. This was good for the profession. We had very little *surveyor registration* in those days. In fact, *engineer registration* was not yet in force in all our States then. Outside of association in ASCE's Surveying and Mapping Division, or the ASEE Committee VIII, many surveyors about the land had little communication with one another except at the local level in a few States where a *surveyor society* did exist.

This new and impromptu association with

* See "The History of Surveying in the United States," SURVEYING AND MAPPING, Vol. XVIII, No. 2, April–June 1958, pages 179–219, inc.

one another made it quickly evident that one half of the surveying profession did not know much about what the other half did—or why they did it. It was just as evident that broad association was needed to exchange and communicate professional viewpoints. It was at this time that the seeds were sown for the formation of what was to become the American Congress on Surveying and Mapping—A.C.S.M., as it has become well known to most of you today.

It was at this time, in the early 1930's, down in Tennessee, that TVA, in the effort to implement and expedite surveys and maps in advance of vast and comprehensive engineering planning operations, adopted and adapted then new and hardly tried photogrammetric methods, in cooperation with the U.S.G.S., for the pioneering first time in the United States, on a project of that magnitude and which extended into parts of seven States.

1941 saw the birth of A.C.S.M., just on the brink of World War II. The war period saw the production of more maps than had ever been made or used before. At the war's end, those entering civil life again, after using so many maps, gave us a map conscious public. This peacetime civil support was influential in accelerating and expanding national surveying and mapping programs.

Each of these events had a salient influence in stimulating improvement and advancement of the surveying and mapping profession.

It could well be said that the first half of the twentieth century was a *renaissance period* for surveying and mapping, but—paradoxically—not for surveying education. As technologies and applied techniques were developed and improved, surveying, in the college curricula, was being de-emphasized, and in some cases well nigh abandoned and deleted altogether.

It is from all this we come. Here we are today, in a century of technical revolution—automobiles, airplanes, rockets, automation, speed, and space. Let us take stock and try to see where the surveyor and surveying stand today.

We have registration now required for Land Surveying license in at least 40 of our 50 States. Some of the others permit licensed Engineers to practice surveying, either as engineers or under the surveying option.

We have knowledge of organized surveyor associations in 29 states.

We know that, as of now, 28 States have adopted State Coordinate Systems.

A National Land Surveyors Conference is regularly held annually under the auspices of the Property Surveys Division, A.C.S.M.

By meetings, conventions, panels, and committees, and by newsletters, bulletins, and journals, today's surveyor does have some means of association with exchange and communication of technological and professional information on both local and national levels.

Because of all this, the land surveyor has gained considerable recognition of improved professional stature, over recent years. With this recognition he must stand ready and able to assume professional obligations.

No longer is mere knowledge of simple straight-line surveying sufficient for full professional status. Today's qualified professional needs to trace and retrace complex, curvilinear, boundary lines of railways and superhighways that twist and turn in modern design through our countryside, even through flat farmland in the typically rectangular-survey-system country.

High standard surveys are required for the National System of Interstate and Defense Highways. High standard surveys are required for city and metropolitan planning. Such surveys are not only recommended by the Urban Planning and Urban Renewal administrations of the Federal Housing and Home Finance Agency, but, as approved, the Agency allows funds for such surveys. Increased real-estate values and urban congestions have created a demand by both landowner and land-title insurance underwriters for adequate surveys in tune with the requirement. Recent agreement between A.C.S.M. and the American Land-Title Association on specifications for such surveys attests to this. High standard surveys are required for survey control, for advantageous connection to and expansion from the national, basic, control system, and for advantage in using and expanding from coordinate systems.

Opportunity goes hand in hand with increased professional proficiency and responsibility. Today's surveyor already finds that slow, time-consuming methods in field or office are insufficient for meeting a client's urgent and pressing demands, or for countermanding rising costs in these days of high wage scales. Time means money.

In meeting this demand for proficiency, the demand for higher education has already overtaken us. As reading for the law, or medicine, or the ministry, has given way to formal education, and even as today's young agriculturalist turns to college to learn modern farming, today's beginner in surveying must seek the broad base of formal education if he intends to compete professionally and survive. Those of us who were successful in achieving professional stature by dint of hard study and long experience over the years, without benefit of formal education—

or with it—would find it doubly difficult to do over again today and most likely find it impossible without the formal educational base.

But—thank goodness—we are able to tell you that surveying education is getting back on the track. Through the sheer courage and determination of a few loyal surveying educators, with support from dedicated organizations such as your own Indiana Society of Professional Land Surveyors, Committee VIII of the ASEE, the Surveying and Mapping Division of ASCE, and ACSM's Education Division; and with a lift from the National Science Foundation following ACSM's national and international reporting to that Foundation after the 10th International Congress of Surveyors at Vienna, Austria, in 1962; it is now possible to get a Master's degree at 12 schools, and the Doctor's degree at 6 schools, in the subjects required for professional surveying —the *master's* at Cornell, Georgia Tech., Kansas State, Ohio State, Princeton, Purdue, Syracuse, Illinois, Michigan, Texas, Washington, and New Brunswick; and the *doctor's* at Cornell, Ohio State, Princeton, Illinois, Michigan, and Texas—according to ACSM Education Division's last reporting.

We are able to tell you further that this last summer saw the successful completion of the first Geometronics Institute, at the University of Washington at Seattle, under a grant from the N.S.F. And we can report to you now that the second Geometronics Institute, under a similar N.S.F. grant, will be held right here at Purdue in your own State of Indiana this summer of 1964. These Institutes are for advanced teaching of teachers of surveying, which is very important to the advancement of the surveying profession at this time when it is so necessary to get surveying education solidly back into the university curriculums.

Geometronics—now don't let that word throw you. It is a term well understood by the National Science Foundation, where those important institute grants come from. *Geometry,* the name coined to describe the mathematical science created by the need to locate the Pharaohs' landmarks along the Nile, and *geometronics* derive from the same Greek roots and pertain to *earth measure.* You surveyors measure the earth, and the word applies to you. Even the name of the international federation of surveyors—F.I.G., or FIG—is Federation Internationale des Geometres.

The *ic* in *geometronic*, like that in *electronic* or *economic* comes from the Greek *ikos* and reflects *pertaining to.* In this day of catch-words, let us hope that *geometronics* catches on as well as *electronics.* This is an "icky" age, and even the work *gimmick* itself, without the *ick,* may well have been just a mere and probably unnoticed *gim.*

It would seem, then, that the surveyor and surveying stand today at a point where the true professional must be separated in identity from the technician, and the highly skilled technician recognized clearly and distinctly from lesser skilled survey party aids, with these identities based in the main from here on out on the degree of education of each and his acumen from experience, with philosophy and technology paramount in the professional level, and technical *know-how* at the technician level, and the proverbial *strong back* and *willingness* with a little bit of old fashioned *horse sense* for the party aids who complete the survey team.

Let us look to the future.

Any philosophy or viewpoint about the future of surveying must clearly recognize that technological advance is inexorable and that electronic or automatic data processing is not only inexorable but essential to being more efficient producers than our competitors in a period when competition with another's professional skills and facilities, and against time and high rising costs, will get tougher every day. The alternative to such thinking would be an economic stagnation that would not even maintain—let alone elevate—either the standard of professional proficiency or an equitable standard of living.

Already distances are successfully measured by wave lengths of one kind or another, and combinations of electronics, optics, and mechanics are well recognized as modern automation—which, according to Labor Secretary Wirtz, will likely be "putting *uneducated* people *out of work.*"

With every new advance, new education must advance in parallel. As with the earlier, punched-card systems, ever since the introduction of the first electronic computer in 1950, manufacturers have had to provide systems-programing education and support services to create the market for the 10,000 computers of various sizes in operation today. This virtually means that the computer experts and those expert with the user's problems need a common middle ground or interpretation center for adequate communication and understanding of problems to be solved and the methods of solving them. This is where the understanding of basic fundamentals of both the problem and the computing device becomes all important. This was important when we first computed on the old, hand-cranked, desk-type, calculating machines. It was just as important when we advanced to the motor-driven, electric, calculators. Just pushing buttons isn't enough. Thus, while the future surveyor will do most of his "drudgery

computation" such as subdivision work, coordinate conversion, and possibly geodetic adjustments, by modern calculators, most likely at some computing center, it remains very important that he should never lose the fundamental understanding of his problems or the knowledge required to solve his problems by other means and by himself.

Everything in the projected future for surveying points to the need for more and more basic education. A future province of a professional land surveyor will be to trace the *lines* of his predecessor. This means that the surveyor of tomorrow must be prepared to trace the lines of a modern subdivision that have been derived from automatic data-processing calculations. He must know the philosophy and technology of modern, machine calculation as applied to professional surveying problems and related matters. To know surveying is not enough. To know modern calculation is not enough. Tomorrow's professional surveyor must know both.

Tomorrow's professional, property-line surveyor must know the philosophy of the legal line as well as the technology of the physically surveyed line. He must know the philosophy and technology of survey computations, and he must know the philosophy and technology of modern computing. To say that he must be a college educated and trained man is understatement. The land surveyor of the future must be a *well* educated and trained college man.

The surveyor of the future will use photogrammetry more and more to *take off* information from the ground, and he will use electronic or automatic data processing for much of his computing. But he will still use ground methods of surveying both to control his surveys and his photogrammetric *take off,* and to *put back* on the ground his planned and designed locations for project situs and construction controls, and, of course, for the land-title property or legal lines.

The land surveyor of the future must be a fully qualified professional, professionally capable and ethically responsible for surveys made under his direction, by surveying teams comprising technically skilled surveymen and less skilled, surveying party aids, and, perhaps, in association with other professionals.

Tomorrow's land surveyor will need to be attuned to an age of superaccuracy in earth measurements and the high speed of machine computations. There will be the refinements of continental and world geodetic datums, resulting from the surface-gravity, astro-geodetic, and satellite-triangulation programs now planned or already under way. With such improvements in precision, and with the rapidity of machine-computed, datum adjustments, will come further refinement of coordinate systems for surveying and recording, and with all this will come an increased use of coordinate systems by professional surveyors of the future. Survey records and land property records of the future are destined to be microfilm, data-storage cards, or tape systems of some sort, streamlined to numbers, in elimination of lengthy descriptions written in words, the simplest format for which will be coordinates.

The economic outlook.

From an economic point of view for the surveyor, and from a professional viewpoint in the public interest, I would suggest that the land surveyor of the future seriously consider being concerned with *land planning* as an additional field of professional interest and for the added potential for increased income.

Those professional surveyors practicing today under both the Land Surveyor and the Engineer licenses know the advantages, from the business and financial standpoint, in being able to undertake major subdivision design or highway surveys including the incidental engineering problems by doing and being paid for both the surveying and the engineering—as compared to those practicing under just the single, Land Surveyor license, who, by some statute, may be limited to just boundary work for their income.

Anyone in major subdivision work is already *half in* land planning as it is, and with the increased professional stature attending the predicted, higher educational qualification of the future surveyor he should consider well the idea of getting professionally further into the land-use planning field. This is the trend in Europe today, and has been so for a long time in the United Kingdom. Commissions in F.I.G. are concerned with both rural and urban land-use planning.

The viewpoint of the Royal Institution of Chartered Surveyors on planning as it concerns the surveyor is well stated as follows:*

"The Royal Institution of Chartered Surveyors does not claim for surveyors a monopoly in town and country planning; nor would it concede a monopoly to any other profession; it is convinced that the best results in planning are achieved by teamwork on the part of the professions concerned, of which the professions of engineering, architecture, and surveying—if not the only ones —are at any rate fundamental."

The Royal Institution of Chartered Sur-

* From page 276 *The Chartered Surveyor,* Vol. 96, No. 6, December 1963, "The Place of the Surveyor in Town and Country Planning," R.I.C.S. Panel, memorandum by F. J. Battersby (F).

veyors further takes the position that no one person is capable of being the complete planner today, because the skills involved are so diverse that it is not within human competence to contain them all in one individual. Among those skills, from the R.I.C.S. viewpoint, three professions are thought to be pre-eminent—professionally recognized Architects, Planners, and Surveyors. Add to such skills to make the planning team, to name but five; the geographer, the traffic expert, the engineer, the economist, and the sociologist.

Now, from our standpoint, in similar view of future population and congested area growth in these United States of America, which will affect our cities, towns, villages, and rural areas; it would seem that our land surveyor of the future needs to be a professional part of the future land-planning team. And, with this in mind, he should be educated for that future responsibility.

The land surveyor of the future, then, it would seem to me, with the more formalized education in basic technologies and philosophies of surveying and associated civil engineering for town and country planning, would take his place in society in truly recognized and respected professional status.

He would, in effect, be the counterpart in stature of some of our early, great surveyors. This land surveyor of the future would be quite like our country's early civil engineers —like George Washington and those to follow, who laid out our canals and highways and the railroads to open the West, and who quite often laid out our early towns on the way. He would be like the old time civil engineer-surveyor we knew when surveying was well taught in the universities, before the trend to steel structures and modern concrete design and construction caused the civil engineer's public and professional image to be that of a construction or structural man—which image is causing a tremendous image gap between most civil engineers and land surveyors today, and which gap needs bridging by education and qualification and by professional recognition of the future surveyor as such a professional.

Until that time comes, we must insist on special license for the surveyor of land-title or property lines or locations, issued by qualification of his philosophical knowledge of the legal line on top of any qualification by technical knowledge of the physical line. On this point may I emphasize that a lawyer without knowledge of survey technology would not qualify as a professional land surveyor. Neither would an engineer, fully equipped with the technology of the physical survey, unless he further qualified with the philosophy and experience concerned with the anomaly of the legal, property bound. Even now, in true sense of land surveyor licensure, both qualifying elements are essential.

To expand his business in the economic sense, tomorrow's professional surveyor, or today's, must concede that license to do engineering as well as surveying is an advantage. In that same sense, the planning license in addition—should such license be required—would be a further advantage in achieving an equitable living standard in the future.

The future is a challenge, both to old surveyors and to the new. Both—by tradition *and* the very history of the past—are up to it.

I believe that our late President, John F. Kennedy, summed it up well in his never-to-be-forgotten words to ACSM's 1962 convention:

"Since the beginnings of our Nation, those of your professional calling have contributed in full measure to its opening, growth, and development. Today, our horizons have extended beyond the limits of the imagination of our forebears. They who founded our Nation included in their numbers men whose professional efforts were devoted, as are yours, to the description in ever more precise terms of the world about us. Then, as now, this effort has made possible even fuller use of the God-given resources available to us. I know that you, with the inspiration which has characterized the work of your profession, are more than equal to the challenge of the future. Among the great contributions on which all of us can count is your continued and valued support of the educational development of those who will follow you. Your efforts in their behalf will help to assure a furtherance of achievements thus far realized."

In the spirit of that challenge and in memory of the late President's inspirational words, the land surveyor of the future has watchwords to urge and spur him on to professional greatness.