Keynote Address

Technology Can Lighten the Burden—But it Needs Our Help

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President McHail, President Brownell, President Doyle, distinguished platform colleagues, ladies and gentlemen, thank you for extending me the honor of addressing you this morning in the Keynote to your Convention. If my count is correct, this is my 28th Annual Convention, and I have sat many times listening to keynote speeches. There have been many excellent ones, but I can assure you that I have taken none of them more seriously than I take this one.

Most often keynote speeches have been at midweek, permitting the Keynote Speaker to commend the organizers of the Convention on the excellence of their Convention. As this is Monday morning, I cannot say what a success the Convention has been—registration began only yesterday afternoon, the exhibits are not open yet, and the hospitality functions have not happened yet either. Nevertheless, the signs are good. The lights all work, the coffee was hot, and your Convention organizers have picked a crackerjack of a Keynote Speaker and got him here on time. I think that bodes well for success, don't you?

Let us examine the theme for this Convention—Technology to Lighten the Burden. During this week there will be a broad array of technical papers on surveying, cartography, geodesy, geographic information systems, remote sensing, photogrammetry, and on education in all of those fields. These papers will be given by Federal, State, and municipal employees, educators, researchers, planners, etc., and repeatedly throughout the week in these papers and in the discussions that follow, the application of technology for the solution of problems or lightening the burden will be addressed. Also during the week in the exhibition hall will be located, without much doubt, the finest collection of surveying, mapping, and photographic instrumentation in the world this year. This instrumentation also is clearly intended to solve problems and to lighten the burden. So why address the theme? With all of that, surely the burden will be lightened, at once. Of course we all understand that in some cases the projected applications will work very well and in some other cases they will not work as well as intended. What will make the difference? The successes will result from clear understanding of the requirements to be met, a sound understanding of the technology or techniques to be applied, and a continuing and active dialogue between the user and the maker.

The Burden—Its Problems and Solutions through Surveying and Mapping

It is well also to remember that part of the burden that is to be lightened by the applications of technology was in itself caused by technology. Perhaps those were technologies whose impact was not fully thought through nor planned, or technology that may have been misapplied and technology that may have solved one problem and caused two or three others. Those of us here attending this Convention this week understand very clearly what our responsibilities are in this matter. It is clearly our responsibility to move strongly into the new technology without losing a firm grasp on the well founded principles of surveying and mapping. In our excitement to solve problems, it must be clear also that, if we are to tackle the job of lightening the burdens of society, *we* must first increase our own burden. I offer this concept to you being realistically aware that there is growing cynicism toward those in public and private life who say they want to help you. There is even a joke that the most ominous line in America today is "Hi! I'm from the Government and I'm here to help you." or the other one-liner, "The people would be pleased to tend to their own business if the Government would only give it back."

I am not suggesting that the way to lighten other peoples burdens is to shut down the national surveying and mapping programs. On the contrary, there is perhaps no more well recognized and traditional role of government around the world, along with the common defense, management of the currency, and the conduct of foreign policy, than a scientifically based system of surveying and mapping. One of the first men hired by George Washington to aid his Continental Army was the geographer Carl Erskine. The Survey of the Coast was one of the earliest departmental subdivisions established by President Jefferson in 1807 to chart the Nation's harbors and waterways. One of the primary missions of the Lewis and Clark Expedition was the surveying and mapping of the new lands of the Louisiana Purchase. Throughout the

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19th century the Congress sent surveying and mapping expeditions, both civilian and military, into the new lands. The Geological Survey was itself formed out of several competing surveys of the western lands. And one of the major goals of our second Director, Major John Wesley Powell, was to carry out a systematic plan of national map coverage.

The intervening years since Powell's plan for national coverage have not lessened the need for surveyors and mappers and their work. On the contrary, as our Nation has expanded and grown, as our demands for resources have increased, there has been hardly a question or an issue involving the Earth and its resources that didn't require us to turn first to a good survey or a good map for insight and guidance.

As essential as surveying and mapping are to the public welfare, those of us in the profession sometimes fail to understand fully how the public may view the benefits of surveying and mapping. Perhaps I can illustrate this phenomenon by reading you a Czechoslovakian poem titled "Brief Thoughts on Maps." An unconfirmed translation of the poem in English is as follows:

> Albert Szent-Gyorgyi, who knew a lot about maps,
> According to which, life was on its way somewhere or other,
> Told us this story from the War
> Due to which history is on its way somewhere or other,
> A young lieutenant of a small Hungarian detachment in the Alps,
> Sent a reconnaissance unit out into the icy wasteland.
> It began to snow.
> Immediately
> It snowed for two days and the unit
> Did not return.
> The lieutenant suffered; he had dispatched his own people to death.
> But on the third day the unit came back,
> Where had they been?
> How had they made their way?
> Yes, they said, we considered ourselves
> Lost and waited for the end.
> But then one of us
> Found a *map* in his pocket
> That calmed us down.
> We pitched camp, lasted out the snowstorm, and then with the map,
> We discovered our bearings.
> And here we are.
> The lieutenant borrowed this remarkable map
> And he had a good look at it.
> It was not a map of the Alps.
> But of the Pyrenees.
> Good bye now.

My source did not outline for me what were the brief thoughts on maps suggested by the title. They may have been these: (1) maps are necessary to life and work, (2) many people do not know this nor do they know whether there are maps or not for their life and their work, and (3) people's confidence in doing a good job is well supported by having a map.

There are, it seems to me, three concerns which heavily burden people and public policy today. These are not the only fears we have but they are concerns which we as surveyors, geodesists, cartographers, geographers, and Earth scientists can deal with. Even if we cannot entirely eradicate them, we can at least reduce them with a combination of advancing technology and the development of enlightened public policies.

Three of the major concerns that burden us today are

> *Concerns about nature*—fire, hurricanes, earthquakes, floods, droughts, volcanoes, they remind us almost daily that while we may anticipate and accommodate, we cannot fundamentally alter the forces of nature;
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> *Concerns about mankind*—we know man to be a noble creation, but we also know all too well his darker sides, the private greed, ignorance, and superstition, insensitive and uncaring initiatives which, if unchecked, can create irreparable harm not only to himself but to the very life support system on this Earth; and
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> *Concerns about poverty*—Many of us can remember the Depression, and know the sickness of fear that can pervade a community when its economic sustenance is threatened or even worse when it withers and dies.

As scientists and engineers it is not common for us to consider how the facts and activities of our professional lives affect the burdens of fear carried by the people. Yet one of the surest ways to lighten the burdens of fear is with the force of applied knowledge, the muscle of technology. By strengthening the technologies of surveying and mapping and applying them more effectively to peoples' needs, we can indeed mitigate the effects of these trying problems.

There are many areas of surveying and mapping technology that offer great promise. I will address three this morning. First is the continued improvement in surveying and particularly in the interpretation and recording of results. Secondly, the technology of computer-assisted cartography and related activities are powerful and explosively growing capabilities. Thirdly, we are all keenly aware that the applications of space technology in surveying and mapping and across the entire spectrum of Earth science interests have great potential for problem solving.

Advances in Surveying Technology

Let us begin with surveying. There are many surveyors here today, and you are all aware of the growth in your specialty and in its importance in the scheme of scientific and engineering activities. Precise surveys of many types are crucial to the functions of locating, defining, measuring, and dimensioning, and furnish the basic framework for spatial relationships of all kinds.

Since the days following World War II when I worked as a field topographer equipped with plane table and alidade, the science and technology of surveying have undergone considerable and immense improvement. The simple instruments and techniques with which I was familiar have been replaced by electronic distance measuring equipment, doppler satellite surveys, and inertial surveying systems. Credit is due to the U.S. military organizations for pioneering many of the techniques, equipment, and systems that we now routinely use in civilian surveying work. As an example of these pioneering efforts, the Geological Survey with the help of the Charles Stark Draper Laboratory is today developing an airborne terrain profiling system that combines a highly sophisticated inertial unit with laser distance measuring. It will bring remarkable speed and accuracy to surveying certain types of terrain, such as coastal areas, stream beds, and flood plains. When we begin field tests we expect the unit to give us vertical accuracies plus or minus to 15 centimetres and horizontal accuracies to within 60 centimetres.

Because of improved surveying technology, the Nation has been able to undertake major programs at far less cost and burden to the public. A very real application of this type was the use of inertial surveying technology by the Bureau of Land Management in their immense task of cadastral surveying in Alaska.

Much excellent work has been accomplished by the National Geodetic Survey (NOS/NOAA). The NGS has successfully maintained the integrity of the networks of national geodetic control and is aggressively undertaking the adjustment of the North American datum, scheduled for completion in the mid-1980's.

There is one issue which is a real if unrecognized burden on the American people and responsibilities for it are shared by surveyors, mappers, and the legal profession. It is a burden which public policy needs to address. I am referring to the need for a multipurpose cadastre. The failure of this Nation to link the system of land ownership and description to a geodetically based and scientifically accurate system of spatial identification results in an unnecessary and multi-billion-dollar burden that costs the people heavily year after year after year. The need for a multipurpose cadastre is explained with great clarity in a recent report by the National Research Council of the National Academy of Sciences.

The report references a 1974 estimate by D. D. Moyer that the American people that year paid $17 billion in land transfer costs for residential and farm real estate. Nearly ten years ago a national survey of real estate transfer records estimated that recording office costs alone were $137 million.

What you and I know is that modern technology applied to establishing a multipurpose cadastre could lift a huge financial burden from the people. The cost of transferring property ought not to be much more than it costs to secure a building permit, or get a dog license.

We may not appreciate, however, how much progress has been made in establishing two essential resources for such a cadastre. There exists a highly accurate geodetic control network. There is almost complete map coverage founded on that control network and at a scale and level of detail from which many property descriptions and much ownership data could be spatially linked. That map coverage is the Geological Survey's 1:24,000-scale, 7.5-minute base map series which now covers four-fifths of the Nation's lands in the 48 conterminous States. Cartographic coverage of the remaining portion is available through orthophotoquads, with total line map coverage to be completed by the latter part of this decade.

The spatial linkage of cadastral information as a next step could lead eventually to a system for orderly and consistent treatment of land ownership and values throughout the Nation. Certainly it would be an immense task. But it is one for which immense groundwork has been laid. And the technology exists to accomplish the task.

There are fears of course that a national multipurpose cadastre could seriously invade the privacy of individuals and abrogate the rights of States, counties, and cities. These fears are real and palpable. They must be assuaged by very clear distinctions in Federal, State, and local government responsibilities, and by careful attention to the privacy issue.

However, fear is a poor substitute for enlightened public policies. Initially at least, we in government could take up the burden of a multipurpose cadastre for the *public lands*. Tried and tested for Federal lands, a multipurpose cadastre could be extended on a voluntary basis to the States for their lands. In time, private and county use could be made so that perhaps by the end of the century an unnecessary and wasteful burden could be lifted from the people of this country. European surveyors have stated that only a country as wealthy as the United States could afford not to have a multipurpose cadastre.

Admittedly, the prospect of a multipurpose cadastre is somewhat mind-boggling. Fully as gripping are the potentials of computer-assisted cartography and geocartographic information systems.

Advances in Automation in Cartography

Last November I had the honor to address the Australian Cartographic Conference in Hobart, Tasmania. The Australian cartographers clearly expressed the excitement that they share with us and our colleagues elsewhere over the possibilities advancing technology is opening up for cartography. They believe, as I do, that we may be at the beginning of a golden age of cartography. This can be an age during which technology, and our appreciation of it, can offer the opportunity to portray the things of the Earth and about the Earth with all of the variable perspectives and possibilities of the human mind—with the assistance of the computer.

We can and should be bound by the lessons and integrity of the classical past. The contributions of Pythagoras, Euclid, Archimedes, Ptolemy, and Newton are as valued as ever. We should retain those aspects of the past that have helped cartographers and geographers to explain to others in the clearest ways how data can best be presented in spatial form, as previously it was primarily expressed in graphic form.

The world of the ancient Greeks was one of balance and order, a world curiously perhaps like a map, with things arrayed as they were supposed to be rather than as they might be viewed by the human eye and mind.

It seems to me that digital cartography offers to us a technology that can go a long way toward easing public burdens of uncertainty regarding the wise and prudent uses of the Nation's lands and resources. We do not lack information for such decisions, nor do we lack scientific understanding. Neither do we lack a public willingness to decide.

What we lack is the means to apply what we know to answer the tough and complex questions of our times. As envisioned by the Geological Survey, a national digital cartographic data base could become an important means for applying what we know to the tough problems of deciding what we must do. The public today bears heavy responsibilities for trying to steer an intelligent course between those who would lock up the Earth to man and thereby impoverish him, and others who would give it away without regard to the consequences. A digital cartographic data base can assist us in applying the wealth of information contained in our maps and scientific reports to serious questions regarding the multiple use of our lands and resources. It would allow us to remove some of the uncertainties over implications of public policy actions.

To do so, however, we must substantially broaden our view of ourselves. We are not just mapmakers or surveyors. We are gatherers of Earth-science data. We are organizers of vast amounts of information and portrayers and interpreters, and we are scientific communicators in a very broad sense.

What links all of these broadened tasks and processes together is the spatial dimension that underlies all of the work of cartographers and geographers. To that spatial characteristic I would now add one more that computer technology brings to us. With data collection seen as a continuous process, with organization and categorization working in tandem, we will be able to depict the Earth in very near real time. Our professions are now challenged to do things never before within our grasp.

With powers of modeling, analyses, and forecasting provided by computers, we will even be able to see into the future. Yes, we will still be able to portray things as they were in the form of maps. But with the new cartography that is becoming possible, we will be able to deal with past, present, and future. The implications are enormous.

From the beginning, mapmakers helped us to visualize the known but unseen. In the far future, the great analytical powers of computers will allow us to visualize what we have neither seen nor known. This ultimate possibility may not be as far-fetched as some might think. Consider, after all, what Eratosthenes did more than two millennia ago. In his time no one had seen the Earth as we now do routinely from space. No one knew for sure it was round. But by recording sun angles and shadows at distant points and at the same moment, he proved the world round and measured its circumference to within 200 miles of what we know it to be today. Eratosthenes told us what we did not know and visualized what we had not seen.

Since we began investigating the nature and uses of digital cartographic data at the Geological Survey, we have been discovering far more than its potential. We have also been discovering its growing present uses and needs. A few examples are

> Fire-fighting agencies are using terrain data in digital form to predict likely paths of forest fires in order to save homes and lives in Southern California;
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> Public and private energy development agencies are beginning to integrate map information into computer-based systems for inventorying and analyzing natural resources such as coal, gas, and oil resources; and
>
> To help manage and protect wildlife, map data in computer form are helping locate and classify habitats so that they may be preserved.

Digital cartographic data permitted the USGS to map a variety of physical and cultural aspects of the Three Mile Island disaster and in a form that concerned officials could readily understand.

Map information in digital form can also serve needs beyond the Nation's physical resources. The future for applying digital data is illustrated in one important way by the National Coal Resource Data System under development at the Geological Survey. When completed, this system will quickly report information about coal resources either on an area or specific site basis and show it graphically on a base map or as an overlay. It will contain much of the information a manager needs for helping people develop this important resource, including for example, geographic positions, political boundaries, terrain data, and point source or specific site information on coal, outcrops, mine workings, drill holes, and chemical and physical parameters of the coal. Much of the System's cartographic data is used in digital form to help analyses as well as display of information. The National Coal Resource Data System illustrates how digital cartographic data will work on an integrated and compatible basis with other kinds of information. This integration of data for special analyses is the area of largest potential payoff.

Indeed, consider the benefits that might accrue to emergency preparedness agencies, from the ability to integrate such diverse data as weather, terrain, and rivers, from satellites and other sources so that both fixed and rapidly changing information could be combined.

Digital cartography allows information from a natural or manmade disaster to be combined, as it occurs, with basic cartographic and other resource data. Were a nuclear plant to leak radiation or a hazardous cargo to be accidentally dumped, weather and topographic information could be combined with site data to predict the spread of danger. This kind of prediction is already possible. Also, calculations are being made at the Geological Survey to project the trajectory of oil spills as part of analyzing potential environmental hazards associated with such spills.

By combining stored cartographic data with other information, public officials could visualize and portray events in ways that would allow people to act more quickly and more wisely to save lives and property. The opportunity will be rich for production of maps that are dynamic, reflecting temporal phenomena, and from them allow people to predict future phenomena. Such dynamic maps could even be transmitted directly into people's homes and offices as is now done with satellite weather data.

Digital technology applied to cartography allows truly revolutionary change in our profession. I have been particularly pleased that the need for this technology has been recognized not only within the Geological Survey and the Department of the Interior, but also by the President's Office of Science and Technology Policy (OSTP). In a special study, recently cosponsored by OSTP and the Office of Management and Budget, findings and recommendations clearly support the national need for and benefits from establishing a comprehensive digital cartographic data base. Maps are no longer sufficient for the Nation's resource and environmental needs. What is needed is the digital cartography technology that will allow us to apply more directly what we know about the Earth to the complex analyses now required.

Advancing Space Technology

Space technology has already begun to lighten the burden in some extremely helpful applications. Accurate weather forecasting, supported by a very effective weather satellite program, has become widely accepted. Communications technology, including the real-time relay of telephone, radio, television, and scientific data transmissions, is effectively functioning through the use of satellites. In surveying applications, the Navy Navigation Satellites assisted by ground doppler receivers have made accurate positioning an operational reality, all over the world. The further improvements in such capability that are promised by the Global Positioning System, presently under development, will refine such positioning to geodetic precision and bring it within the reach of all who are equipped with reasonably priced ground observing equipment

In the field of Earth resource sensing satellites, the Landsat program represents the farthest advance so far. The first Landsat (ERTS 1) was launched in July 1972. Since then Landsat 2 and 3 were launched and are still aloft, though they are showing signs of failure. The multispectral imagery from the Multispectral Scanner (MSS) has been useful, particularly in developing countries with inadequate mapping and incomplete knowledge of their national resources. The imagery had a lively market in the U.S. but that market seems to be leveling off somewhat. There is rapid growth in the utilization of digital image data and in that regard, a substantial accomplishment has been effected at the EROS Data Center (EDC) in Sioux Falls in the establishment of a completely digital image processing system with a consequent increase in the quality and utility of delivered materials to users. Also, NASA is making available higher resolution data from the Return Beam Vidicon (RBV) sensor on Landsat 3, which is finding wide application. We hope they are successful in completing that data base worldwide while Landsat 3 is still operational.

Next to come is Landsat D (mid 1982) with a Multispectral Scanner (MSS) and a new Thematic Mapper, offering increased ground resolution and more spectral bands.

As you know, NOAA has been given government-wide responsibility for developing an operational land observing satellite, with NASA retaining its responsibility for experimental systems. There is a good chance that Landsat D1 will follow Landsat D, probably within a year. There is very high governmental pressure for operational space systems to be self sustaining, and the experience so far indicates that cost return sufficient to support such expensive systems fully is still far in the future.

NASA is studying the Operational Land Observation Satellite (OLOS), looking to a multispectral capability somewhat similar to the Thematic Mapper and using multiple linear arrays. The system proposes many improvements of interest to mappers but certainly at very high cost.

USGS has funded a study for a proposed operational system called Mapsat, which will be described here later this week by Dr. Alden Colvocoresses of USGS. Mapsat offers some practical improvements to other proposed systems at very favorable costs. We think that Mapsat deserves serious consideration by the user community.

The French Centre Natioanale d'Etudes Spatiales is presently building the SPOT system. SPOT will have 10 metre pixels in the panchromatic mode and 20 metre pixels in the multispectral mode, will permit stereo, and will be launched in 1984. The European Space Agency (ESA) will build an Earth Resource Satellite (ERS) with similar capabilities. The Japanese are developing a well thought-out program for both marine and land observing satellites. Accordingly, there is now strong possibility that the U.S. will lose its preeminent role in providing open dissemination of space data on a global basis.

NASA has built the Large Format Camera (LFC) with 30-cm focal length, and a 23- by 46-cm format that will provide 10 metre resolution imagery usable on already available stereoplotting instruments. This camera is scheduled to fly on the space shuttle but, unfortunately, not until 1984 and then only for a short three-day flight at an inclination providing U.S. coverage only for Texas and southern Florida. We believe film systems like this have much value and we urge more consideration of LFC-type capability.

As an important spinoff to the space program, cameras of the quality and capability of the LFC prompt us to believe that such cameras could be modified for use with aircraft platforms and used for achieving national coverage of extremely high quality and high resolution for multipurpose use. Several agencies including USGS, Soil Conservation Service, Forest Service, Bureau of Land Management, Agricultural Stabilization and Conservation Service, and others are interested in obtaining such a national capability in support of the National High-Altitude Photography Program, and work toward that development has already begun.

All the foregoing are only a fraction of the technological applications that hold promise for relieving the world's concerns about the transgressions of nature, human kind, and poverty. Their potential is real and with thorough planning and knowledge can make a real difference. Before we rush into the embrace of technology's promise, however, let me add some warnings.

Conclusion

There is a natural progression to technological development, and it's just as real for us in surveying and mapping as it is to those in other disciplines. I remember in the early 1960's when many new nations coming out of their colonial period were looking to the western countries for assistance in setting up national mapping programs. All too often they were treated to photogrammetric razzle-dazzle when what they needed was some practical help in using simple instruments and basic materials like aerial photography.

We need to recognize that changing methods offered by technology do not necessarily mean changing the classical principles upon which our science and ethics are based. Of particular concern to me is the need for classically trained people steeped in the basic principles of our professions to aid us, to keep us straight, as we bridge the gap from the old methods to the new.

We need to listen to one another more attentively so that we can learn. We need to listen more carefully to our customers, to the public, to find better ways of making information available and more useful to peoples' needs.

The involvement of universities and colleges is of essential importance. Through their assistance we strengthen professionalism and the qualifications of our new people for building upon the structure of knowledge we and our predecessors have erected. Advancement of professionalism in all our fields comes from education and knowledge and they must be continuously applied.

Technology alone cannot lighten the burden. When combined with sensitive understanding of need and of the capabilities of the new technologies, we can indeed lighten the burdens throughout this land and this world.

So I challenge you this morning to consider not just the issues of a technical nature that regularly occupy the agenda of these annual conventions. Consider the effectiveness of applications, not only the elegance of processes. We really can make a difference in solving this country's problems, and the opportunities are here for us to continue seeking their solutions by application of the technologies we represent. Thank you.