Conference Opening

Dean T. Edson, Presiding
USGS, Conference Chairman

William A. Radlinski, Keynoter
Associate Director, USGS

Warren E. Schmidt
CIA, Program Chairman

Edson: My name is Dean Edson, and I am your conference chairman for the next 4 days. I am delighted to see the tremendous response for this conference, and I simply welcome you to the U.S. Geological Survey National Center. I hope that your next few days will be profitable, useful, and pleasant.

I want to recognize the cosponsors of this conference, that is, the American Congress on Surveying and Mapping and the U.S. Geological Survey. Many of you are members of ACSM and completely familiar with their scope of activities. ACSM's current president is Robert Reckert and I would like to note that Bill Overstreet of USGS will assume this post shortly. In so far as the Survey is concerned, you may also be aware that Dr. Vince McKelvey is the Director and I welcome you to the Center in his behalf. Without the cooperation and support of both ACSM and USGS, we simply could not put on an important meeting like this. The organizing committee also recognizes the many people, not only in Government agencies in the Washington area but also in industry, who have given of their time and talents to make this meeting a full spectrum meeting in terms of automation in cartography.

I was contemplating last night about what to call a group of people interested in automation in cartography. A couple of possibilities crossed my mind: the first was "cartographers of automation," but that did not sound very good; then I thought of "automated cartographers," but that sounded even worse. I guess the best way of recognizing the group would be to refer to them as "cartographers of the 1970's." Certainly the scope of our meeting has a lot of exciting ramifications; things are going on in the field of cartography that were unthought of just a few years ago. Perhaps after our meeting concludes we will have a better idea of what the future might hold.

I think everyone should start a meeting with a wornout joke. This particular one concerns obtaining expertise in the year 3000. Instead of going to the university, you simply go to the brain bank, shop for the kind of brain that you want, and have it installed--a savings of at least 4 to 8 years. In this particular case a young man went into the brain bank to look at the price list. The attendant was going through the catalog, commenting that an engineer brain would cost $350/oz; a lawyer brain cost, $375/oz. If you wanted a technician brain, the cost would be considerably less. When he got to the cartographer brain, he quoted the price of $850/oz installed. The young man was astonished: "My gosh, that can't possibly be right." The attendant replied, "If you had any idea how many cartographers had to die before we get an ounce of brains, you would understand why it costs so much."

The 1970's hold significant potential in the field of cartography. Before I launch this meeting I would like to quote from a recent ad by a prominent computer manufacturer in Smithsonian Magazine, really a sign of our times. It stated simply that in 1952 the cost of processing or performing 100,000 manipulations on their particular computer was $1.26; in 1958 the cost dropped to $0.26; in 1964 it dropped to $0.12; in 1970, to $0.05; and now the cost of 100,000 manipulations is a penny. When you think that over the last 20 years our consumer price index has gone up 80 percent, you begin to get the feeling there is indeed tremendous potential for this gadget called the computer, particularly in the field of cartography. At some point, which I believe is now or at the very least in the foreseeable future, cost-effective computer operations will certainly be realized. No wonder people are excited about the possibilities for automation in cartography.

Before I get on with the meeting, I would like to introduce one of the principal actors in this unrehearsed play--Warren Schmidt of CIA. (Editor's note: Schmidt is now employed by USGS.) He will be your program chairman during the conference and will have much more to say to you a little later on.

We are fortunate this morning in having a keynote speaker who can focus for us some of the real problems facing cartographers today. He hails from New York where he earned a degree in mathematics from Hofstra University. And he did a considerable amount of graduate work at Georgetown University in astronomy. He received two honorary awards--Kappa Mu Epsilon and Pi Alpha Theta--during his academic career. His introduction to topographic mapping came as an officer in the U.S. Army during World War II. After working for the Army Map Service a short time, he joined USGS in 1946. His illustrious career has been marked by many awards for outstanding work primarily in the field of cartography. He has held key positions in ACSM (such as chairman of the Cartographic Division of ACSM) and in many other professional societies. He is the author of numerous published articles, and he was, I believe, an editor of Photogrammetric Engineering some years ago. Having represented USGS at conferences throughout the world, you may recall that he moderated the USGS and London Royal College of Art Symposium on Map and Chart Digitizing held in 1969 in Washington, D.C.

Most important, though, is the fact that our keynote speaker is currently the Associate Director of USGS and is thus in a position to be keenly aware of today's problems and potential methods for their solution. It is my pleasure to introduce the person that everyone in USGS calls Rad--William A. Radlinski.

<u>Radlinski</u>: I believe the first thing one must do when he keynotes a cartographic conference is to define his terms, because there are so many different "official" definitions. According to an old USGS definition, modified by me for this paper: "Cartography is the art and science of expressing graphically or digitally, by use of maps, charts, or other display, the known physical features of the surface of the Earth or extra-terrestial bodies and the works of man and his varied activities." Classically, cartography is the art of map construction and the science on which it is based. I will direct my remarks to map construction and digital aspects of the art, including the traditional color-separation drawings and the modern numerical data in machine-readable form that are the building blocks of map construction. Some of the more technical people call this "symbolized geographic feature display." I will also talk about the direct use of digital data.

Since I've started with a definition, I had better go all the way and also define what is meant by automation. Automation here will mean exactly what it does in most other disciplines--the science of operating or controlling a mechanical process by highly automatic means, such as electronic devices.

Now let's ask ourselves <u>why</u> we should automate cartography, for if we don't have some good answers to that question, we might just as well end this conference now. After all, automation is not a universal cure-all because it is usually very expensive to install, can cause labor problems, and sometimes results in a reduction in quality of the final product. However, when one considers the magnitude of the workload facing the mapmakers of the world, automation may be the only way to get the job done. The enormity of the task was quantified by Professor K. A. Salichtchev, immediate past president of the International Cartographic Association, when in 1971 in Paris he said:

> To solve the problems that confront humanity, we must know our planet, its structure, conditions, natural wealth, the distribution of the population and economy; therefore, we must possess and keep up to date a multitude of maps. What is the actual number of this multitude? I shall cite only topographic maps covering the Earth's land areas as an example.

Salichtchev then established a reasonable basis for estimating the number of maps that will be needed and concluded:

> Under these circumstances it will be necessary to publish more than 1,000 updated topographic maps every day. Then again, how the figures will increase if we take into account thematic maps and ocean charts. The execution of such a task is inconceivable without automation!

Closer to home, it may come as a surprise to some of you that 21,600 of the 54,000 7.5-min-quadrangle, 1:24,000-scale maps it takes to cover the lower 48 United States have not been published, and of the 32,400 that are published, 8,000 need revision. At our present rate of production, it will be 1984 before all of these maps are published and before the backlog of out-of-date maps is eliminated through current revision.

I can think of more specific reasons for automation:

--To speed up the mapmaking process.

--To improve the economics of mapping.

--To generate digital data for direct dissemination and rapid manipulation to produce, with a minimum of effort, maps at different scales and with selected contents.

--To facilitate map revision.

--To reduce the incidence of errors.

It seems to me that any one of the cited reasons, if valid, is sufficient to justify automation, but when combined, the case becomes overwhelming. The relative importance of these reasons will vary among mapmakers and users, but the order in which I have given them is my priority. You may have other reasons for automating cartography that we will learn about later, but for now I would like to talk about the five I have given.

1. To speed up the mapmaking process.--It is interesting to note that the glossary of "Automation Terms in Cartography," published by the International Cartographic Association in 1973, defines automated cartographic systems as, "automated methods of producing charts and chart products, in graphic and digital form, with the view of radically reducing total production time." It would seem that, by definition, ICA is also saying that the number-one reason for automating is to speed up the process of mapmaking. Consider, for example, the bad news from the mapping program of the Geological Survey. On the average, 59 months are required to complete a standard 1:24,000-scale, 7.5-min quadrangle map. Nearly 5 years is a long time to wait for a final map, not to mention what happens to the currency of the content in that time. The inevitable result is that the map is out of date--sometimes grossly so--by the time it is ready for use.

Breaking down these 59 months, we find the following elapsed times to carry out the various mapping phases (these are figured on a project basis for an annual production of about 2,000 maps; a project may consist of 4-40 maps and will average about 20):

Phase	Months
Authorization and planning	1.5
Photo delivery time	9.6
Ground-survey control	11.5
Photogrammetry	8.7
Field completion	5.6
Cartography	14.7
Reproduction	7.4
	59.0

Most of this is shelf time with the map on the shelf awaiting its turn to enter the next phase.

Time savings in the mapping cycle can be realized by more careful planning and programing but the significant improvements will come from better technology, such as automation. Not only will the individual phases be carried out more rapidly, but shelf time will be reduced because the map will not have to await the attention of a skilled human technician. A specific example would be the recording of selected map data directly from the stereoscopic model in digital form for use in the automatic preparation of the color-separation graphics.

2. To improve the economics of mapping.--In these days of spiraling costs, economy of operation is an attribute dear to everyone's heart and a real prime mover toward implementing automated techniques. Not too many years ago when people presented papers on the subject of automation, they avoided the cost effectiveness factor like the plague. Today, it is a different scene: equipment effectiveness is rising with ever-increasing speed to the point where, in spite of inflated hardware and software costs, new techniques are truly competitive.

USGS costs for the standard 7.5-min, 1:24,000-scale map in the United States are:

		Cost	Man-years
New map			
	Average	\$17,000	0.7
	Range	\$13,000 to \$25,000	0.5 to 1.0
Revision			
	Standard	\$12,000	0.5
	Interim	\$ 1,900	0.07

(Standard revision is a complete reworking of the map, including field checking. Interim revision includes only those changes that can be made from aerial photography, with no field check; the new information is overprinted in purple on the old map information.)

These quadrangle costs translate into an average cost per square mile for new mapping of \$304, ranging from \$241 to \$470/mi^2. The direct man-hour cost averages about \$13/mi^2.

Despite continually higher costs of equipment and manpower largely due to inflation, overall mapping costs at USGS have not risen because of our increased efficiency. But there is reason to believe we can reduce these costs significantly by using new technology and present personnel.

3. To generate digital data.--It has been estimated that the average U.S. topographic quadrangle contains over 100 million separate bits of information, more than the average map reader could absorb in a year's time, and the topographic sheets of many other countries contain even more. While maps are extremely efficient devices for the storage of spatially associated data, even more information about an area together with positional coordinates can be stored in computers.

A major advantage of cartographic data in digital form is the convenient interface with other geographically related information and management systems. Such interfaces provide a means for numerical data in machine readable form to be utilized in complex modeling and problem analysis. Examples of the type of data required for various systems include: positions and elevations of manmade or natural features, transportation routes, lakes, streams, shorelines, slopes of terrain, land use, cadastral and political boundaries, population distribution, soils, geology, hydrology, and flood-prone areas. When these data are digitized, the end product can be in a variety of forms and at any scale.

It is reasonable to assume that nearly everything that is constructed by man is known at some level of government. We therefore must strive harder to seek ways of accessing local government data in an effort to achieve the goal of best information for the least possible cost. And for greatest utility, such data should be collected and disseminated to users through a central coordinating mechanism such as the Survey's newly established National Cartographic Information Center.

Another advantage of digital data is that it can be manipulated rapidly to produce, with a minimum of effort, maps at different scales and with selected contents. In the past, cartographers have mapped specific areas of interest at a scale commensurate with the units in use that best satisfied the average map user requirement. As such, the level of content was, of necessity, limited by the scale selected. Past technology has also condemned the end product to be a hard copy at a single scale with limited and generalized content.

Far too often users have found it necessary to produce their own maps because of their need for specific content or particular scale. Of course the scale of the general map can be changed by using a copy camera, but the content must be treated separately and manually. These analog processes are sometimes expensive and limited by optical or mechanical constraints. Today, automated techniques in cartography can be applied to develop new and different forms of presentation.

4. To facilitate map revision.--Maintaining existing maps is often just as important as compiling new maps. Several methods for revising maps are in use today, each requiring review of recent source material and manual cartographic procedures. With the digital computer, automated processes are seen as the ultimate means of map revision in the future. In digital form, cartographic information can be updated continuously from reliable sources, permitting current graphical display on a truly timely basis.

We have a research effort underway to develop a process utilizing automated cartographic techniques specifically aimed at map revision. Again, digitization of the existing map is necessary. Digitized source material is then merged with the digitized map data, and the results are edited and transformed to high-quality graphic form by means of automated plotting equipment. However we are not sure whether it is more cost effective to store map data in digital form and update the data bases prior to producing a revised map, or to store map data in graphic form and convert the base to digital form prior to incorporating new data. The door of opportunity is wide open for innovative developments in this area.

5. To reduce the incidence of errors.--To produce an absolutely perfect map or chart must surely be every cartographer's dream. We have always accepted this dream or goal as being unattainable. Additionally, the degree of perfection or tolerable amount of error is tied closely to economics.

Automated cartographic techniques may help us on both ends--providing a more reliable and complete product at lower cost. While accuracy is normally limited by the inherent capabilities of the various machines utilized, reliability and completeness are a function of costs and human judgment. Each phase of mapping that can be removed from the frailties of human judgment and be automated is likely to become more error free.

Summing up, the introduction of automated procedures to mapmaking and map maintenance presents a whole array of opportunities to improve the cartographer's art. It can eliminate vast amounts of tedious work and cut years off the time presently needed to produce new maps. It can mean the timely updating of existing maps. It can permit the cartographer to be much more responsive to the demands of map users for special content or scales. It can provide access to extensive data which are not now used effectively because by present methods of data gathering and accession they cannot be assimilated economically in the mapmaker's data base. And it can do all these things faster, better, for less cost, and with less chance for error than they are now being done. The use of automated techniques in cartography can be likened to letting the genie out of the cartographic bottle--releasing a giant slave whose services may be utilized almost at will. It is a rose well worth pursuing.

Now, let me tell you that I was once a mathematician (when you reach the management levels of Government, you no longer are anything you once were). In those "good old days," I could put just about anything in life into an equation. I'd like now to revert to my past and put some of my thoughts on cartography into the following equation:

$$MV = f\left(\frac{C_1 \cdot C_2 \cdot C_3}{T}\right)$$

What this equation says is that map value is a function of content (C_1) times completeness (C_2) times clarity (C_3), all over preparation time (T). You will note how readily you can increase map value by reducing the preparation time, or vice versa.

Some of you may think that we have a good equation--that's just great, but I would be surprised. Others of you may think that it's only a partial equation and that map scale needs to be factored in--that's okay too; I think scale could be a factor. Still others may think that I may have <u>been</u> a mathematician but time has dimmed my memory--because those <u>should</u> be plus signs in the numerator, not multiplication signs. If you fall in any of these groups, I'm glad because I've got you thinking about the problem, and that, I believe, is what a keynoter should do. In your closing session, you will be better able to establish the function more precisely. Good luck in your deliberations.

Schmidt: When we originally planned this conference, the idea was to examine automation in cartography with emphasis on the current state of the art (that which is operating and available). We were trying to cover the topic comprehensively--it's a very complex one--and to provide maximum interchange between participants. To do this, we considered different approaches: strictly presented papers, key papers and panels, and the informal panel. Looking back for a model, the 1969 Symposium on Map and Chart Digitizing and the 1970 International Geographical Union Conference on Geographical Information Systems have been successful meetings with a great interchange of information.

We also had some other purposes in selecting the panel format; one of them was to avoid the problem of clearing the papers, especially in the military mapping and the intelligence agencies. The panel format avoided freezing the topics 6 months before the meeting and does foster greater interchange between the panelists and the audience themselves. However, for this meeting to be effective, I will ask the cooperation of the chairmen, the panelists, and the audience in several ways. First, I will charge the panel chairmen to keep the dialog going and to keep on the subject. Because this is being recorded, we will ask the speakers to identify themselves, and if they don't, the chairmen should ask them to do so. Lastly, if possible, stay within the time limits. I had considered bringing a whistle, but I hope it won't be needed. I will ask the panelists to keep to the point, to identify themselves, and to avoid commercials. This is not aimed at the business people but at everyone; we all like to sound the trumpet for our own organization. Lastly, I will charge the audience with several things. First, when asking questions please identify yourselves because we want the discussions in the proceedings. Second, please be patient--if something is not covered or is unclear, please speak up. If it is not covered in depth, realize that we are just sampling--there will be opportunity to do this later, perhaps by seeking out the speaker. Lastly, I will say that most of the people that are active in automated cartography are in this room, and therein, I think, is your greatest opportunity--that of meeting and talking with these "activists."

Before starting, one quick word about the workshops and the tours. We do have 4 tours: one to Suitland, Md., to see the Census Bureau and the Defense Mapping Agency Hydrographic Center, the second to the National Ocean Survey in Rockville and the Defense Mapping Agency in Glen Echo, the third to the Engineer Topographic Laboratories, and the fourth one here in the Geological Survey. Among the workshops we have INPOM--Interactive Polygon Mapping System--created by Harvard Laboratory for Computer Graphics and Spatial Analysis. This is an interactive display of polygonal information, manipulations, and pattern fills. Also there are some samples of ongoing work. The Bureau of Census DIME system will not be a primer but rather a problem workshop; you will be expected to know something about DIME. The CAM system, from CIA, is available but will be limited by space. No one will be able to participate in all these tours or workshops, so you must make a choice among the opportunities on Tuesday and Wednesday afternoons and Thursday morning. Please sign up for the tours at the registration desk.

To open the sessions, I would next like to introduce Dr. A. Raymond Boyle, who will chair the sessions on hardware. Ray was associated with the Oxford system in 1960-1964, and in 1965 he immigrated to Canada where he became a professor of electronic engineering at the University of Saskatchewan. He worked on the Canadian Hydrographic Service system until 1970 and since then has been the leader of the Graphic System Design Applications Group at the University of Saskatchewan. I think that Ray could best be called "Mr. Hardware," and that is why he is here.