OPENING REMARKS

MR. JAMES E. CHAMBERLAIN, CONFERENCE CHAIRMAN: Good morning, ladies and gentlemen. We are pleased and happy to see so many people for the opening sessions of AUTO CARTO III, the Third International Symposium on Computer-Assisted Cartography. The two previous meetings were held on the East Coast, and were sponsored by the Cartography Division of the American Congress on Surveying and Mapping. That proved to be highly successful, and we have been very encouraged with the response that we have received thus far to the West Coast version of AUTO CARTO III. We are happy to report that the meeting looks to be a complete success. Our registration is higher than we had anticipated, and the exhibits have proved to be the best we have ever had, and we are very encouraged by all this. I would like to say at this time that this meeting is a success because of the hard work of a good many people that a lot of you here probably may not even see during the meeting, but they have been involved for a year in the preparation and organization of this meeting, and I think they have done an outstanding job. If I went through the list to name these people and give them their due recognition it would consume too much time. But they have worked long and hard, and they are dedicated to the complete success of the meeting and to making your stay with us here an enjoyable one.

I would like to introduce these people at the head table now and ask them to say a few words of welcome, beginning with Mr. Jon Leverenz, who is the President-Elect of the American Congress on Surveying and Mapping. Jon is very active in the automated cartography program here, and has been for years. He is associated with Rand McNally in Chicago. It is a real pleasure, Jon, to have you with us. Would you like to say a few words for ACSM this morning?

MR. JON M. LEVERENZ: Thank you, Jim. On behalf of the American Congress on Surveying and Mapping I would like to extend a hearty welcome to each one of you today for what I would hope would be a very lively and thought-provoking week. A number of years ago--I will make these remarks short, but I think there are some good things to be said about this conference--a number of years ago it seemed that the time had come for a conference that would focus on automated cartography. The American Congress on Surveying and Mapping, the Cartography Division of that group, planned and organized, with the USGS, AUTO CARTO I; and I think many of you were here at that time. Following on its heels was AUTO CARTO II. Now we have come to AUTO CARTO III. Having attended each one of these, I think I have always gone away rather inspired by the information that I have gained and by the way in which the AUTO CARTO Conferences have been handled. I think the fact that there

has been this continuity and this need shown and this tremendous turnout in each one of these is because, first of all, I think the papers -- and I have attended all of the AUTO CARTO Conferences -- the papers and panels were good. The format for the delivery of the papers and for the interchange of ideas from the audience to the panel members was good. That format worked.

The third thing, as I recall, I think there was always a lot of uninhibited questioning from the audience. In fact, it became very thought provoking, and it was very interesting. The fourth thing I think is obvious from the many people that I keep seeing showing up here is that the people that attended, both the speakers and the people listening and interacting in the audience, went away from the Conference obviously with new knowledge and a good update on their AUTO CARTO III knowledge. I think and I hope because of this continuity and this organization we see developing here that this week will be no different than AUTO CARTO II and I. We will all, I think, go away with an increased knowledge of the AUTO CARTO field. So, again, I want to extend on behalf of ACSM a very hearty welcome to everyone, and I hope you will have a good and lively week. Thank you. (Applause.)

MR. CHAMBERLAIN: Thank you, Jon. I would like to acknowledge now also that although this is a meeting of the American Congress on Surveying and Mapping and the US Geological Survey -- It is a co-sponsored meeting -- it would not have been a success I am sure without the complete cooperation of the American Society of Photogrammetry. They have been a big help to us in every way, in organizing and conducting this meeting. It is a pleasure now to introduce to you the current President of the American Society of Photogrammetry, Dr. Vern Cartwright. Vern?

DR. VERN W. CARTWRIGHT: Thank you, Jim. On behalf of the American Society of Photogrammetry, I wish to welcome you all to San Francisco. How many are from outside San Francisco? That is pretty good. Last year this was going to be a great desert if we did not get any rain this year. So, please, when you go out in the streets, smile at the San Franciscans and say, "You've got beautiful weather here." (Laughter.) But we love it this way. You know, we have a change in the weather; we also have a change in technology. In the next decade there will be more changes in photogrammetry and surveying, I predict, than there will be in our lifetime. This is brought about by, in the photogrammetric field, by interactive graphics. We have new tools. Whether you call it data banks, computer cartography, data management systems, data systems -- anything you want to call it -- it is still a matter of semantics, and it is still making maps.

Sometimes you tie demographic data to a geographic basis, which in a way gets outside of map making. In map making you have, for instance, a photogrammetric base, you might have a land survey base, and then you add the different data levels of information. You can add thousands of data levels of information. You can sit down with a little computer, and out pops the information on just the data levels you want to the scale. It is tremendous technology. Within surveying, things are going to be changing in what I would say a drastic manner. I predicted, along with Charles Andrea, that it is going to revolutionize surveying within the next decade. This is all going to be brought about by the NAVSTAR geographic positioning satellite. There will be 24 of these satellites. There are about three up there now. But in 1984 there will be 24 of them up there at 20,185 kilometers. What these satellites will do, they will give us the X, Y and Z positioning to within inches. So, what will be the survey of the future? Will he carry a little black box around, put it out, push a button and get the X-Y position, feed the data mag tape information from that into a computer, have all the controls laid out? The technology is really here.

I can envision in the police department, for instance -- we came up with a system using digital data banks to show the traffic people the conditions that may exist. Say, for instance, there was an accident at Mason and Eddy. Up pops a map on the screen, say on your CRT. With this Telstar information satellite, you will have the police cars, all of the emergency vehicles on this digital map placed in their geographic positions. As they move you can see it, you can see the equipment. This would apply as well to fighting fires and disasters. So, in my opinion and in the opinion of many, this black box revolution is going to start taking place in 1984 when the NAVSTAR positioning satellite is going to revolutionize a lot of our areas. We have a change and challenge in our technology, and I am glad you are all here. We are going to see state-of-the-art conditions. Thank you very much. (Applause.)

MR. CHAMBERLAIN: Thank you, Vern. Before introducing the next speaker here, I would like to take a minute to recognize Dean Edson, who is on my immediate left. Dean is our Program Chairman and Chairman of AUTO CARTO I. He has been involved in digital cartography for a good many years. Dean has worked tirelessly to ensure the success of this meeting. So you will be seeing a lot more of Dean throughout the week. But since he is not speaking to you right away this morning, I just wanted to acknowledge that and give him publicly my wholehearted thanks. Thank you, Dean.

Now, I would like to introduce the current Chairman of the Cartography Division of the American Congress on Surveying and Mapping, and the one who is principally responsible for getting this meeting under way. It was just a little over a year ago that Dean and I met with Dr. Morrison here in San Francisco, and the seed was planted for this particular meeting. I am not sure when Dean and I agreed to organize this meeting when we really realized that all this was involved. It has been a long year of hard work, but we really have enjoyed it. I am sure -- and I cannot speak for Dean, but I have learned an awful lot about the field of automated cartography in just organizing and associating with so many of these very fine people.

Dr. Morrison, the current Chairman of the Cartography Division of the American Congress on Surveying and Mapping. Joel?

DR. JOEL MORRISON: After that introduction, I feel that I should limit my remarks to thanking the organizing committee, because they did most of the work--all of the work, let us put it that way.

On behalf of the Cartography Division of the American Congress on Surveying and Mapping, I would like to welcome you to this, our third in a continuing series of international symposia on computer-assisted cartography. It was in December of 1974, a little over three years ago, that the American Congress on Surveying and Mapping, together with the United States Geological Survey, initiated this series of symposia at the U.S. Geological Survey National Center in Reston, Virginia. In spite of our current preference for the term "computer-assisted cartography," the nickname, "AUTO-CARTO" series quickly took hold.

People have eagerly awaited each successive symposium. The first symposium highlighted the technical progress in computer-assisted cartography, with general attention being paid to what could be done and what was possible. Following that successful symposium, the United States Census Bureau teamed with the American Congress on Surveying and Mapping, and staged AUTO-CARTO II, again at the United States Geological Survey National Center in Reston. AUTO-CARTO II highlighted graphic design and the map reader's reaction to the computer production of maps. We all remember the huge success of the AUTO-CARTO II symposium. Most of us have been repeatedly asked when and where AUTO-CARTO III would take place. Fortunately again, the United States Geological Survey agreed to co-sponsor with the American Congress on Surveying and Mapping this third symposia, and the site was selected in San Francisco.

The theme of this symposium could not be more apropos to my way of thinking: Let's put computer-assisted cartography to work. The "gee whiz" days of computer-assisted cartography are in the past. A few years ago one could reasonably expect major developments to take place in rather rapid succession. Today, the routine aspects of computer-assisted cartography are evident, and will remain so. Implementation problems and data management problems are not insignificant. Economic considerations for small users are extremely important.

Computer-assisted cartography is an established fact of life for most of us today. It probably is true that many of us still tend to think initially in terms of manual cartographic production, and we still seek the map as output. But with each succeeding year we feel more comfortable with the transitions in our thought processes to computer-assisted terms. It is not unlike the coming conversion to the metric system where the thermostat set at 20 degrees means comfort, where the home is seven kilometers from the office, or where 15 milliliters replaces one tablespoon.

For the cartographer, the conventional map produced with computer assistance can be hard copy output. A computerized relief model can be called a DTM, or a photohead can replace a scriber. Transitions are usually difficult, and they take time. The move from manual cartography to computer-assisted cartography is proving to be unusually difficult because of the rapid speed of the transition, the introduction of jargon, and because of the almost complete change in technology utilized by computer-assisted production. We are not through this transition yet. That is why the theme of AUTO-CARTO III is so poignant to us today. We know we can produce maps with computer assistance that not only meet established standards of accuracy and visual effectiveness, but also that are economically viable. Our job today is to translate what can be done technologically and economically into common practice. Computer assisted cartography must become synonymous with the mainstream of cartography so that the adjective "computer-assisted" can be dropped. This is not an easy task, and it is not necessarily as fun or as exciting as it once was.

I hope that each of you during this coming week, in addition to gaining information on recent developments pointing in future directions, gains a greater sense of feeling "at ease" with computer-assisted cartography. You must question the discussants. We need honest appraisals of what does not work as well as the glowing reports of what does work. We need to know the inefficiencies and bugs of a system as well as its efficiencies and selling points. We need to be precise in our terminology and not create needless jargon. These things, I believe, will help

to maximize the success of this conference, and it depends to a large extent on each of you in your willingness to ask questions that you have had in the back of your mind, or your willingness to admit shortcomings of your experiences with computer-assisted cartography.

Finally, I must acknowledge the interest expressed by the American Society of Photogrammetry. Increasingly, a welcome commonality of interest among photogrammetrists, people interested in remote sensing, and cartographers is in evidence. This symposium welcomes the addition of the cooperation of the American Society of Photogrammetry in seeking to satisfy this interest.

I bid you all welcome to AUTO-CARTO III. Have an enlightening and enjoyable week. Thank you. (Applause.)

REVIEW OF TECHNOLOGY INTRODUCED AND DISCUSSED AT AUTO CARTO I AND II

MR. DEAN EDSON: The object of AUTO CARTO III, as has been the case in AUTO CARTO I and II, is transfer of knowledge. Certainly one of the fitting ways to start a meeting like this is to review the essence of much of the discussion, much of the technology that was introduced and discussed at previous meetings. I think that we need this refreshing look backwards in order to better appreciate and understand what we are going to be exposed to the remainder of the meeting this week.

To do this I have selected a person who simply excels in qualifications regarding this review of technology, and that is Dr. Bob Aangeenbrug. Dr. Aangeenbrug is presently a geographer at the University of Kansas, and is a super member of ACSM. I say that because he has been extremely active. Dr. Aangeenbrug received his doctorate in cartography from the University of Wisconsin in 1965, and is a Ford Fellow in urban studies and is a past president of Urban and Regional Information Systems Assoication. He was also the chairman of AUTO CARTO II, held two or three years ago in Reston, Virginia, co-sponored by the Census Bureau. Bob, I think with that we will hear from you, and hopefully be super smart and be able to pick up from where we left off a couple years ago and forge on. Bob? (Applause.)

AUTOMATION AND CARTOGRAPHY: A PROGRESS REPORT 1974-1977

DR. ROBERT AANGEENBRUG: Thank you, Dean. It has been a couple of years since the last AUTO-CARTO conference, and some of us are still slightly exhausted from the experiences. There is little question about the importance of these kinds of experiences. Something rather caught my attention as I listened to Joel Morrison. He said that the time perhaps is past for what we may call the cult of "what was invented here works better than that invented any other place, and we can transfer our achievements to every other place". Objectivity is a difficult thing. One of the things I liked about AUTO-CARTO I, and one of the things that convinced me to consider holding another of these conferences, was the kind of atmosphere of give and take and the seriousness of our purpose.

I came back to Washington in the early 1970's out of an atmosphere of revolution that was foisted on us at the University of Kansas in the late 1960's and early 1970's. I was not particularly impressed with the establishment, but I was taught a very quick lesson at AUTO-CARTO I about the massive accomplishments in the federal sector. Literally (quite honestly) for three or four years I pretended that these were not really of any consequence, and, moreover, these feds--particularly the military types--were wasting the taxpayer's money. That was not at all the case. It was a rather humbling experience in part taught to me by the likes of Edson and Schmidt, who involved me in the first AUTO-CARTO conference. An interesting thing in reading over the proceedings was that the reasons why we held AUTO-CARTO I and II, to a considerable extent, were the same. Both Radlinsky and Overstreet

stated that essentially we were here to learn about the experience of, say, a large agency's point of view.

First of all, the production demands in cartography require automation. Second, there is a desire for currency, and it is an extremely important one. If we do not do it, I can assure you the television people will take over cartography, if they have not already. At least that was my interpretation. And, by George, if you look at the Sears-Roebuck ad which shows a wall full of little snap-in cassettes for hundreds of computer games--there is a large maket and the retail industry is telling me that they can sell computer graphics and cartography, without substantial input from cartographers. Another thing is, at AUTO-CARTO I I was reminded of the fact that I am not really a cartographer. I was trained at Wisconsin in geography, although I did have some cartographic training, that, according to Robinson, may or may not have sunk in--(laughter). And it did not really matter to me because, for instance, like my colleague, Duane Marble, I was not really interested in cartography. It was a technique that you needed if you studied certain kinds of spatial allocation and/or urban information systems problems. Some of us got involved in automation because the cartographers did not want to get involved. I think that is still occurring. I like the interdisciplinary nature as well as the open-endedness of the mix of designers, academic, and "real" users.

Currency is still a problem for us. We will still have people flashing around new hardware and software which they are either selling us or giving away, while claiming they have the ultimate systems which will solve all your problems with no transferability problems. Currency is important in the public sector, there is no question about that. Instant weather mapping will probably be demanded by the public before long. We now actually find among some of our students in the introductory geography courses an understanding of what a cold front is and what it looks like from the air. Perhaps in four or five years they will be expecting this stuff and perhaps might even understand some of the mathematical attributes of such surfaces. Maybe you do not believe that, but some of our students seem to be looking at the world differently because of graphic images they have seen on TV. That was not so clear to us in AUTO-CARTO I and II.

Another thing that we did learn and we knew about in the previous conferences were the problems we now face with scarce resources. Such resources are viewed in our domain primarily from the point of view that "this great nation cannot do everything, this great nation can't fight all these wars, invent this, and cure all diseases and solve all of humanity's problems". But even as we have become a more introspective society, we are still facing serious problems. For example, something which occupies a lot of the legislators' time is, how to prevent the medical profession from absorbing the entire GNP. The AMA currently appears more threatening in the eyes of some folks

than even some of the military-type spenders in the Pentagon. That is kind of good, and it is kind of interesting. The use of graphics in health problems is something that we must be involved in and we have been remiss. The next AUTO-CARTO conference had better discuss some different scalar operators so we can do the cartography of the inside of a lung. I can hear some of the cartographers saying why they do not want to be interested. But the technology and the solution to the problem can in part be contributed to by the likes of yourselves and we can certainly use the results.

Resources are also scarce because the number of educated human beings in this society is limited. Rostow and others, when they talked about the development strategies of the great countries, primarily in the Western world, more or less came to the conclusion that the ultimate society as they understood it was one that was market-oriented, that the real strength of this country is in its market economy based on a skilled labor force and an educated public. The desperation sensed in Saudi Arabia or in a small underdeveloped country is primarily due to a lack of human resources. We are beginning to equip ourselves with technology. Our tools are not half as important as our knowledge about their proper use and utility within the national societal framework. I hope that the return of mathematics as an accepted attribute of a real college degree will return to our universities. Because if you are going to be involved in automation of cartography any longer and really understand it and really use it, you may have to re-evaluate your capacity to use the technology. This may mean you may have to go back to school. Because of this scarcity problem in our society and in others, more of us may actually have to be employed longer and know more in order to assist our own society with its complex problems.

We have developed a need, I suppose, for high-speed and direct dissemination of maps. This was pointed out in both AUTO-CARTO I and II. We are creating something that has been called at various times the virtual map--that is, the map that exists primarily in machine storage and is rarely used as paper copy. No one is going to worry about shrinkage of paper or heat, etc. I think I had several lectures on that, including examples and fieldwork. That may be irrelevant for virtual maps. Of course we are now going to have some new problems. Can you store something electronically and really understand the difficulties you have when you conflate that map with its previous states? A number of other types of difficult problems are going to raise their heads. The virtual map is not going to be a solution to all problems, but it is likely to determine to a great extent how we will be seeing the world. I do not think we will have the end of paper maps, but they are certainly not going to represent the majority of maps or pictures that may be in existence a few years hence.

I was quite impressed in both previous conferences, and I am sure I will be here, with the extensive long-range planning that took place, particularly in several of the larger federal agencies--DMA, USGS, NOAA, Bureau of the Census, CIA, and what-have-you. Obviously some bureaucrats took some risks, spent some money, and did some pretty substantive work in trying to anticipate the need for essentially automated mapping on a continuing basis. I am not really sure whether we can meet those needs. Maybe in the 1980's. I do not think we are ready yet to have machine-readable topographic mapping delivered to every civic agency in every county of the United States and have anyone actually use it. We are still at the stage that these experimental maps are still carried around, in a manner of speaking, in the same flashy way we carried the printout under our arms in the early days of computing, for instance. We are beginning also to address the extended product notion to the variable needs for maps. We are talking about, say, a map that can be rescaled. Its contents can be screened, re-evaluated, added to and deleted from. In a manner of speaking, we are going to demand and develop some massive kinds of overlay systems. This has been anticipated in the previous two conferences, and we hope to find out what progress is being made.

Part of this demand is tied to the need for the facilitation of revision From my perspective at AUTO-CARTO II, I learned of the experiences of the urban mapping folks who had had the benefit or the plague, depending on the point of view, of having to live with the GBF/DIME files or the super geographic base files somebody else gave them. The utility of these files was very marginal because the maps could not be revised very easily. Although intellectually and in terms of some specific experiences they were and could be useful, often they were quickly put on a shelf. That reminds me of the planning reports produced for urban agencies between the 1950's and 1970's, which were made from essentially the same format; you change a few numbers and names, and practically the same comprehensive plan for 1975, 1980, and 1985 is produced by XX and Associates for any city.

I think we are now beginning to re-think what kind of maps we will make available, for example, to urban users. I am not really sure what we are going to do about having to develop, or even think of, engineering accuracy types of maps that the urban folks that are thinking about for cadastral mapping may want. Certainly it is not the kind of stuff I am going to be able to do on my little old "xyz" mini computer. It simply will not do it. In fact, even some of my students are getting bored with the interactive graphics we are doing in our small minis. The demand has changed for more complex mapping systems even in the classroom. This was pointed out, at least in part, at the previous conferences.

Reduction of errors is, of course, something that really concerns us.

Something I learned when I worked at the Bureau of Census and dealt with the urban environment is that the thing most politicians ask first when they get a map or a booklet with numbers about their city is: "Is the thing accurate in terms of my interests or will it emabrrass me or make my city look bad?" They will look at a specific item on that urban map or on the statistical table. The obsession of the public with apparent or real errors, or accuracy, is going to increase as these kinds of products enter public domain in larger numbers. Their expectations are going to be that your maps are, in fact, accurate. This problem of reduction of errors was in part addressed by some of the papers on statistical mapping held in the last conference, and I think we will probably have to re-address ourselves to these. Another reason for holding these conferences is to examine some of the lessons we learned about basic map design. The designer must be in charge, Robinson argued, and the bad map is not primarily the result of the technician's error. One thing I want to point out: no cartographer, pseudocartographer, or geographer can get away with blaming the software, the hardware, or even good old Ray Boyle. If you do not do your homework and do not understand the basic mathematics and the technical aspect of a computer mapping and cannot get someone who can translate for you, please do not put the blame on the technician. As the designer you are responsible in every sense of the word. I was a little frightened by both Robinson and Jenks, as I sometimes am--not for long, as you can be assured. But they kept assuring me and the audience that the cartographer has to be in charge of the map message. Now, we do not know a heck of a lot about learning models. One of the things that rather humbled me was to listen to some of these speakers at the previous two conferences telling us that they do not really know how the human mind operates, or let alone how you would make a mathematical model out of it. Part of these digital maps and part of the design problems we face really have to do with our understanding or our ability to preduct the perceptual consequences of the image we are processing or representing? The answer is, "We don't really know very much." The standard cartographic texts are useful, but they can hardly be used by themselves to address that question.

Obviously, the designer has not really crept into cartography quite as far as he or she should have. Simplicity is a recommendation. And, in fact, the thing the American cartographer is always telling you is that "it's got to be simple". It does have to be simple, especially in the thematic maps. I come from an environment where you put everything on the map, sometimes including stuff you wish was not there. But, nonetheless, I am not ready to really buy the presumption that cartographers, for that matter artists or propagandists in central government, are always able to tell you what to think, or let alone, how to think. That was kind of an unresolved controversy left over from AUTO-CARTO II, and probably a good one to have. Obviously, the cartographers have a great deal of design wisdom. But unless they

design maps that are useful for urban analysts or the medical profession or somebody else, others will make their own. After all, Howard Fischer wasn't a cartographer but he got something started. In other words, we may continue to see an increasing number of maps produced by non-cartographers.

Speed of production is, of course, going to cause a real problem for us. It is usually our first concern and, as Dean Edson pointed out in the last conference, it is one of the reasons why USGS is seriously thinking and perhaps has already completed a system of digital cartographic data bases to replace the manually developed series. Speed of consumption will then be our next problem. Are you really ready to produce these many maps? Do you think the public will like what they see? I suppose it is an old rehash of "garbage in-garbage out". But, nonetheless, one of the things that led to AUTO-CARTO II was partially Vince Barabba's concern for the feedback he got when he gave his flashy presentations. He came back home wondering why the reaction of the public was not entirely favorable. They did not like some of the maps. They were expensive, and they sold many copies. But many cartographers and many urban analysts did not understand what they meant. The rate of comsumption is going to increase whether we are involved or not. Somebody will produce some kind of virtual image, and at an increasing rate. Their utility will not be decided primarily by the inhabitants of this room. Hopefully, we will be contributing.

The statistical utility of these maps is something we need to further examine. Kruskal was not really too impressed with the research that has been carried on within the cartographic profession. In the proceedings he indicated that the real basic research in how we measure statistical properties of maps is really fairly marginal. Not enough research has been done. I would like to remind you that basic research is still very, very crucial. Show me a federal agency or university that is not doing basic research in cartography prior to starting new applications work, and I think they will be headed for problems. What encouraged me is that in AUTO-CARTO I and II there were reports on a lot of basic research. My advice to you is, listen to the folks involved in it. Do not be too "quick-results" oriented. We have to learn more about the basic structures, including that of statistical utility.

Let me shift for a minute, though, to one of the things that came out of AUTO-CARTO I and was not stressed as much in AUTO-CARTO II, and that was the emergence of large cartographic systems. They were still developmental in those days. And until I am conviced otherwise, they probably still are. They are expensive and they are impressive; they cost millions of dollars and employ a lot of people. But they are not as yet in the public domain. At the University of Kansas we cannot really use a lot of this technology, but until that moment comes we

will not be satisfied. There is some progress on the horizon that I want to talk about.

The USGS is now releasing some products that come essentially from large systems at the, I believe, 1 : 125,000 scale. This is something we all need to take a look at. I hope to hear this time that World Data Bank II is effectively in the public domain. The large systems are not yet delivering to us users what we like to hear or, for that matter, what we can use. But then we will always be disappointed--we always want more. Nevertheless, the first payoffs for automation and mapping in the public sector, I think, probably are going to depend more on large systems work than they are on small systems work. We do not really understand massive amounts of information and massive data structures. We need to know about them. Indeed, I think this conference is in part possible because of the many men and women with vision that convince large agencies, including DMAC, EPL, CIA, USGS, NOAA, Bureau of the Census, and several large agencies in Canada, to go ahead and build these large systems. The problem of the utility of these to others still remains. The payoff is generally internal; transferability has yet to be accomplished on a large scale. The ultimate payoff, though, is cartographic wisdom; I think that is a worthy goal.

Some remarkable advances have been made in terms of line following, for instance, raster and cathode ray types of interactive systems, in part were made possible because of the investment made by the large system folks. The products are in part here: The DMAC has computer-generated topo maps. CIA has World Data Bank I still in use, and it is a useful teaching and training tool. Hopefully, the second edition will be in the public domain. NOAA is actively engaged. The Department of Energy, Mining, and Resources in Canada is similarly producing goods. We need to know what other progress has been made.

The most dramatic changes took place probably because the small systems were responsible for the transfer of computer mapping to the public domain and within the academic ranks. The small systems brought, say, operational systems within the universities and, in many cases, in small local and state government. That, I think, was of profound importance. That, in turn, may result in state government and universities investing in larger systems. The birth and development and adoption of the mini-based interactive system was accomplished from about 1970 to 1975. This is indeed a remarkable rate of technology transfer. But manual editing is still nearby. I do not think Ray Boyle is yet satisfied that there is a public utility around where a local government can get digitizing and some basic geo-processing done, so that one does not have to depend on a large interactive system and a manual back-up.

Data storage and transmission is still a problem in small systems.

Map files of medium complexity cannot really be processed. All my students want is a map of 105 counties--after all, it is the number of counties in Kansas--and some data and the lines and the roads and a few other things in order to study a real problem. Well, we can hardly get it through out "x-x-x" mini-system at the band rate to the x-y-z hardware that we have on the main frame. This problem has to be resolved, and I hope that it will be.

Another problem is the absence of standards. We do not really have any standards for how one digitizes a line, not that I know of anyway, and none that I can provide for my students. Oh, I can get 19 pieces of advice, including two or three gurus who emerge to tell me they have the only way to do it. Good. If it is documented, I will more than likely listen to you. But that is something we will need we do not really have, although I believe it is emerging, by that I mean very good standards for feature generalization. We do not have very good standards for editing maps. Oh, we have some, but they are still kind of on the horizon.

Classification is another problem. Although, historically, cartographers have done more work with it, it is primarily work on thematic classifications. Cartographers haven't a clue what to do with all that linear spaghetti. That is the kind of classification I am talking about. It does not have to matter who is going to do it, but that is going to have to be sorted out.

At AUTO-CARTO I and II we did have some papers and some discussion about the topologic data structure. As far as I am concerned, that is perhaps one of the most important areas of research. We do not really have very good answers. And although the various speakers were convincing in their wisdom and the need for topology, with which I agree, we need to know even more and we need to have more basic research done. In addition, we really do not know very much about, say, data structure's simpler problem, say, the theory of the line. Peucker was willing to address this and did an excellent job in AUTO-CARTO II. But I am not really sure, and I would like to hear, whether he is satisfied yet. It is difficult, you see, for an urban geographer to teach computer mapping with the off-the-shelf wisdom. That, I hope, will come out of this conference or perhaps some other one.

What are the implications of all this? I think Joel Morrison put his finger on one important point. We are beginning to get the decay of the not-invented-here syndrome. I really like that. Part of the comments made by our keynote speaker in the previous meeting pointed out that the federal agencies are beginning to be forced together for one reason or another, and are beginning to think of not repeating somebody else's work again. In part, the pioneering efforts of some of the international agencies--UNESCO, IGU, and others-- have been of

great assistance. Some insightful folks have begun this very difficult and academically not very rewarding process of getting folks together. I think you ought to commend these people for doing that. It is very important that we minimize the duplication. Users must be persistent, though. I would like to see fewer dilettantes. I would like to see people commit, say, ten years or so to pursuing computer mapping. Now, that may be hard and there may not always be a payoff for that, but we will still need it. We will need to support some devoted academes or bureaucrats who do nothing but topologic or line research, color mapping, or something else. We need to demand that they be supported. Because we really do not know a lot of things about automation and cartography.

The federal emphasis, of course, is going to continue in large system work. I would urge you during AUTO-CARTO III to examine the larger scale systems, and to discuss the third dimension. We are currently exploring fish-net type interactive cartographic representations of medical potential service needs for the State of Kansas.

Are we really ready to bring automation to cadastral or utility mapping? Are we ready to map the space outside of the earth? It is becoming a resource, you know, not only of the spirit but also for real. We need to define the purposes of our maps, particularly these virtual or fugitive maps. As was pointed out at the previous conferences, these maps will only exist for a little while. It is kind of marvelous about them; perhaps your mistakes will be short-lived. That is the problem with paper maps, you know. (Laughter). But, on the other hand, automation is also going to allow us to bring folks into the design process who will bring new ideas to it, the ideas of artists and others. In order to take advantage of these ideas we really need to know more about cartographic data structure.

One of the things that AUTO-CARTO I and II tried to accomplish was to get discussion of cartographic data structure started. Although we congratulated ourselves endlessly on how much fun we had and how many good presentations we heard, it is an unfinished task, and probably should be. The cartographer, as a scientist is, of course, somewhat ill-equipped for this task. In fact, much of the contributions to automation in cartography has been made by people like electrical engineers, physicists, and English and Philosophy majors who became programmers. Their contributions will extend the dimensions of the map and the image. Perception and cognition, though, are still going to be problems. We need to think of the creation of mathematical models for what we see, how we see, and how we present it. As Al Ward pointed out, we still need to think on how to express a design through automation. I do not think we are quite ready for that yet, although some of our smaller interactive systems are allowing us to think we are doing it. But I do not think we are quite there yet. But, hopefully, we will hear a report on how far we have gotten.

Another concern we will need to address even in computer graphics, is confidentiality. In the city of Lawrence and in the city of Wichita Falls, where I have some experience, the cable TV systems are technically designed to be two-way communication devices. That is, you could, with some electronic attachment, actually manipulate informatio back to City Hall or some central station. With the addition of mobil communication, sooner or later we will know exactly where you are. I think the public may begin to challenge this kind of worrisome problem I do not want anybody to know where I am in my car. Of course, I am a man of excellent moral principle. That is not really the reason why I just do not want anybody to know. And I think the public is going to examine that question. But then it is not all that profoundly important.

Another issue is a political one, that what we are doing is sometimes so magic that the public, including City Commissioners or directors of X, Y, or Z divisions may say to us, "We love your research and we would like to give you more money, but there are other priorities". Sometimes your dazzling graphics are going to have to be a blend of practical results.

I hope perhaps we can convince some of these agencies that have done so, to begin laying out the specifications for maybe something like the SPSS or BMD package for computer graphics for both large and small systems. I think its time has come. Now we have many people here--Wittick, Marble, Tomlinson, and others--who have really been pioneering in software exchange and documentation. But we need to pin them down and ourselves, and provide support to see that this ultimately gets established, mainly because duplication of software is getting frightfully expensive.

Well, I always have a tendency to go on and on if I let myself. But I really think this conference is going to be one of interchange. Five minutes more of my time remains. Use them for meditation or discussion. Thank you very much. (Applause).

MR. EDSON: It is always exciting and interesting to realize that, as Dr. Aangeenbrug pointed out, we have experienced two meetings that could be characterized as associated with anticipation. Indeed, we are looking forward to the emergence of reality in this conference and from here on. In order to better focus on that reality, I will turn the meeting over to Jim Chamberlain to introduce our next speaker.

MR. CHAMBERLAIN: It is a real pleasure for me to introduce to you our keynote speaker for this meeting, Mr. Rupert B. Southard, better known as Rupe to all of us here. Rupe is a close personal friend, and it is a real pleasure

for me to do this. He is a real friend also of all of us in the surveying and mapping profession. He has supported this meeting from the very outset, and is responsible for the Geological Survey being the co-sponsor of this meeting. There are a number of other things that I could say about Rupe that are not listed in the biographical sketch that is published. I do not know whether he would want me to say all this, but he is a singer of note, a piano player, an actor, and has a wonderful family. I know that it has been a real effort for him to be here with us at this meeting. He has come at considerable sacrifice to himself and his family, and we are deeply in his debt.

Rupe received his degree in Civil Engineering from Syracuse University, where he majored in photogrammetry. During World War II he served with the Marine Corps as an artillery officer, and in his second tour of duty in 1950 through 1952 he was a Survey Officer for the 10th Marines. Rupe began his Geological Survey career in topographic field surveys with our Atlantic Region in Arlington, Virginia. He transferred to our Washington staff in 1955, where he has progressed to positions of ever increasing responsibility. He was involved with the development of the orthophotoscope, which has contributed much to the revolution that is in progress now in our mapping operations, and the early applications of orthophotography. Following this, he directed the Topographic Division's international activities. In 1965 he became the Assistant Chief Topographic Engineer for Plans and Program Development. He has represented the Topographic Division at many international symposiums and meetings, and has authored numerous professional articles on a wide variety of subjects. He has received a number of awards, including the Department of the Interior Distinguished Service Award. He has been active in professional organizations, and in 1963 was Director of the National meeting in Washington, D.C. of the American Society of Photogrammetry and the American Congress on Surveying and Mapping.

In 1972 and 1973 Mr. Southard participated in the Office of Management and Budget Federal Mapping Task Force. He was the Department of the Interior representative. This task force did an intensive study of all the mapping operations in the Federal government. In 1970, Rupe was named as our Associate Chief Topographic Engineer, and presently he is our Acting Chief of the Topographic Division of the Geological Survey. Rupe, it is a real pleasure to have you here with us, and we are anxious to hear what you have to say.

MR. RUPERT B. SOUTHARD: Thank you. Jim, just a couple of comments about your introduction. You say I am a great friend of all of you in the surveying and mapping community. There are a couple of exceptions. (Laughter.) I notice they are not here today, though. Jim said I supported this meeting from its very inception. Actually, Dean Edson called me after having talked with Joel Morrison, and said that there is a strong request being made for GS to co-sponsor AUTO CARTO III. My recollection is that all I said was "Yes, go ahead." And that is the last time I had any connection with it until this moment.

It is a pleasure for me to be here to give the second keynote address. (Laughter.) I didn't understand a thing Dr. Aangeenbrug said, but I fully believe it -- (Laughter.) -- but I fully believe it, and I agree with all of it -- (Laughter.) -- and I am going to take advantage of some of the things he said to simplify my talk. It has been a very busy weekend for me. Over the weekend I was down at Fresno attending the convention on surveying and photogrammetry at California State there. I was so busy that I lost 50 pounds. That is, with the help of United Airlines. (Laughter.) They misplaced my suitcase, and rather grudgingly returned it to me just before I got here. So, I stand before you in this sartorial splendor courtesy of United Airlines and Fresno.

A few historical items of relevance -- at least I think they are relevant. Back in the early 1880's was a day when Nicephore Niepce pointed his camera out an attic window overlooking his sleepy little country estate in Lille, Eastern France. He hardly dreamed at that time that the result, the world's first photograph, would change the course of society. Niepce was a polite, modest man who preferred his country study to the brilliant salons of Paris. He worked with admirable persistence through 20 years of slow and groping progress before the final breakthrough came. In 1813 a craze for lithography swept over France. Nicephore, who could not draw -- he was an early cartographer -- (Laughter.) -- tried to find ways of copying designs on lithographic stones. He spent three years with various cameras of his own design, using stone, glass, metals and paper, from materials which he sensitized with various chemicals. In 1816 came a success of sorts. He produced weak negatives on paper treated with silver chloride.

The next progress came when he managed to reverse the tones and produce a photoengraving of a lithograph of

Pope Pius VII, which was a winner -- (Laughter.) He lent it to an excited cousin. It is not entirely clear to me -- This part was prepared for me -- It is not entirely clear to me what the cousin was excited about. (Laughter.) He showed it to a friend who promptly dropped it and smashed it. Then he wasn't excited any more; he was sore. (Laughter.) Then Niepce tried his first ever photograph of nature by aiming his camera out the attic window. Eight hours later he closed the camera shutter, and the world's first photo had been taken. The long exposure produced at least one strange effect, in that the sun seemed to be shining on both sides of the courtyard. We still get that a lot. (Laughter.) Except now, of course, with advancing technology it doesn't take eight hours; we can do it right on the spot.

But this very important breakthrough was not to earn a franc for Niepce. In 1829, four years before his death -- and he was in a very financially impecunious stage; he was broke, was what he was -- (Laughter.) -- he signed a contract to share his secret with Paris showman Louis Daguerre, who had dabbled in the field of cartography. And he was excited too. Daguerre saw the immense commercial possibilities of the camera, and it was he who adopted Niepce's original invention so that photography became practical as distinct from possible, and made all of this (indicating) possible. Updating further, June of 1874. Quotation from the June issue of Scientific American. "The French papers seriously discussed today transferring the work of the surveyor to the aeronaut. It has been found necessary to revise the real estate maps throughout France, and it is proposed that a balloonist should photograph each tract of land. This may be practical, since balloonists have already taken such photographs. The estimated expense, however, of three and a half million dollars, makes doing the work by surveyor cheaper."

A hundred-year update. In 1970 at the ASP Symposium on Computational Photogrammetry, our own Dean Edson, who is here and is Program Chairman for AUTO CARTO III, gave a paper suggesting that a digital topographic data bank be established with some rare, but forgivable understatement; he concluded that the total file size for the topographic data bank of the United States will be about three times ten to the 13th characters. To collect such a volume of data and store it in useful form, Dean said, a well thought out system must be developed if the topographic data bank is to be any economic and technical success. Except for the numbers, the point is well taken

today. I did not invent that wheel. Dean mentioned it.

In August, 1973 at the ICA meeting on automation, a new trend in cartography in Budapest, the opening address was given by a colleague, Dr. Sandor Rado, who was then chairman of the Hungarian National Committee of the ICA. He called attention to the growth in cartography of automation He pointed out that reason for automation in cartographic work -- and the American language is his, not mine -- "has these following manyfold purposes: rationalization of cartographic work; the updating of the map contents; the objectivation of the map compilation; the improvement of map's expressiveness; and the improvement of the labor condition of people doing cartographic work". There was not much mention in Dr. Rado's remarks of the value of the data itself rather than perhaps in map form.

Jim mentioned that I was a member of the Federal Task Force. He just knew I was going to quote something from the Report of the Federal Mapping Task Force -- didn't you? I'll give you a small segment from that report which is on the subject: "Eighteen federal agencies expended 37 and a half million dollars and 2500 man-years on cartography. This effort includes domestic cartographic compilation and map finishing, but not photographic processing. Most of the cartographic work is accomplished inhouse at numerous facilities throughout the country. The complexity of cartographic techniques varies considerably among the agencies. For example, the efforts of GS, NOS, Forest Service, Soil Conservation Service, Census, and TVA, amount to approximately $24 million, and are devoted to products distributed widely for multipurpose uses, whereas the remaining civilian agencies usually compile products for internal use, which in most cases have less demanding requirements for content and accuracy, and, as a matter of fact, accessibility. Generally, conventional manual methods of compilations and map finishing prevailed through the community." We also found that major agencies with cartographic capability are in the process of developing and implementing computer-assisted automated systems, although no complete system has emerged So far there has been no concerted effort to make these separately developed systems compatible with each other. Complicating the situation are fast-growing requirements to understand the proper relationships of points and areas to social, ecological and economic phenomena in any combination, and to present them in digital or hard copy form as required. The overall national effort to collect and store interrelated spatial data, therefore, can be

facilitated by implementing standard automated procedures based on knowledge and principles inherent in the cartographic process.

"We concluded that in aggressive implementation of computer-assisted techniques for digitizing and displaying spatial data the following advantages will accrue: Formation of a sufficiently large base to support fast growing requirements. Greater flexibility to manipulate and portray massive amounts of time-sensitive data through integrating incomplete existing systems; production of digitized information as well as standard hard copy products during one operation; reduced manpower per unit of output; and shortened map and chart production cycle." Remember, this was only about four years ago.

At AUTO CARTO I, when Bill Radlinski gave the keynote address, he called attention to three things. He wrung his hands about the extreme length of time it took to produce a standard topographic map, and quoted some figures which you may remember as taking a project-oriented map, that is, first to last map in a project, of 59 months. And he allowed that was pretty much too long, and that with advancing technology one of the things that must be accompliched is to reduce the time in which we can get that cartographic data into the hands of the user. Regarding cost effectiveness, he pointed out that not very many years ago people presented papers on the subject of automation, they pretty much avoided the cost effectiveness factor like the plague. I think they pretty much still do, but this is my keynote speech, and I am now talking about his. Today it is a different scene, he said. Equipment effectiveness is rising with ever increasing speed to the point where in spite of inflated hardware and software costs, new techniques can truly be competitive. Then he concludes that by continuing to use the new technology aggressively we can at least hold the line on costs, if not indeed reduce them somewhat. Considering the directives of cartographic data, digital cartographic data, Radlinski estimated that the average U.S. topo quad contains many million separate bits of information. That means more than the average map reader could absorb in a year's time, and the topographic sheets of many other countries, as Dr. Aangeenbrug pointed out, contain even more data.

While maps were extremely efficient devices for storing data, even more information together with positional coordinates can be stored in computers. A major advantage

(this is an important point, and it is very true and will continue to be true, and needs emphasizing) 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. At AUTO CARTO II, Bill Overstreet pointed out many of the same things, that it is a good thing we are about to investigate, and we needed to be on with it.

A recent article that I will call to your attention in the ACSM Bulletin for November of 1977 is by Bill Riordan, who is Deputy Director for Program, Production and Operations at the Defense Mapping Agency in Washington. Here are a few comments excerpted from that. "Over the past few years a basically manual graphic operation has been rapidly evolving into a mechanized digitized process. What is more, the combination of accelerating technology and aggressive government agency competition for limited resources is driving the community toward a full range of digitally-oriented production equipment. An outstanding example of this is the relatively new LANDSAT technology. LANDSAT-C, soon to be launched, will expand present digital collection capability and produce a lot of data.

"Doppler, along with its logical replacement, the Global Positioning System, will locate positions on the earth within inches -- and many other systems which could be named will lean ever more heavily on digital technology in the future.

"At the beginning of a vigorous and growing program, the Defense Mapping Agency (DMA) has now digitized elevation data over almost seven million square nautical miles of the earth's surface. At the same time, DMA has digitally encoded two and a half million square nautical miles of the earth's surface as far as cultural details such as roads, cities, waterways and so forth. Judging from today's requirements alone, terrain digitization and cultural digitization each will cover ultimately 18 million square nautical miles. A recent internal DMA study was made to forecast the size of the digital data base necessary to meet the needs of weapon systems of the future. It showed a potential requirement for a base composed of ten to the fifteen bits of information. To face these challenges we require more than equipment. We need imagination, we need concepts, and we need organization. It is not hard to foresee that the rising wave crest will

have an impact on civilian mapping agencies as well in the not too distant future."

Now, these observations are but a few. They clearly mark the inevitable development of computer-assisted cartography and systems related to it. The development is inevitable; successful development is not. Let us take a few examples of what is presently going on. I will talk to you about what is going on at the Geological Survey. There are people here from Geological Survey who will be taking an active part in the workshops and sessions this week who can tell you a great deal more and in greater detail. We recently conducted, with the help of the International
We recently conducted, with the help of the International Geographical Union, a searching study of spatial data handling techniques in the Geological Survey. I will point out to you later, from another source, something of the major findings of that study, which was highly enlightening and very helpful. Organizations like IGU, and in particular the Commission on geographic Data Sensing and Processing can be of great help for people to understand problems they may not even know they have yet. Dr. Roger Tomlinson, who is here, is connected with that effort. Roger has talked to me for several years, saying, "Rupert, you must exert some leadership in this area. Follow me." (Laughter.)

To some extent we are exerting leadership. In the Topographic Division (USGS) we have formed a Digital Applications Team in the Office of Research and Technical Standards. That office is headed by Roy Mullen, who is here (indicating). The Digital Applications Team is headed by Dr. Robert McEwen, who is also here. The team is set up with five or six people at the moment. The efforts that they are overseeing are connected with monitoring and setting in motion the research and development necessary for us to get into digital applications. It is, of course, important also for us to do some pilot projects in connection with that effort. Some of those pilot projects are being done with other federal agencies so that we will learn together about what is needed, what can practically be delivered, and what the costs, both in time and resources, may be. Elsewhere in the Geological Survey, the IGU found somewhere around 55 data base efforts going on -- not all big ones, some little ones, some rather specific ones. I will point out a few to you. Of course, one that is very close to our own work is the Land Use and Data Analysis project, involving land use

mapping and the digitization of land use and land cover data.

Our Geologic Division is heavily involved with the Coal Resource Data Base, which will require considerable support in digital cartographic data, digital terrain data, property ownership or jurisdictional data, as well as transportation and drainage. The Water Resources Division has considerable data bases, primarily point data for well locations as well as digitized boundaries of hydrologic units such as drainage basins. And on and on and on. As I said, 50 to 55. It is quite possible that as we now are more aware of what others are doing in the Geological Survey, that some of those data bases can be organized in a more efficient and effective way. It may also be that some of them would be better left separate.

Other data system activities in the Geological Survey are: Conservation Division is into digital activities in the coal lease reserve. Royalty accounting is being done, digitally. In the Geologic Division they are also doing Oil and Gas field data digitally as well as Earthquake/ Strong Motion Studies. In the Topographic Division work is being done on development of a national digital cartographic data base. Topo is doing, in connection with other federal agencies, an Aerial Photography Summary Record system, which shows both where photography is being flown, has been flown and is about to be flown. We are going into digitized geographic name information as well. Those are just a few examples of the kinds of things that are going on. We are going to be a great deal more heavily involved in spatial data activity, not because we know so much about it, but because we need to know much more. And we feel sure that within ten years we will be primarily digital. Our production system, our operation system and the data that we deal with will be primarily digital, we believe. That is not to say that printed maps will be discontinued, because they won't. People will always want them. They freeze data in time, and they will always be a useful record for that time.

But the requirements for data these days, of course, are voluminous. They have tremendous appetites for data. The more you give the more you have to give. I should mention this: Our priorities for the data we are presently considering digitizing are civil boundaries, rectangular survey systems, surface hydrography, terrain surface and transportation. Those are our primary data categories at the present. The secondary ones are geographic

names, manmade structures, woodland, orchards and so forth, and non-vegetated features.

Dr. Aangeenbrug did a better job than I believe I was prepared to do to mention some of the problem areas that need to be not just looked at, not just talked about, but addressed. You will be talking about those problem areas this week, but the list that I would have is exactly the same as the list he would have. We have to deal with digitizing problems.

An estimate that was done by the IGU for what it might take the Geological Survey to digitize all these quadrangle maps of the United States, (which will ultimately number 56,000 at the 1:24000 scale) an estimate ranging from 400 million to 500 million dollars' worth of activity. That is a lot of digitizing. Before we produce that much digitizing we need to be sure people want it that way. So we are going a little slow. We have been criticized for going so slow on getting the right kind of an answer to that problem. One can clearly see that the maximum payoff in putting computer-assisted cartography to work will result only from a carefully planned approach to design of a data system to serve both short-term and long-term requirements of an array of users that we may not even know about yet. That array of users will have a further array of both comprehension and sophistication in either the way they could handle data or the way they would be willing to handle data.

A number of relevant remarks on the subject were offered by Dr. Hugh Calkins, who is with the Geography Department at the State University of New York at Buffalo. In a contribution to the Proceedings of the IGU Commission I mentioned earlier, the Commission on Geographical Data Sensing and Processing in Moscow two years ago, in a paper titled "Information Systems Developed in North America," Hugh cited five important lessons to be learned from the North American experience. I think these apply just about everywhere. "Almost all of North American geographic systems (Hugh said) have been developed in response to specific problems or needs. Consequently, there is no, or little, compatability between systems. Each project is started and proceeded independently, and it is almost impossible to move a system to a new location and use it in solving different problems. Five specific points are discussed below as critical to the future of geographic information system development. There is no clear concept of what constitutes a full geographic information

system. The term is used to cover activities such as the Canada geographic information system at one extreme, to simple plotting programs or subroutines at the other. Some standardized concepts of geographic information systems are obviously needed. Two: The format of data before encoding is significant. Well prepared graphic documents, maps, can in fact mean the difference between success and failure. Digitizing is currently the most difficult task to complete. Three: The volume of spatial data is also very significant. This has often been underestimated, and has led to excessive costs or outright failure. Four: The resulting utility of geographic information systems has frequently been reduced by decisions made when the data are encoded. Substantial loss of information such as systems based on a large grid cell cannot be tolerated by all users. Five: The non-technical problems, essentially the management of the system, are equal to or greater than the technical problems.

Sooner than we think, sooner than we guess, virtually all spatial data will be computerized. In most cases the data will be collected and accessed in response to the immediate needs of the primary user. Great care must therefore be taken that secondary and tertiary requirements be considered to the maximum extent possible for effective multiple use of the data. Growth must be planned, not allowed to happen accidentally. Agencies handling large amounts of data must increasingly make known what that data is and how it can be gotten and used. Education of all, but most particularly managers, is a crying need." In that connection, the work that I have mentioned of the IGU Commission on Geographic Data Sensing and Processing can be very helpful. There is excellent work going on at a number of universities, including Kansas and Harvard, the State University of New York at Buffalo, the University of California at Santa Barbara, Wisconsin, and many others. We must take advantage of that work that is going on, and we must talk to each other about what we have learned.

I think symposia like this one are extremely useful in that educational process. The education will need to continue because the rate of change in that technology is at a break neck pace already, so you cannot turn your head for even a moment. An important point from my own personal observation: Professional societies like ACSM, ASP, IGU, ICA, ISP, and FIG, and others, will need to begin working together for examination of problem areas, as the input of many disciplines will be required for most effective solutions. The whole payoff for this is much too import-

ant to let it fall apart over turf battles.

The government agencies, federal agencies, must continue to take an active role rather largely because of the extreme cost of some R & D efforts. If R & D is to be done, it has to be paid for, and the government agencies can make that contribution. While they are making that contribution their work should not be kept secret. It would be much more to the point to sing it from the house tops, even if the research has failed. Sometimes that is more useful than reporting successes, and there is a lot more of it. (Laughter.)

The challenge is an exciting one. Not for a long, long time and maybe never again will cartographers, geographers, surveyors, photogrammetrists, mathematicians, computer scientists, have a rich and rare opportunity like this one to make a real contribution to mankind's wise progress. I would like to give my congratulations to the organizers of this symposium for holding this symposium in sun-drenched California. (Laughter.) The program looks like a very good one. The people that are on the program as speakers and moderators are the best or among the best in the business. I wish you luck. Thank you. (Applause.)