ECONOMIC REQUIREMENTS

MR. DEAN EDSON: The first afternoon session of AUTO CARTO III is now convened, and the first panel session of this afternoon will be on the Economic Requirements. This is an important aspect that we felt should be covered and should be addressed honestly and openly. I think we have a panel that will give us some real insight as to the problems associated with justifying a lot of the things that we are either doing or thinking about doing. To head up this very important panel we have Jon Leverenz, who is currently the General Manager of Cartographic Creative of Rand McNally, Chicago, and, being in the private sector, is very concerned about the economic impact of the kinds of things that are being implemented because, obviously, a commercial firm has to make a profit, and unless you can get hardware and software systems working for you in a profitable way it does not make any real sense. It is certainly a pleasure to again introduce Mr. Leverenz, who, I will remind you, is the President-Elect of ACSM, and will introduce the subject and his panel. Jon?

MR. JON M. LEVERENZ: Good afternoon and greetings again. Thanks a lot, Dean. The Economic Requirements Panel was assembled, and the personnel were chosen to bring us information on the economics of computer-assisted cartography from a number of varied segments of the mapping community. Roy Mullen is from a federal civil agency, United States Geological Survey, and he will talk on economics of digital mapping from the United States Geological Survey's perspective. Dr. Joel Morrison, from the academic community, University of Wisconsin, will talk on a university's special automated cartography requirements and economic considerations. Fred Hufnagel, from a federal military agency, DMAAC, will discuss DMAAC's advanced cartographic system.

As Dean said, I am from a part, only a part of the private industry segment in cartography. I will start talking about the economic requirements by discussing the considerations, some of the considerations of a commercial map firm on the threshold of automation. In talking about a commercial firm on the threshold of automation, my thoughts are going to center basically around the more important considerations that a mapping firm would have to make. Possibly, the title "brink" of automation, rather than "threshold" may be more appropriate, because it connotes a greater risk, and that is usually how the financial management of a firm usually thinks of automation, as quite a risk. But I did settle on "threshold," thinking that it was the doorway to something new, or hoping that it will be the doorway to something new.

The cartography firm of which I speak is concerned with the preparation of maps that are based upon a variety of information obtained from diverse sources, such as existing maps, census data and other statistical data that is being mapped. The operations run the gamut of cartographic operations such as the gathering, interpreting and selecting of data, the geographic research and editing, the compilation of the manuscript map, and the final construction of the various kinds of art work needed to produce multiple copies of the maps.

I will briefly run through these slides to attempt to illustrate some of the operations and some of the materials that are used in map making. (Slide 1) This is the gathering of information and the original manual compilation of the material, the type of detail that is found in such an operation for a land use map at a very small scale. (Slide 2&3) This is the scribe line work, showing the detail again, and a peel coat, which gives you an idea of the intricacy of the open windows to produce a published map of this sort. (Slide 4) The relief and type -- the type is sparse, but this is the relief rendering, giving you an idea of some of the techniques that are needed and must be considered in making a map. (Slide 5) These are the final positives that are used to make the plates which are then used to print the multiple copies. (Slide 6) This is the finished map that is usually produced by one of these firms.

I want to focus the examination even more and make sure that we all understand the type of commercial enterprise that I am talking about. It is really a segment of the community which encompasses those companies that manufacture cartographic products, the sales of which yield a sufficient monetary return on their total investment to enable them to stay in business and to continue to re-invest in product development and production facilities. This cartographic firm is, therefore, quite distinct from non-profit institutional cartography, government cartography, as well as those surveying firms or other industrial and commercial companies where the mapping activities produce products for internal use only or for a few specific technical users.

The basic difference really in all of these is in the profit motive and in the mass market, which, in the long run, determines what will be produced. For if the market accepts the product and buys it, this will enable the return to create that product, will enable a return to cover other expenses as well as the cost of capital investment for that product. The converse is true: If they do not buy it, the profit is not made and it cannot be reinvested, and therefore, eventually the company will not find itself in business. I emphasize market and profit, even though they appear to be rather elementary, because they are the most fundamental considerations when a firm is on the threshold of automation or when it is on the threshold for any investment, for that matter. These commercial firms of which I speak, by and large will produce travel aids such as road maps and street maps. This is just the type of map that I am sure you are most familiar with. (Slide 7) Other examples are globes, and general reference maps for atlases of the world. (Slide 8) These are usually the products that the firms I am talking about produce.

Now, aside from these complexly produced esthetic products, the general market has really rarely shown a great need for the rather unesthetic computer-drawn maps showing specialized distributions. What small market there is for such automated products has usually been satisfied by certain companies' internal map production operation or by an academic or a government source.

Another aspect of the commercial map makers' considerations is that generally its products have the following range and scales. A.) The first scale range is 1:30,000 to 1:50,000 for street maps. B.) The second scale range is 1:300,000 to 1:2,000,000 scale for individual state road maps and atlasas. C.) The third category is the 1:1,000,000 scale to 1:10,000,000 scale for world general reference maps and atlases. Those particular scales and sizes are partly dictated by the size of the printing and manufacturing equipment that can effectively and efficiently produce multiple copies of maps. The mass market also influences the scale for it will spend money for only a limited number of maps and/or a limited size of atlas. So, those two things very much help to determine the map scale and the size of any particular product.

What these two aspects mean to a firm is that when it considers automation, it must consider the type and amount of information it needs in relation to the purpose of the map, which is partly dictated by the market and the detail of information in relation to the scale of the map, which is partly dictated by the manufacturing equipment. These are very important considerations.

Although data banks produced by some government agencies are available to the commercial firm, they usually are too detailed, containing much non-essential information, and they are not structured to the commercial needs. I think this is understandable, but what it does mean is that the firm must consider the fact that it must totally underwrite the cost of developing a file structure and a data base suited to its own needs, both in structure, information, detail and the efficiency of the retrievability of data. The firm is not going to get a tremendous amount of help from the government agencies.
Another characteristic of the commercial firm that must be considered when contemplating automation is its map-film library. The size of the map-film library varies, but it generally contains 25-50 pieces of film elements for each map produced. The elements carry the

scribed lines (see Slide 2), the area open windows which are utilized to print the area tints (Slide 3), and the type and the final plate making positives (Slides 4 and 5). These elements and positives are for a rather complex map, but serves to show the amount of information embodied in a map-film library and indicates the large investment in film.

The number of map elements (sheets of film) also serve as a graphic data base. It would seem that with such a source of separated and classed data that it would be a logical decision to utilize it as a source for digitization. But, on the contrary, these elements are in such condition that they may be updated and redesigned by manual methods, and reasonable size changes may be photomechanically produced at low cost. Actually, the availability of such a map film library raises this question: Is it necessary to invest -- and this is to the people making decisions as to where to invest corporation money -- is it necessary to invest dollars in computer equipment and programs to convert the graphic data base now in element form to digital form only so that it may be plotted in its original graphic form or similar to its original graphic form? This is a basic question. The map film library, therefore, and its value, makes it less likely that the firm will invest in the automated cartography field.

You will recall that the mass market we are serving does not call for great numbers of new maps. I want to emphasize that. Therefore, the commercial firm's work consists of about 20 percent new map work a year and about 80 percent revision of existing map elements. For instance, in the last 30 years in the United States, there have only been about six major completely new commercial world reference map series produced in the United States, only about five series of new state road maps, and only about four new road atlas map series. These are the large series of maps that appeal to the general market that I am talking about which this commercial segment must service.

There have been hundreds of street map titles that have been produced, but once they are produced, the elements are relatively easily updated by manual methods.

So, given these considerations and these factors: 1.) a mass market that supports relatively few well defined map products and does not support frequent new map programs; 2.) an industry with considerable investment in relatively easily revised map elements; 3.) an automated technology and data that has been developed by government agencies and that has had little direct application to commercial needs, and 4.) an ever-changing technology where the emphasis has been upon large expenditures of funds on experimentation with methodology rather than on refining economically sound production facilities; I believe one can understand the firm's less than enthusiastic endorsement of automation.

I have presented the foregoing just to establish a basic understanding of the commercial motive, its market environment, and its complex map making system, and how these factors help shape its general attitude toward automation.

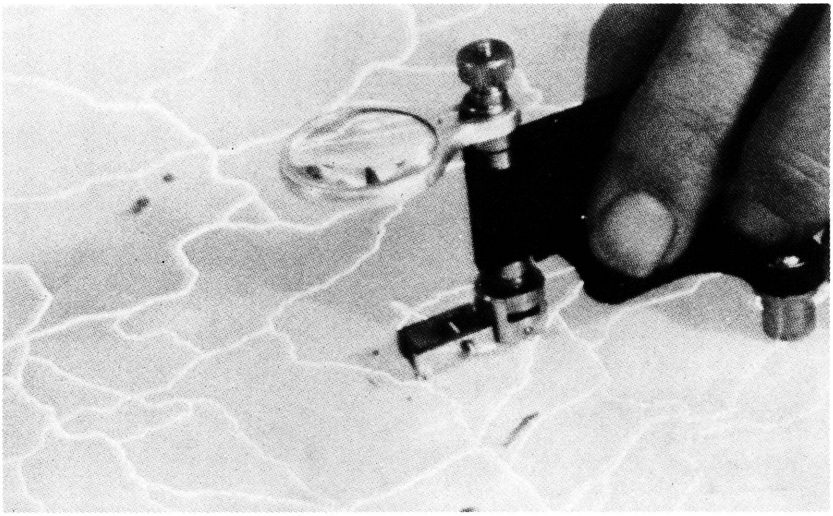
In the following few slides, I have set up a model used to compare the manual map-making operation to the automated assist operation in order to arrive at the cost benefit and the economic justification of an automated assistance system. This model may be used by the firm once it overcomes the preliminaries and recognizes some of the automation may be a potential investment. For these slides, unit values and percentages have been used to show the relationship between the automated assist and manual method of map making. This comparison that I am going to make assumes both manual and the automated assist starting from scratch to build a map series. It does not consider, unfortunately, the amount of time and money to develop preliminary data file structures and so on. Slide 9 shows the map making operations and the percent of time in each operation necessary to produce a large scale map of a state. Only the operations that have been proven to work in an automated production situation are considered for this model.

On review, over a long period of time, I feel that efforts in automation have produced operational production systems which have made the automated scribing of lines, the flashing of symbols, and some dye-strip, the blockout work commercially feasible. I feel that efforts in the automation of the stickup of names have not been successful, and, as far as I can see, no operational production system exists that is commercially feasible. Another area that automation has aided has been in reducing the amount of checking necessary by making the checks more efficient and thorough than the manual operation. If you look at Slide 9 you will see that the automatable operations amount to about 30 percent of the time of the total task.

Another fact that we can derive from this chart is that the automated operation decreased the work load in the production area of map making, and less so in the compilation area. Because the production is a lower rate operation, the cost benefits are not as great as 30 percent displacement in time might indicate, because it displaces it into a higher wage-rate area.

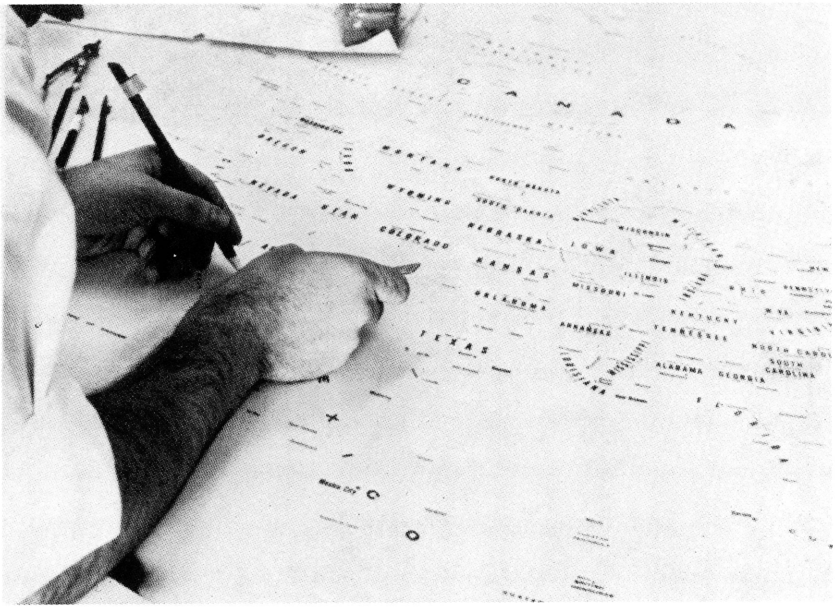
Slide 10 shows the manual compared to the automated assist method if we assume that there would be two plots from one set of input information. Based upon a review of our particular manpower at Rand

Slide 1

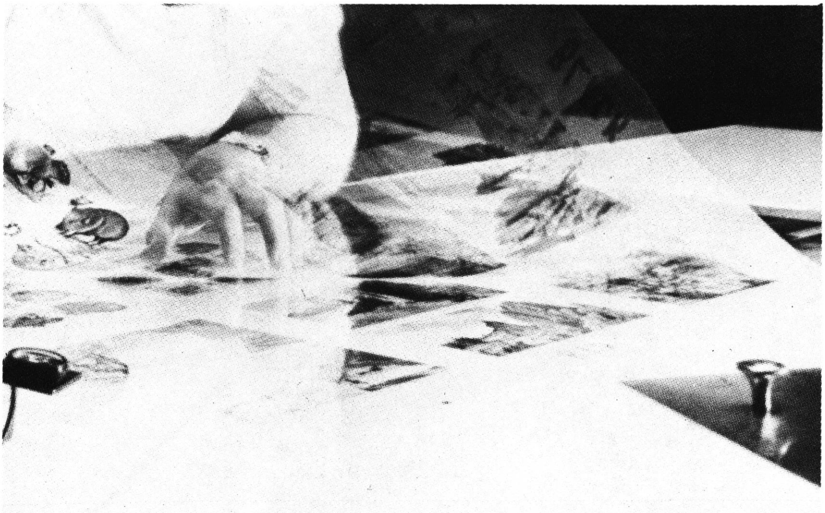


Slide 2

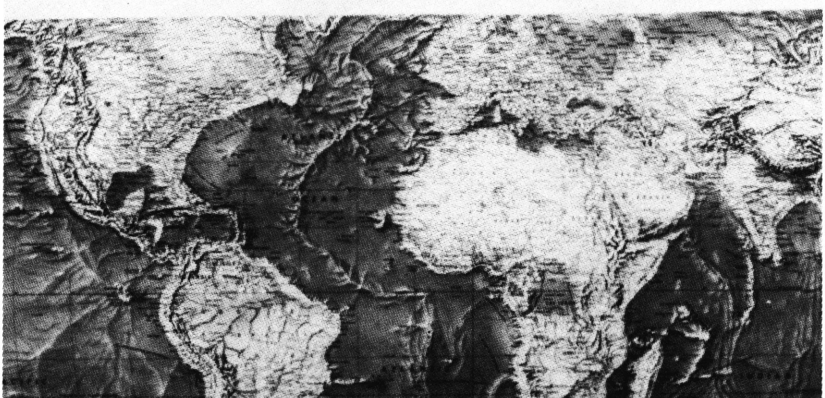
Slide 3



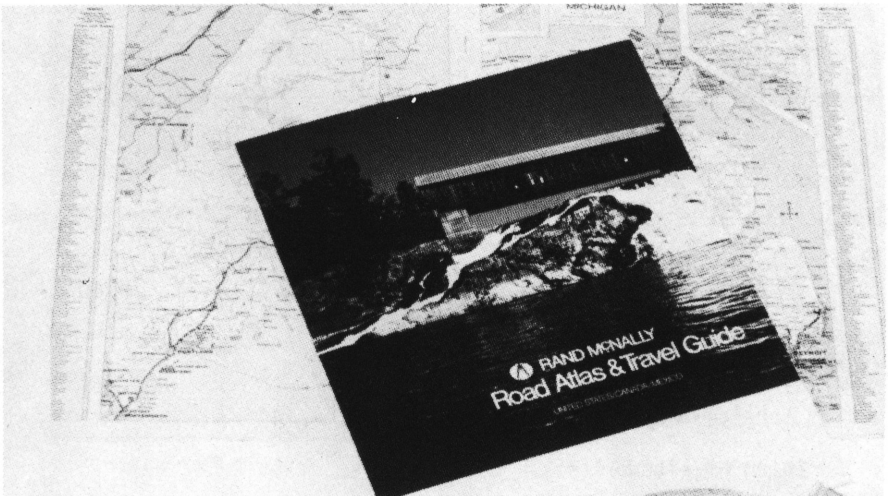
Slide 4



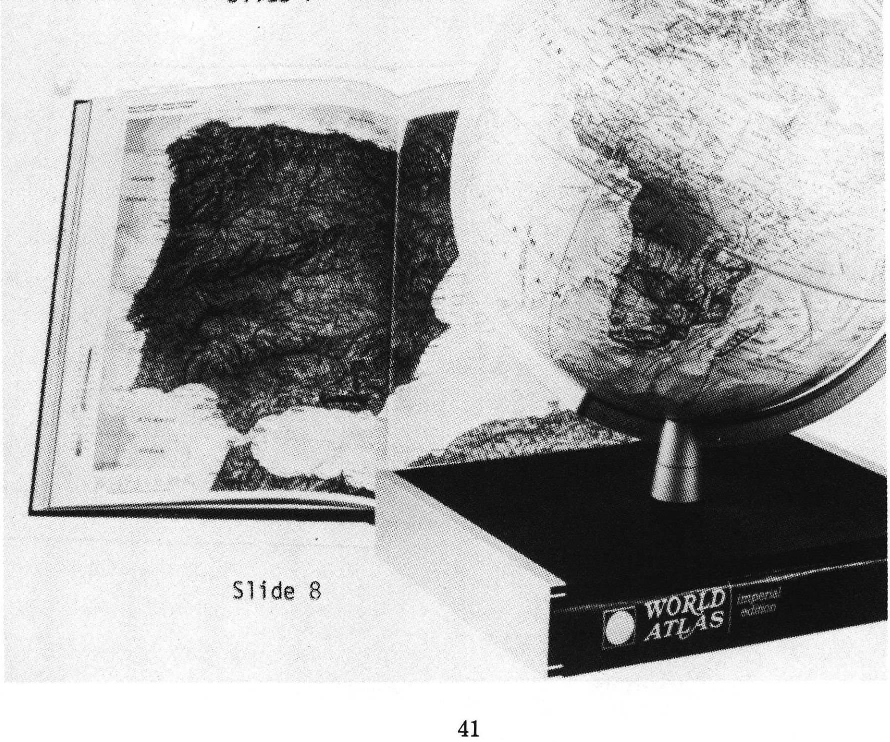
Slide 5



Slide 6



Slide 7



Slide 8

MANUAL MAP-MAKING OPERATIONS (Slide 9)

COMPILATION & RESEARCH	PERCENT OF LABOR	PERCENT OF COSTS
Planning; research; linework, area place, type compilation; and editing	33%	40%
PRODUCTION (FINAL DRAFTING)		
Scribing; stickup of type; area tints; contact and checking.	67%	60%

Proven automatable operations of line-plotting and symbol flashing eliminates:

1.	Some preliminary contacting =	4%
2.	Scribing of linework =	20%
3.	Point stick-up =	6%

TOTAL POTENTIAL TIME SAVINGS WITH AUTO ASSIST =30%

RATIO OF AUTO-ASSIST TO MANUAL ASSUMING TWO PLOTS FROM STORED INFORMATION*
(Slide 10)

	MANUAL	AUTO-ASSIST (1st Plot)	AUTO-ASSIST (2nd Plot)
COMPILATION & RESEARCH			
Planning to Editorial	.39	.35	.06
PRODUCTION & CONTACT			
Organization to final positives	.77	.44	.44
DIGITIZATION & PLOTTING			
Manual digitizing	---	.05	---
Point coding	---	.02	.02
Line coding	---	.10	.02
Editing	---	.02	.02
Plotting	---	.02	.02
TOTALS	1.16	1.00	.58

*The unit value is assigned to the total of the automated assist. All other values relate to it.

McNally, and physical plant, and because 30 percent automation had to be integrated with the total map making effort, it was determined that we could support three manual digitizing stations, two shifts on 240-day year to turn out roughly 25 maps per year all the way from compilation to digitization to plotting and production.

Slide 11 shows the arithmetic to arrive at the cost benefit of automation on a per map basis for one plot. This compares the cash flow between the manual and the automated assist operation, as I said. The operations and the percentages indicated in the charts that I just showed were used along with approximate wage rates and approximate equipment costs.

If we take a five-year amortization of the equipment costs we can arrive at an equipment cost per year.

Slide 10 shows the arithmetic. As I say, we are using 25 maps a year as a yearly output, as I mentioned, and we arrive at 5% less out-of-pocket wage, material and equipment cost per map for the automated assist

Because these figures are actually expense items in determining the corporate income taxes, as many of you may know, they may be deducted from the amount of income the corporation makes and thus reduce the taxable income and the outflow of cash. Because the tax rate is about 50 percent, it means that, in effect, only one-half of this expense is actually deducted, which allows a new savings of only 3% for automation over the manual method. At this particular stage in the cash flow, the savings because of automation is really slight. However, the effect of purchasing equipment is where the large savings of cash is found.

The depreciation of equipment is also an expense item, as you know, and it becomes a credit item, and in effect allows less cash to leave the corporation. So, therefore, the net result is an out of pocket cash flow of 23% less for the automated assist method.

Naturally, the digitizing process and the computer storage would be structured so that it would build a data bank from which maps of varying scales, sizes, and coverage could be recalled and plotted, as I mentioned. It is here, of course, that the real benefit accrues to automation, but, of course, only if the market, as I mentioned, indicates that there is a need for another series of maps. Now, on this particular model I have assumed the ratios on Slide 10 for a second plot, and the savings is 38% more per map for automated over manual. It should be interjected here that no leasing arrangement would enable a sufficient savings for the automated assist method, mainly because leased equipment really cannot be depreciated by the firm and therefore no cash savings can be derived.

CASH FLOW COMPARISON BETWEEN MANUAL AND AUTOMATED ASSIST ON A PER-MAP BASIS (Slide 11)

MANUAL Cost/map		AUTOMATED ASSIST Cost/year	AUTOMATED ASSIST Cost/map
1.00 =	Total wage & materials/map		.67
	Total automated equipment cost: 25.71 5 years =	5.14	
	Total maintenance, rent, power, tax, etc.	1.89	
	Total/year equipment, maintenance cost	7.03	
	Approximately 25 maps/year: 7.03 25 =		.28
1.00	Total expense/map		.95
.50	Corporate Income Tax (50%)		.47
.50	Out of Pocket Expense w/o depreciation		.47
---	Depreciation of Equipment/map 5.1 25 maps)		.20
.50	Total out of pocket expense/map		.27

Approximate Net Savings/Map = .23

Slide 12 is the final slide. It shows that with a total equipment investment of a unit value 1.00, and a savings per map that I just determined, and assuming that the market will demand two 50-map series in a four-year period, a four-year payback results which, according to many firms, is a reasonable payback period. So, you are paying back your equipment costs essentially in 3.3 to 4 years. It would appear, therefore, that the cost benefit model indicates the investment to be sensible if the assumptions about the market are true. I do want you to recall that this example did not discuss the money necessary to set up a file system and a structure for the data bank, and that would be one of the final considerations and probably a large number of dollars. It would appear that with the facts that are accumulating concerning cartographic automation, the value of the data bank itself will be positive and will probably exceed the value of the investment to develop the initial file structure and the first series of maps. It is also evident that once the initial series has been produced, there would be a savings in revision, especially at the compilation and research stage. For instance, one entry in the data bank would enable revision, at the appropriate time, of all the map series.

More consistency and accuracy is another positive advantage of an automated plot. These, however, are what I call intangibles, and become tangible only after the data bank has been developed. There are other final considerations before a decision can be made such as, how fast will the equipment become obsolete? Will the positive tangibles of re-use offset the fact that a large deal of money must be expended to deliver and develop a file structure? Then, finally, can the company get a safer and/or larger return on its investment in some other venture? This is always the trade-off.

To summarize and conclude. 1.) The general market requires or demands a relatively few types of maps in large enough quantities to make automation economically feasible to be used in their production. 2.) The cartographic industry that I speak about has a large investment in a film library capable of easily updating to satisfy almost all of the general market needs. 3.) Relatively few operations of the map making process have been really proven to be automatable on a production line basis, approximately 30 percent of the total time. 4.) Relatively little technology is directly transferable from government to industry at this time. 5.) Once the market indicates a great enough need for a new map series, the equipment investment and depreciation makes it a viable investment or so it would appear from the model we had here. (But there still are the unanswered questions of development costs of a file structure and data retrieval systems, and how that will affect the economic decision to automate.) and 6.) How can one really get a measurement on the intangibles of new markets for map products, and re-use of data base material? How can we get a better idea of the economics of this so that we can plug them into the model and get the effects they will have on the investment payback model? Thank you.

Slide 12

TOTAL EQUIPMENT INVESTMENT		1.00

PAYBACK

1. Varies: but assume minimum return is 30% pre-tax return per annum on investment. Therefore, payback should be about 3.5 years

2. Assume two 50 map series over four years.

23% out-of-pocket savings per map on first series of 50 maps	=	.44
38% out-of-pocket savings per map on first series of 50 maps	=	.74
TOTAL PAYBACK IN ABOUT FOUR YEARS	=	1.18

The second person to speak is Roy Mullen. I think many of you know him. He has had 25 years of experience with the United States Geological Survey, and at the present time he is the Chief of the Office of Research and Technical Standards at the United States Geological Survey in Washington, in the Topo Division. He is going to talk about the economics of digitizing from the USGS perspective.

MR. ROY MULLEN: Thank you, Jon. Good afternoon. If Rupe Southard is here I want to say just one thing about that introduction. After the one he got this morning I want to point out that the importance of the job is not directly in proportion to the length of the introduction that you received. I want Rupe to be sure to understand that. (Laughter.) I would also like to say one other thing about that short introduction. I liked it, but I would like to add one thing: There was another highlight in my career, and I do not say that just because I am back here in San Francisco. From 1972 to 1976 I had the opportunity to head the West Coast operation of the Geological Survey's Topographic Division, and I still consider that to be a highlight in my career. There is one other thing I would like to say--If Vern Cartwright is present, and if Vern Cartwright is not present he should have been observant enough this morning to have noticed when he asked how many people were from out of town--I could have told him who all the Californians were, because they all had mildewed shoes. (Laughter.)

I would like to say something about the economic requirements for digitizing in the Geological Survey. I could have, in trying to find a title for the speech, or presentation--it is not a speech; Jon very carefully informed us that we all had 12 minutes. I do not know exactly what that meant after I heard his presentation. (Laughter.) But I would like to say that I want you to listen very carefully, because the amount of money that the Geological Survey--and I should refine that--the Topographic Division of Geological Survey, which are the programs I am going to be speaking about, for the amount of money we spent on digital activities and plan to spend in this fiscal year, you are hearing, in 12 minutes, about $333,333 worth of information per minute. So don't turn your head and don't blink your eyes or anything else, because you will miss about a third of a million dollars' worth. The question arises, can you afford to digitize? There are two paradoxial questions: Can you afford to digitize? And the answer is probably no. The reverse of that is, can you afford not to digitize? And, unfortunately, the answer to that is also no. So that is the kind of position you are in. We do not think we can afford not to digitize map information. We are also, of course, in a position, and I think that position has been stated, and Jon referred to it himself: We do not have the philosophy to digitize to produce another graphic. We do not believe that that is a cost effective way to go. We firmly believe that the collection of the digital data and the management uses of that information after it has been collected are far more important than going through the process of producing digital information so that we can produce some more graphic map products.

The size of the task facing the Topographic Division of the Geological Survey was referred to somewhat by Rupe Southard this morning.

We have about 55,000 plus 1:24,000-scale maps, and I might say that we have adopted the 1:24,000-scale map series as the largest scale map that we should begin collecting digital data for. It also has about the amount of resolution that we think the mapping community, the users of this information, need at the present time. This presents us with a couple of problems. Fifty-five thousand plus 7 1/2-minutes quadrangles; about 40,000 of those are already in existence as graphic products. So how do you go about the process of digitizing those some 40,000 maps that already exist? We are already in the process of producing those other 15 to 17,000 maps. The question arises: Should we begin collecting digital information now at the map compilation stage to produce those maps? The jury is still out on that question. We do not have the answer to that question yet. But I will say this, that we are not doing very much of that kind of thing--that is, digitizing straight from the stereo model.

We have concluded several things about digitizing. As I say, can we afford not to? We have concluded that enough demand exists now for digitizing cartographic information, and are thus devising what we are calling a multipurpose cartographic data base.

We feel it is our responsibility under the National Mapping Program to be the base data collection agency for the federal government. We also feel that producing graphics, cartographic map products like we do in the Geological Survey, to turn over to another federal agency like the Forest Service, who is interested in terrain information, the Bureau of Land Management, who is interested in the land net on the maps, the Water Resources Division, who is interested in the hydrologic units and the hydrology on the maps--we feel that producing those graphics to turn over to them to digitize is not the proper way to go either. Consequently, we are looking at addressing the digitizing problem from those objectives. Our objective is to devise, design, and implement within the federal government the multipurpose digital cartographic data base. How easy that is to say and how difficult that is to do. Because I know there are many of you in the audience who have had some experiences in trying to do these things, and you know how difficult it is.

I might also say that we are taking an approach which somewhat parallels the suggestion made this morning by the good doctor from Kansas who suggested that research not stop. We are doing research at the same time we are doing production work, and we intend to keep it that way and probably not only intend but will have to keep it that way for probably the next several years.

The enormity of the collection task, plus the cost of the task, is staggering. The cost of the task for digitizing the 1:24,000-scale cartographic data base for the United States was estimated by the people who produced the IGU study; it being on the low side from about 60 cents per line inch to $4 per line inch. If we take those figures and apply them to the numbers of inches of line information on the maps, the figures do become staggering--for contours alone, from $141 million to $938 million. The study does point out that these figures are not accurate, that they do not have sufficient data to support those numbers. After reading the report and trying to come up with some numbers from that, extrapolating numbers from that, I assumed, okay, we will average the low to the high, but the number still comes out to be somewhere in the neighborhood of about $500 million. At the risk of giving away company secrets, that is more than we have spent in producing the entire topographic map series for the Geological Survey for the past 25 years.

Also another factor that might be of interest is the fact that while those figures, as I say, did not have any data to support them, we do have some recent figures on a recent digitizing contract that we let. We are doing some digitizing outside the Geological Survey as well as inside, and some interesting numbers come from that. One of the proposers said they could do the work for about 20 cents per inch, which is one-third of the cost used in the IGU report. The highest proposer on that particular request for proposal was $2.20 per inch, more than ten times as much. But some other interesting figures come back in there. The coding, for instance; the proposer who could do the linear digitizing for 20 cents an inch also required 75 cents an inch to code that data. When you consider those two figures together: comparing a company who proposed to produce digital line information at about $1.20 an inch and code it for 15 cents an inch and the company that was going to produce it for 20 cents an inch and code it for 75 cents an inch, it would cost almost $6,000 less to pay $1.20 an inch than it does to pay 20 cents an inch, so that is kind of an interesting little sidelight there.

FROM THE FLOOR: You said $2.20 earlier. MR. MULLEN: What I said was the highest proposer was $2.20. It was not the highest proposer who came in with the lowest bid. One dollar 20 cents an inch is from the proposer who happened to come in with the lowest bid but had a very high cost per inch but a low cost to code that data per inch.

We suggest in the Geological Survey that there are many, many problem areas, and there need to be some important decisions made as soon as possible on the data base design, on developing a true multipurpose data base, on hardware to support such a selection task, and on the software programs in support of the collection, storage, and then support in the dissemination of the volumes of cartographic data that will be developed in this country in the next few decades.

Now what must be done, or should I say, what must we do? And that is not a self-serving statement. We, the people in this room, who are here obviously because we are interested in the development of digital data bases, we think that before any economies can be truly realized, we think that there are these three areas--and there are many others--but these three areas where we need to do some further work. We, the Geological Survey, are involved. I know that the DMA is involved, and I know others are involved also. One, we must truly solve the raster to vector conversion problem. Two, we must be able to tag and code data without requiring labor intensive interactive intervention. We must, say, get after the industry to develop mass storage devices. Another area which I mentioned, the on-line versus the automatic scanning, comes into consideration when we are talking about the development of digital cartographic data bases. There is another factor that we could perhaps consider, and that is the fact that if we have truly automatic digitizing systems, we would not necessarily have to develop that total national cartographic data base at the present time, but do what I would call on-demand digitizing; when someone asks for a certain graphic to be digitized, be able to produce that digital information in a very short period of time. We think that is an area that needs some development work, and I think it is an area where perhaps a philosophy ought to be developed as to how we approach digitizing from that aspect.

I have not addressed the economics of manual or free cursor digitizing versus automatic scanning of line data. The procedures followed to produce the cartographic information are labor intensive, but in spite of that we believe there are certain cartographic information data which may almost always best be digitized manually, not necessarily total automation of the entire process. We are going at developing digitizing capability in that way also. One best guess is that a four- to five-year time span lies ahead before we realize any economies or many economies in the digitizing process. We do not, if you will permit a pun, we do not believe that we can wait to buy in that far down the digital stream. Thank you for listening. (Applause.)

MR. LEVERENZ: Thank you, Roy.

The next speaker is Dr. Joel Morrison, who is the Chairman of the Department of Geography at the University of Wisconsin. Joel is going to speak today on a university's special automated cartography requirements and economic considerations.

DR. JOEL MORRISON: This will be quite a change of pace, I think, from the two speakers we have just heard. There are special economic considerations which a computer-assisted cartography instructional program faces in a university setting. In order to talk to you about these, I would first like to describe the basic characteristics and constraints that mold any computer-assisted cartography instructional program within a university setting. I will then describe three possible stages of capabilities that a university cartographic program could aspire to, and, finally, I will detail our experience at the University of Wisconsin, Madison, in developing our computer-assisted cartography program.

An initial word about economics is in order. As everyone is aware, there is a tremendous cost squeeze in most universities today. I will cite what I believe to be two principal contributory factors: First, a university is heavily invested in human resources, not material or machine resources, and as we all know, the cost of labor has risen drastically recently. Secondly, bureaucratic paper shuffling is consuming an inordinate amount of these university human resources.

Other industries may not be as heavily invested in personnel relative to materials and machines as is a university. And although the cost of human resources in a university has not risen as rapidly as the cost of human resources in the federal government in the past five years, the rise in cost has still been drastic. The second reason is the tremendous waste of the university's human resources that is being forced upon it under the guise of "accountability." These rules are especially prevalent in public universities such as my own, which must answer to both the federal and a state government. A lion's share of the blame, though, must be placed with the federal government. A sizable bureauracy is now a necessity at each institution to merely answer the numerous federally required reports. Much of this is to demonstrate that the university is not discriminating against people on the basis of sex, race or creed, while another large chunk of the reporting concerns the economics of the use of the monies within the institution. These two areas of report answering alone probably ensure that we at the university do discriminate against both instruction and research, the two items that should be our primary aims at the university. However, I will leave my pet peeves for a moment. In summary, let me say that a university does not have a lot of unencumbered money lying around, and I want you to keep that fact in mind as I continue.

It is simply out of the question within the university's budget with which I am familiar to purchase at one time all of the capital equipment necessary for a complete computer-assisted cartographic system. And I am talking about a really small system at this point. Setting up a computer-assisted cartographic facility at a university must be done under constraints in addition to the economic one, and within the following setting.

First, by 1978, it is a pretty safe assumption that any university has a rather large-capacity computer facility. In most cases, this facility has been in existence for some years, and has existed to serve a whole spectrum of disciplines ranging from the university business office to the departments of engineering, physics, art, and so forth. This facility will, in all probability, have the standard statistical and mathematical routines that a cartographer will need in order to classify map data. However, few will have strictly cartographic routines. This is what Bob Aangeenbrug talked to us this morning about; we do need the equivalent of a BMD or an SPSS or something like that in cartography. Most facilities may have some graphic output device and a modicum of graphic software to draw graphs, curves, et cetera. However, few will be able to draw finished copy for map products. Furthermore, interdisciplinary professional jealousies do exist. Assume this scenario, and consider the economic fact of university life described above; then let us view the cartographic discipline in this setting.

A university cartographer usually can get his first map drawn with computer assistance by requesting time on the university's existing large CPU and by taking a set of data, processing it, and requesting hard copy output. By analysis, one can characterize then the first two requirements for a computer-assisted university cartography program. These are merely a set of data and the requisite software. This immediately brings to mind an initial stage of development consisting of two priority items for the establishment of a computer-assisted cartographic system at a university. First, a person who can develop or obtain and modify the necessary cartographic software, and second, some equipment that can create or "capture" machine-usable data that can be of use to a cartographer. This represents a basic level capability.

Generally speaking, the cost of processing the data at a university is subsidized, and thus is not of major concern in an academic environment. Likewise, the need for speed is not critical. In instructional use, the need for high resolution is also not critical. The University is not a map production agency, and, therefore, to wait overnight or even over the weekend is not critical. On the other hand, the need for full, complete and easy to understand documentation is critical. The university, when not filling out a required federal form, must impart information to its students. Ease of access, therefore, by many individuals with various levels of training becomes a major requirement. Another major requirement is flexibility of the individual system components.

Truly, one should seek to maximize capability for the minimum cost in a university setting, while utilizing the available human resources to the utmost. This means that it is not necessary to buy a complete working system from one manufacturer at one time, even if that were an economic possibility, but, rather, it is necessary over an extended time period, as money becomes available, to pick and choose individual pieces of equipment, to be able to program the links between these different pieces of equipment, and to select equipment that is, and will likely remain, flexible.

All of this selection of components represents an integral part of a university's education function. Obviously, when one does buy from a number of manufacturers, efficiency is lost in setting up a working system. However, once again, it must be remembered that the university is not a production shop. Therefore, downtime or inconvenience for a few months is not that critical, and often the solution to these problems may turn out to be as instructional as would actual production. Thus, in a university setting, the capacity to create or capture cartographic data and to generate software represents an initial stage in the development of a computer-assisted cartography program. The availability of both machine-readable data and software is increasing each year. Thus, most university cartographic instructional programs should be able to attain a Level I computer-assisted system, provided personnel are present.

A second stage probably consists of gaining in-house remote access to the central university CPU. This, I believe, is the next priority in the game of developing a university computer-assisted system. After the software development and the data creation capabilities have been met, the cartographer, for ease--because we do normally deal with large amounts of data--obtains a remote access terminal to the main CPU for processing purposes. This may be the final stage for some university cartographic programs. It is possible to perform some fairly sophisticated cartographic manipulations with a Level II capability. In fact, some manipulations, because a large CPU is being used, can be more complex than those available in what I will refer to in the Level III system shortly. What a Level II system does not offer is the instructional benefits of in-house, hands-on computer assisted cartography.

A third stage that a computer-assisted cartographic department could follow consists of a major step. This step is not one that all departments should take. This step is to gain a complete in-house capability. In most instances, Level II capabilities are retained as a program moves to a Level III system. The obtaining of an in-house capability is a step of considerable magnitude, and represents a substantial commitment on the part of the university to a cartography program. Accompanying this step are some built-in inefficiencies. Initially, for example, all software must be modified to fit on the smaller capacity CPU that is brought in-house. Considerable redocumentation may also be necessary. Nevertheless, a Level III system coupled with Level II capabilities probably represents the optimal system for educational purposes.

I have outlined three possible stages of levels of development for a university computer-assisted cartographic capability: (1) Software development and data creation capabilities. (2) Remote access to a large CPU. (3) Complete in-house capabilities. Not all departments should strive for Level III development. For those that do, the economics of the university setting will usually dictate, unless some wealthy alumni can be enticed to give the required sum of money, that the third level will be reached with due caution over a number of years. To attain it takes almost continual lobbying for monies from various sources.

I would like to share with you now the information about the system with which I am most familiar, the one we have at Madison. We started in April 1968, by getting a Thompson Division Pencil Follower Digitizer, which was interfaced to a rented IBM 026 Keypunch at a cost of about 18,000 dollars. In September of 1970 we got authorization for a part-time employee to be a software programmer. In March of 1972 we got a magnetic tape recorder interfaced to the Pencil Follower Digitizer at a cost of $8300. In January of 1973 we were authorized a full-time specialist in computer-assisted cartography.

In July of 1974 we purchased a Bendix DATA-GRID digitizing table, with a magnetic tape recorder and keyboard at a cost of a little in excess of $19,000; and in March of 1975, we purchased a Princeton Electronics Products Model 801 graphic terminal at a cost of about $9500. In May of 1976 we purchased the IBM 029 Keypunch interfaced at that time to the Pencil Follower Digitizer for about $2,000, and in February of 1976 we were authorized to purchase a PDP 11/34. The cost was $10,300. We were further authorized to purchase a DIGIDATA 1730, nine-track magnetic tape unit, $6,700, an AED8000 Controller for an 80 megabyte CDC disk drive, $14,900; a DEC writer

LA-36, $1,440, and RT11 operating system and Fortran compiler, an additional 16 K memory for the PDP 11/34 and a disk pack, $3,350. The total cost was in excess of $30,000. Finally, in December of 1976 we were authorized the purchase of a Versatec Model 1200 A electrostatic printer/plotter at a cost of $12,000.

All components are operational by mid 1977. Thus, we can see that essentially we, in Madison, reached a Level I system in September of 1970, a Level II system by March of 1975, and a Level III system was authorized by December 1976. The total expenditure in hardware of the pieces I have mentioned came to slightly in excess of $100,000, not including numerous interfaces, software development to link all of the equipment, and personnel time. This capital equipment cost spread over essentially a ten-year period averages to a little in excess of $10,000 capital dollars per year. Viewed in this light, it is not an especially expensive investment. Granted, the actual investment total committed to the system must be, at a minimum, two and a half times that figure per year when personnel time and material costs are included, still, this translates into only the cost of a full-time senior professor. The hardware costs for the system that we have are finished for the moment, and no additional hardware is contemplated. The benefits from a facility for student training have been considerable, and I think now we are in a position where we can offer in-house full-time hands-on training.

Therefore, for the future the hardware within our instructional program will prove to be cost effective, and one can conclude that the system is a wise investment from an instructional point of view for a university who makes a commitment to go into cartographic education. I thank you. (Applause.)

ADVANCED CARTOGRAPHIC SYSTEM

MR. LEVERENZ: The final presentation is going to be made by Fred Hufnagel. Fred has been an employee at DMAAC since 1948. During this period he has worked on a wide range of cartographic programs there that have led to his responsibilities dealing with advanced automation technology. As I said, Fred is in the Advanced Technology Division of DMAAC, and he serves as a project manager and staff consultant on the development of new techniques and applications dealing with cartographic sources and equipment. The topic of his discussion will be DMAAC's Advanced Cartographic System.

MR. FRED HUFNAGEL: Major advances in computer technology have affected us all, one way or another. In the case of aerospace programs, these advances have had a pronounced impact on aircraft, missile and space navigation systems, as well as aircrew simulators used for training. In turn, these systems are demanding increased numbers of highly sophisticated digital products from our Defense Mapping Agency Aerospace Center, in favor of graphic products. DMAAC recognized this distinct trend in changing user requirements in the mid-1960s. Work was begun, in conjunction with Rome Air Development Center at Rome, New York, and various commercial companies, to acquire and implement a series of automated systems. The new breed of products left no doubt <u>whether</u> to automate. Rather, the question at our Center was <u>what type</u> of systems would best satisfy our production requirements economically and responsively? Today, the developments started in the 1960s are continuing. New capabilities are being integrated into existing processes on an evolutionary basis, as technology progresses. This group of equipments and related software is collectively known as the Advanced Cartographic System, or ACS.

Before describing some of the major ACS components, I want to show a few examples of those programs that are driving our digital data production. First, great emphasis has been placed in recent years on training aircraft crews in digital flight simulators, such as that for F-111A aircraft (Figure 1). Substantial savings will be realized in funds, fuel and aircraft operation and maintenance. Essential to the operation of the simulator is data in digital form that defines the basic characteristics of both relief and planimetric features having radar significance. This data is used in the simulator for computation and real-time display of radar scenes for various sets of aircraft location and range parameters. Derivation of the cartographic input data is performed by the ACS at DMAAC. The right side of the vugraph shows sample portions of the main training area, near Las Vegas, Nevada, that has been analyzed and simulated. The next slide shows, in more detail, how the DMAAC data is produced.

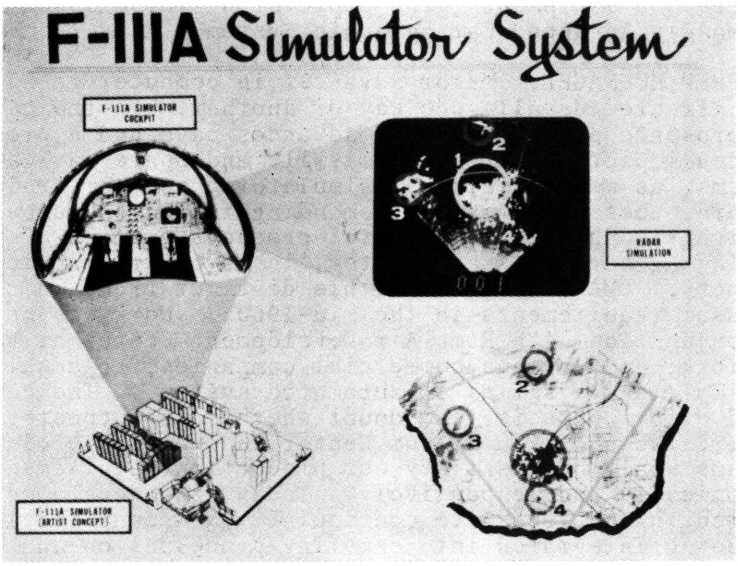


Figure 1

Using a variety of source materials, mostly photography, radar significant features are thoroughly analyzed in terms of size, location, orientation, composition, etc. (Figure 2). Outlines of the features and identifiers are compiled on a manuscript and a related descriptive record--called a Feature Analysis Data Table--also prepared. The manuscript is digitized by the ACS equipments. The descriptive data is also converted to digital form. Both digital records are then merged in our UNIVAC computer system to produce the magnetic tape that is provided the simulator user. The data is used in the simulator computer with a set of transformation software to produce the desired radar scene displays.

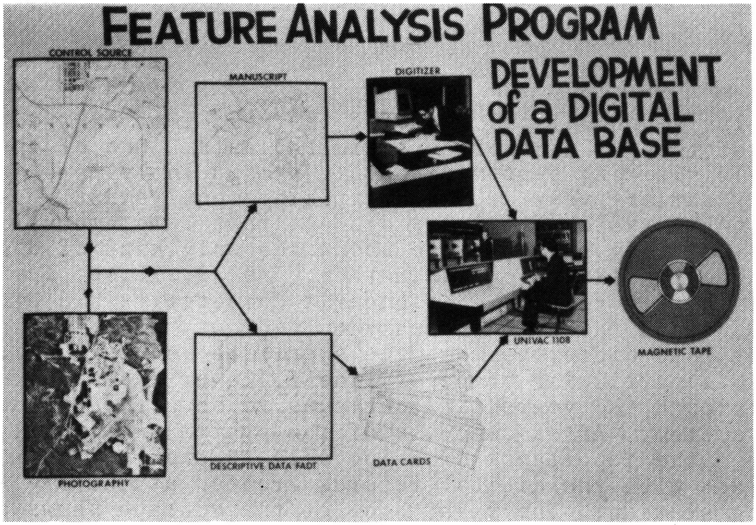
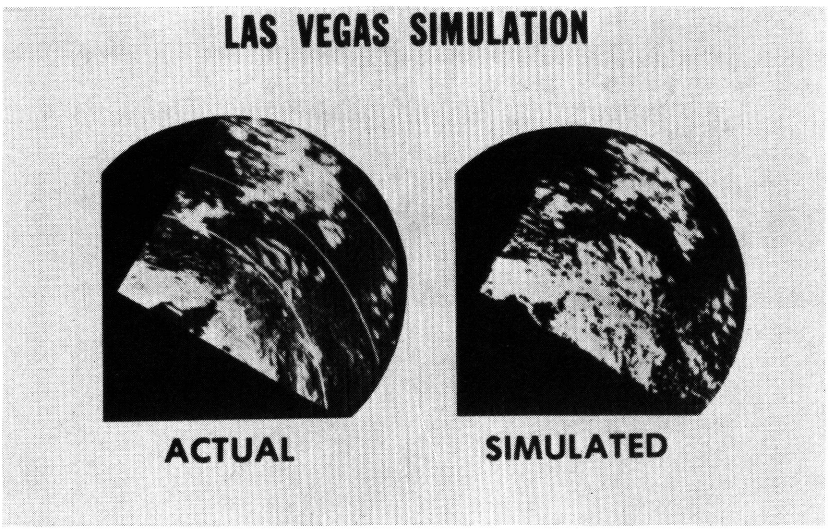


Figure 2



(Figure 3). This slide contrasts an actual radar scene of the Nellis AFB, Nevada, area with a synthetic one in which the radar return from terrain and planimetric features has been simulated.

I'd like to now discuss some of the more important equipment of the ACS that produce digital data. One of the first digitizing systems brought onboard in 1973 to initially satisfy very urgent digitizing requirements was this CALMA system. (Figure 4). At that time, manual line-following systems were about the only kind of digitizing capabilities on the market. We advertised our specification requirements under a competitive bid procurement and the CALMA Company turned out to be the lowest cost bidder to meet the specification. This is how this particular brand of line-follower was acquired and through the years, it continues to be a good production system. After some use of the system, we quickly learned the importance of being able to examine and interact with the ditital records created at the digitizing station. The right side of the vugraph shows a CRT display that we retrofitted to the computer for these purposes.

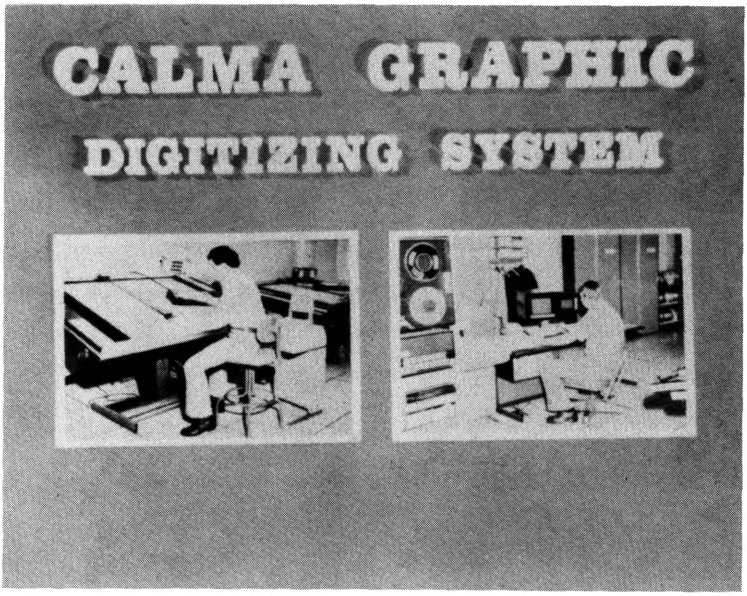


Figure 4

Figure 5 shows the cost figures, in terms of thousands of dollars, for the different CALMA system components.

CALMAGRAPHIC SYSTEM COST ($000)

	PER UNIT	NO. UNITS	TOTAL
○ DIGITIZING TABLES	$ 20	2	$ 40
○ NOVA MINICOMPUTER	12	1	12
DISK UNIT	13	2	26
MAG TAPE UNIT	10	1	10
TELETYPES	1	2	2
READER PUNCH	1	1	1
○ INTERACTIVE EDIT STATION	73	1	73
		TOTAL:	$164

(NOTE/ SOFTWARE DEVELOPED IN-HOUSE)

Figure 5

Figure 6 depicts the next, more elaborate, digitizing system that became operational in 1974. This is our Lineal Input System, or LIS. As you can see, eight work stations are on-line with a DEC PDP-15 computer. A Xynetics proofing plotter and interactive edit station round out the LIS components. Now let's look more closely at one of the digitizing work stations.

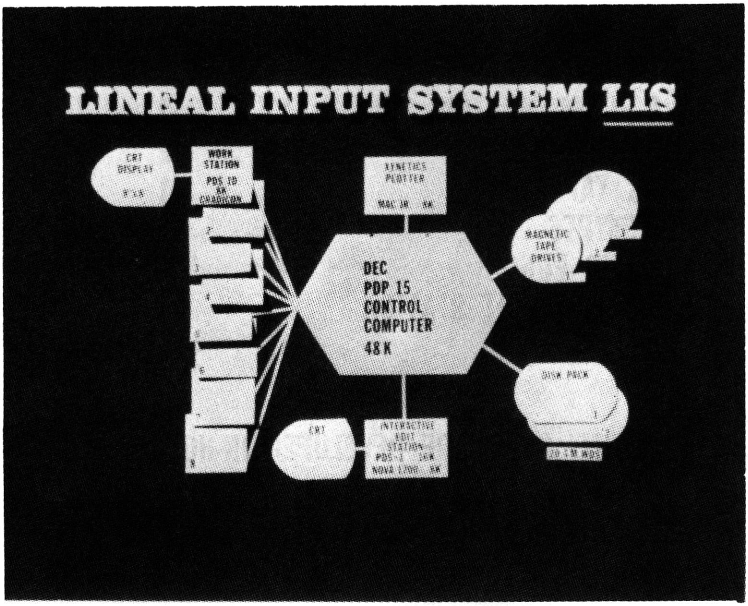


Figure 6

Figure 7 shows the Gradicon table interfaced with an IMLAC PDS 1D minicomputer and CRT display. The CRT not only displays segments of cartographic features for cursory examination and editing, but also menu code listings as shown on the slide. The listings facilitate input of the code identifiers that must accompany the feature data in the digital record.

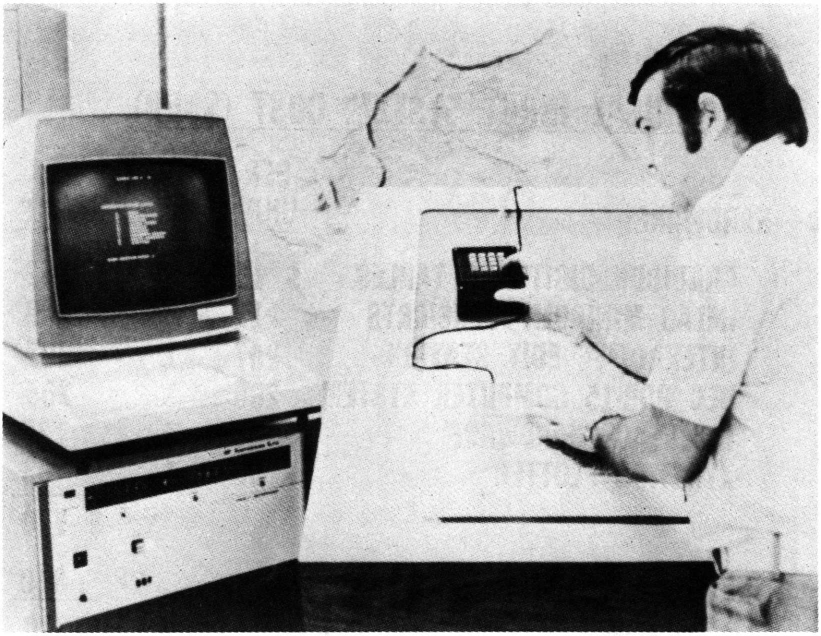


Figure 7

The LIS cost is itemized on Figure 8. As you can see, a large part of the cost was expended on software, both system and application software. In addition to typical functions dealing with feature and feature identifier entry, deletion and related modifications, the software performs a wide variety of other functions such as clipping and joining features, sectioning, table to geographic coordinate transformations, datum shifts, projection transformations, etc.

LINEAL INPUT SYSTEM COST ($000)

	PER UNIT	NO. UNITS	TOTALS
○ HARDWARE:			
GRADICON DIGITIZING TABLES	$ 19	8	$ 152
IMLAC MINICOMPUTERS/CRTS	11	8	88
INTERACTIVE EDIT STATION	207	1	207
DEC PDP-15 COMPUTER SYSTEM	205	1	205
INTERFACE HARDWARE	25	1	25
XYNETICS PLOTTER	93	1	93
			$ 770
○ SOFTWARE:			840
		TOTAL:	$1610

Figure 8

Figure 9 is a picture of our Raster Plotter-Scanner, or RAPS, System that will begin to be operational at our Center later this year. It will be capable of both digitizing single color graphics in a scan mode, as well as plot final negatives, in sizes up to 127cm (50") by 178cm (70"). It will perform either of these functions for a given graphic within 30 minutes, or a fraction of the time and cost now required. While raster systems entail considerably more computer processing, we are taking steps to expand our computer capability for this and other reasons. With the proper balance of computer power, we believe raster technology is the direction to strive for in the future, particularly if one has large volume digitizing and plotting requirements.

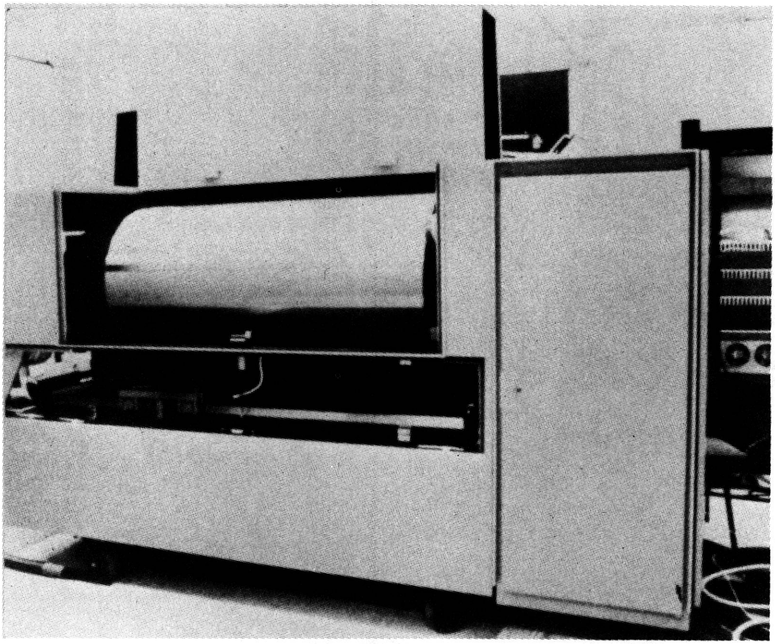


Figure 9

Figure 10 is a picture of the type of color raster scanner system we plan to bring on board in a couple of years. It carries the raster digitizing function one step further by distinguishing between colors, and therefore feature categories, when scanning multicolored graphics. One application will be to rapidly convert source maps to digital form for more efficient exploitation in the compilation processes.

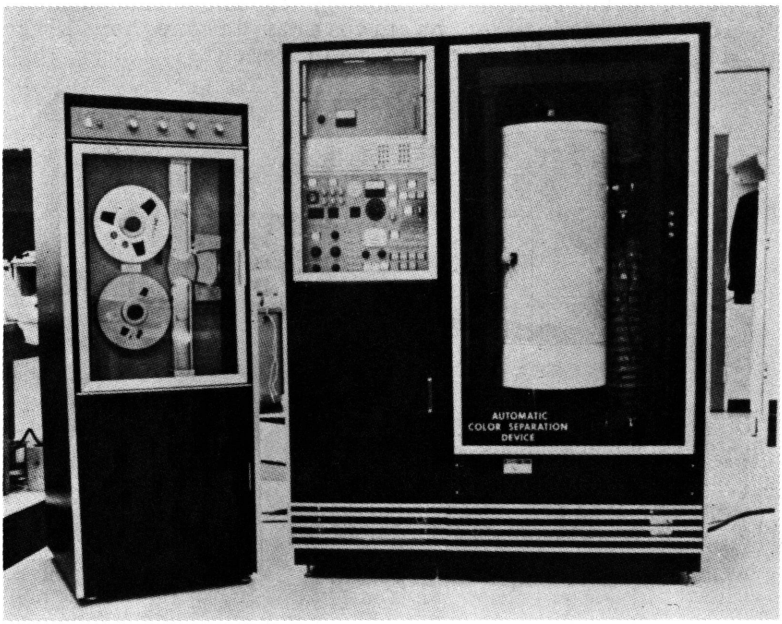


Figure 10

The Aerospace Center has a number of AS-11 stereoplotting systems in operation today. The system shown on Figure 11 is the latest and most sophisticated model of the AS-11 family. The vast majority of these stereoplotter equipments were designed to perform tasks other than digitization of various photographic source materials. However, all of these systems and future acquisitions will be configured to efficiently scan and extract relief data from photo sources, as well as manually collect planimetric features.

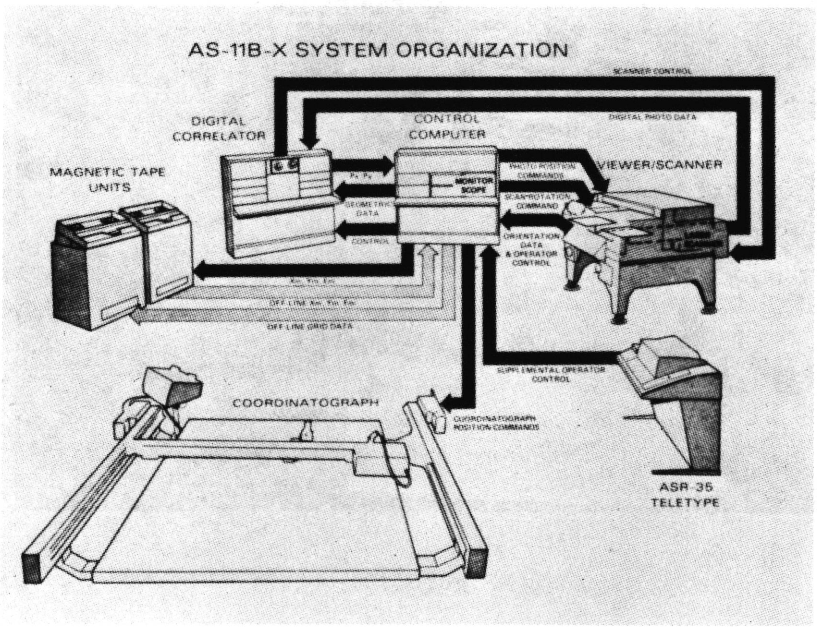


Figure 11

Figure 12 simply shows what the actual components of the AS-11B-X stereoplotter system look like. An effort is underway which is termed Integrated Photogrammetric Instrument Network, or IPIN, System. When fully implemented in about two years, the IPIN will pool all the individual AS-11 stereoplotters together into a single system for increased flexibility and productivity.

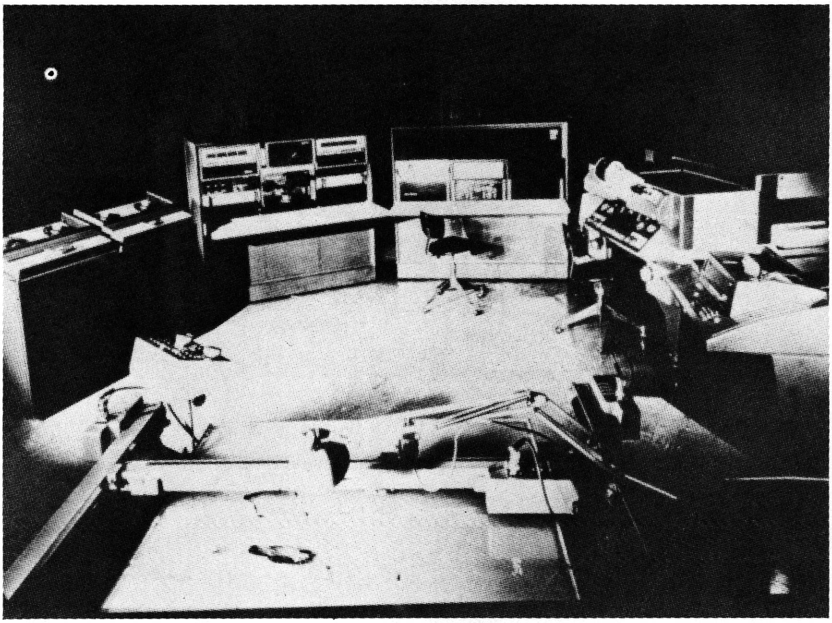


Figure 12

We have several different types of plotting systems and I'm sure most of you are familiar with the type of Gerber plotter shown here on Figure 13. This is our Model 2032 that has been in operation for about five years, and uses a strobe light to plot line work at optional speeds of 75, 150, or 225 inches per minute--depending upon the complexity of the cartographic features.

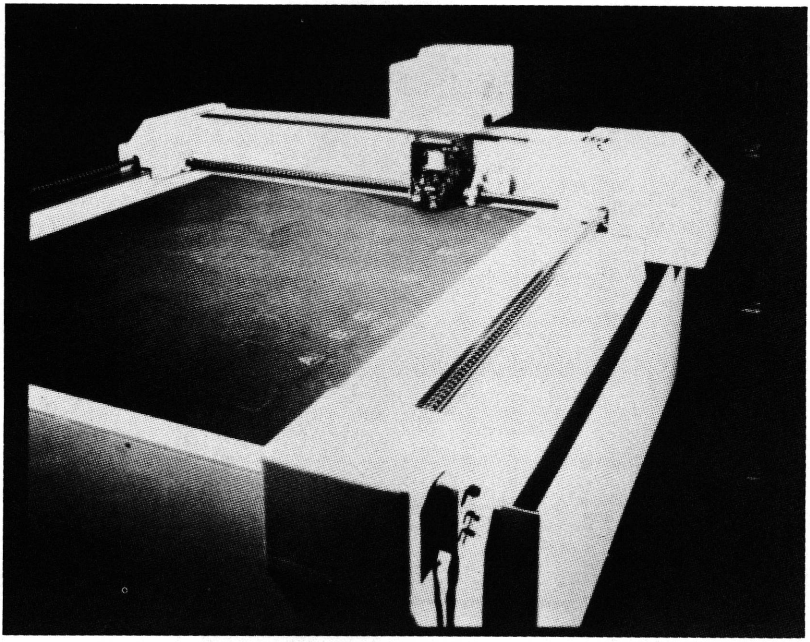


Figure 13

About mid-1978 we will be retrofitting a CRT onto the plot head gantry (Figure 14). The electron beam of the CRT will "write" symbology and alpha-numeric characters onto sensitized film as it sweeps across the CRT face. After all data is plotted for a given CRT location over the film, the process will be repeated for another data set at the next location on the film. The CRT print head is expected to speed up our Gerber plotting by four times.

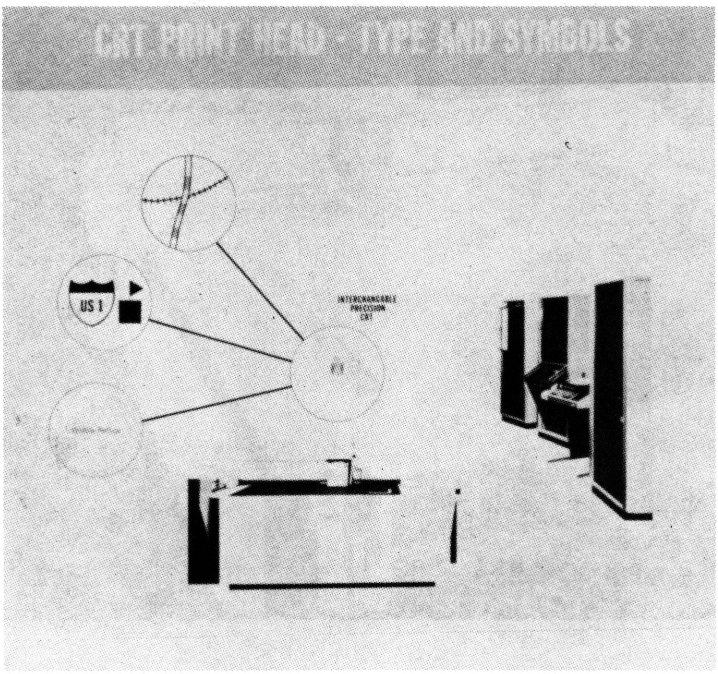


Figure 14

Figure 15 depicts what the CRT head will look like mounted onto the Gerber Plotter. As shown, part of the system is a DEC PDP-11/45 processor system which will manipulate the data and store the digital fonts for the typographical plotting applications.

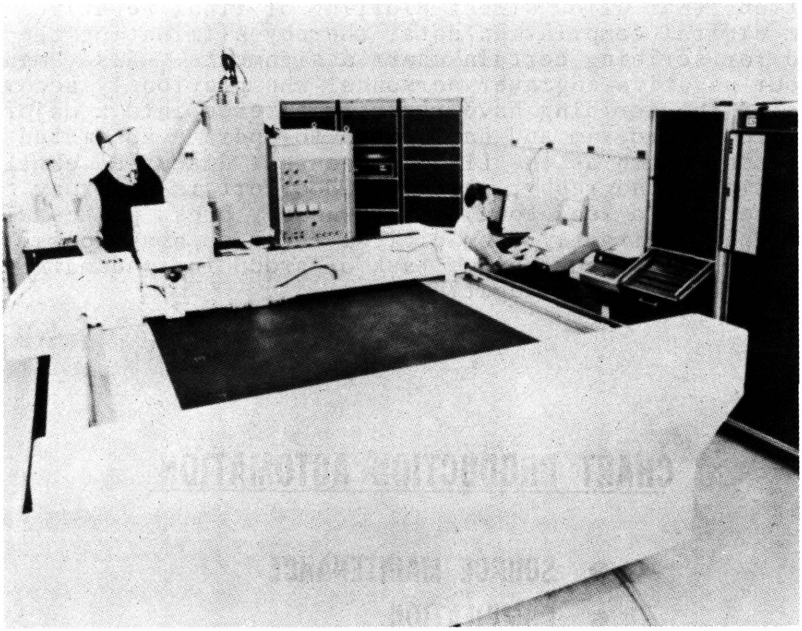


Figure 15

Although the volume of our chart production is diminishing in favor of digital data production, DMAAC expects to continue to support aerospace users with graphic products for a long time to come. As such, we have taken positive actions to automate many of those processes dealing with chart production (Figure 16). In the area of source maintenance, we have reorganized files and established automated management systems to better control the accountability and use of the thousands of map, photo, and textual materials we have on file. As to the fundamental phases of compilation, we are just initiating an R&D effort that will design and implement a system that will mechanize many of the steps comprising these phases and be operated by professional cartographers. At this preliminary stage of development, it is expected that significant use will be made of advanced display devices to take advantage of their ready access and relatively easy interaction with digital data records. With respect to scribing, software programs are already available for one of our major chart series, and others continue to be written, that allow direct plotting of final negatives from digital compilation data, thereby eliminating the need for scribing certain chart assignments. Also, many of our negative engraver personnel who previously accomplished the scribing have recently entered into a major retraining program and have begun to operate automated equipments such as the LIS components I discussed earlier. Regarding lithography, another R&D effort is underway that is expected to lead to a system whereby press plates will be prepared directly from digital records, again possibly eliminating the burdensome task of producing and maintaining large size film negatives.

CHART PRODUCTION AUTOMATION

- SOURCE MAINTENANCE
- COMPILATION
  - SOURCE SELECTION
  - FEATURE SELECTION
  - FEATURE DELINEATION
- SCRIBING
- LITHOGRAPHY

Figure 16

As a final slide, I've attempted to highlight some thoughts on the pros and cons of implementing automated systems on Figure 17. First, as it did at DMAAC, it allows you to produce new types of digital products that previously was not feasible, regardless of how much money or time was available. With more powerful computers being marketed every year, coupled with higher speed digitizing and plotter devices, improvement in production speed and shorter response times are certainly major benefits. Similarly, expanded use of computer processing increases flexibility of operation in terms of the options available for such considerations as workflow, product output, and data exchange. This last consideration is especially important to the Defense Mapping Agency where separate Production Centers are involved. I think there is no question about the ability to raise volume output with automated systems. As to economic savings, each agency's requirements are different and obviously, the cost of any given system has to be weighed against the anticipated savings and analyzed and evaluated on its own merit. By system I mean all three basic components of hardware, software, and people. However, I think generally it can be said that integration of automated systems into manual processes can usually be economically justified where production needs demand high volumes over several years.

Under disadvantages, a heavy outlay of funds is necessary at the start and this, of course, has to be considered as part of the overall economic analysis. Different skills will be required. This necessitates retraining, such as in the case I mentioned earlier at DMAAC involving negative engravers, and sometimes hiring of new personnel. For systems of any size and complexity, facility modification must be recognized and planned for. As an example, it cost 73,000 dollars to prepare the production area for the Lineal Input System I described a few minutes ago.

I hope I have enlightened those who are contemplating the introduction of automation into their cartographic processes. Thank you for your attention.

CARTOGRAPHIC AUTOMATION FACTORS

- ADVANTAGES
  - NEW PRODUCT FORMATS
  - PRODUCTION SPEED IMPROVEMENT
  - INCREASE IN FLEXIBILITY
  - HIGH VOLUME OUTPUT
  - ECONOMIC SAVINGS (HIGH VOLUME--LONG PERIOD)
- DISADVANTAGES
  - LARGE INITIAL COST
  - DIFFERENT SKILLS
  - FACILITY IMPACT

Figure 17

MR. LEVERENZ: Dean has informed me that we are going to have about 15 minutes for questions. All questions should be asked from the floor. I would like you to give your name, and address your questions to a particular person on the panel, please.

MR. TOM WAUGH: My name is Tom Waugh from Edinburgh, Scotland. I would like to go back to Mr. Leverenz's first discussion we had this afternoon. I find it somewhat amazing, somewhat amusing, in fact, in that if you take the kind of figures he quotes and the kind of attitude that he suggests, and divide the figures by a constant factor, I think that talk to a certain extent could have been given by David Bickmore ten years ago. I do not think the difference between automation and manual methods of producing atlas maps is any cheaper now than it was ten years ago. I think what has happened, is that hardware is cheaper, manual costs have gone up, and hardware has gotten better. Therefore there is a slightly increasing gap there between the efficiency of one versus the other. I disagree with quite a few of his assumptions, one being this business of automating a complex manual process. As has been shown time and time again, and I think some of the British Ordinance Surveys in the UK are a graphic example of that, that it is the by-products of automation that will save you the money and the other productions you can produce, not the original thing you actually got in for.

However, it is very interesting that the atlas companies have not really gotten into it, considering it was the atlas company, or Clarendon Press, in this case, that actually started this whole business way back in, what, '63, '62, something of that nature. I think it is surprising that none of them have actually gotten into it. I have a sneaky feeling that when the atlas companies actually take less risk, as they call it, and go into automation, then finally automated cartography has arrived.

MR. LEVERENZ: Thank you for the comments. I think you are right. There were in 1963 or thereabouts, early '60's, there was a tremendous grandiose plan proposed by David Bickmore. However, I think at that time Rand McNally as well as many other commercial firms were looking closely -- and many of the things that David suggested were implemented in various parts of the automated cartographic field. However, still, an automated system, even automating part of a commercial production system such as, as you say, an atlas company, is still not an economically sound investment. That is based upon the fact that the market market does not call for the by-products you talked about. I think that is the one main item. We cannot say, as in many countries, you are going to use this product, and get subsidized by the government, and therefore, produce that product. I tried to make it clear that the market must support the product that is produced. There just are not that many by-products that the market wants right now -- the general market, I speak of. Are there any more questions?

MR. CRAIG SKALET: My name is Craig Skalet with the Geological Survey in Menlo Park. When I was going to school in Wisconsin someone said something to me that has become etched in my mind, and I do not want to name any names, but he was a professor, and his initials are JM. (Laughter.) He said to me that in the future he did not expect automated cartography to be anywhere but in government. The implication being that it was not at that time cost effective for private industry to get involved in it, and he did not see that the future held anything for private industry. I would like someone to comment on whether that has changed, and whether the future holds anything for private industry with respect to automated cartography.

MR. LEVERENZ: I guess I will have to at least make one comment. I think some of the figures that I showed on the slide probably went by rather quickly. Maybe there will be time to talk about them later. But I do think that, yes, in fact I do think that the commercial industry, commercial cartographic industry that I described will be into automation very shortly. I think the cash flow figures shows that there is a lot of potential. Incidentally, this, as the first question intimated, this has changed in the last four years very dramatically to where a four-year payoff is possible, as I indicated. Would there be anybody else who would like to speak to this as far as their idea of the commercial firm and whether they might get into it in some way?

MR. MITCH MODALESKI: My name is Mitch Modaleski. I am with Environmental Systems Research Institute in Redland. Don Cooke helped, I think it was, Pizza Hut locate some 10,000 facilities several years ago using DIME files. That is a commercial application. In fact, I think Don is a millionaire today because of that project. Just the other day, Utah International, situated here in the city, was advertising for a systems programmer type person to do geographic data base development. I do not think there is any question that the commercial sector is already in the business of building geographic data bases or digital cartographic data bases, whatever you want to call them.

MR. JOEL ORR: I am Joel Orr. I am a computer-graphics consultant. I feel obligated to add a few words of motherhood to what Mitch was saying. Maybe mappers just do not realize it, and the map has become an end unto itself, but information is power, and not only for government. Geography happens to be a very convenient way of looking at that information. Whether it is Pizza Hut or the First National Bank who is analyzing good ways to spend their money and probabilities in terms of loaning money and so on, there is a great deal of activity going on in the public sector in this country involving automated cartography as a means to an end, and not as an end in itself. Of course, Rand McNally and people who produce maps in and of themselves, have to look at the potential of automation as far as saving them money and what they do. However, it would probably be wise if these companies -- I am sure Rand McNally has explored this -- would consider the possibility of selling the byproduct, as our friend in Scotland called them earlier, to people who are more interested in the by-products than in what Rand McNally would call the main product.

MR. RAY DILLAHUNTY: My name is Ray Dillahunty, and I am from Geo-science Division of Petty-Ray Geophysical in Houston. When you were talking earlier, you were really referring to what I would consider road maps. Rand McNally, in my opinion, sells more of a public type map than do some companies in the commercial markets that make aerial survey maps, topographic maps, more similar to government type maps. Do you think your figures hold true in that type of application also, or is there a bigger cost advantage or disadvantage in those kinds of applications?

MR. LEVERENZ: I tried to define the fact that there was a different approach for the firm that I was talking about from the firm that is making studies for McDonald's or so on, or for internal use, as I call it, even though, granted, there may be a need for that and a market for it. I cannot really speak for the photogrammetric or the aerial survey type of operation. I am not really that familiar with what market there is, but it would seem the market would be more for a specific product that would be used internally, for oil exploration or something like that, that would be more specialized, as I would call them, computer products. I think the figures that I have for investment and the method of analyzing it is a standard economic method of analyzing a payback. It all depends what figures you plug in there.

MR. PETER WILLERUP: I am Peter Willerup from the Pacific Gas & Electric Company in San Francisco. We are on the verge of entering into the mapping age through the computer. A couple of our sister utilities south of here, in San Diego and Los Angeles, are actually into this computer mapping. I feel sorry that there are none of those representatives sitting up at this panel to discuss that type of computer-assisted or cartographic output that was not only mentioned before that results in maps, that results in information, in management information of such things as utilities, whether they are gas, electric, sewer, water and so on. And I would like to have heard some financial analysis on those types of computer-assisted cartography. Because I think that has been left out completely. You are sitting up there as basically governmental agencies, with one type and a very special type, in Rand McNally, but there is a wide range of uses and management tools, for instances, utilities. But I am sure many other industries would be in the same boat as we are.

MR. LEVERENZ: Thank you. I agree. That was a shortcoming of the panel. Vern?

MR. CARTWRIGHT: Yes. Private industry has come up here. And what they are involved in -- American Society of Photogrammetry, there are about 400 map-making firms in photogrammetry in the United States. A large majority of those have been in digital mapping one way or another for ten years. More and more of them are getting into the interactive graphic system. The thing I would like to ask Roy Mullen, I would like to see if you would share your software with some of us fellows, and also the data you are getting into your data banks. Can we borrow that to make our own maps to the scales we want?

MR. MULLEN: I was prepared, if no one asked any questions -- I had a question to ask myself, and that was: Why didn't somebody say what can you give me tomorrow? That is the good question. Vern, as you know, all of the programs that are developed, software programs to support digital cartography, all of the processes of mapping that the United States Geological Survey develops are all available to the public. They are generally sold for the cost of the reproduction. None of the costs of the gathering that went into that map -- And I would like to comment on that. I wonder how much -- Who was it, Pizza Hut? I wonder how much Pizza Hut would have been willing to pay for the information that they had available from the DIME files to begin with to begin that study of locations? Would they have been willing to pay the access costs for all of that data to make those studies? I think that is the thing. And that is why I feel when I mention our responsibility in the national mapping program is to be the federal collection agency for that data. I will assure you that when that data is collected it is available to anyone and everyone who asks for it and pays for the reproduction cost of it.

Now, what is available? At the risk of delaying and cutting into somebody's coffee time, and everybody that knows me knows that I don't give a damn about your coffee time . . . (Laughter.) . . . there are what we call digital elevation tapes available from the GPM. We have a complete, for those of you who are developing a software system, we have complete 7 1/2 minute quadrangle contour information, totally cleaned data, that is available for any testing or proving of systems that you would like to work with. I would like to be able to say that I knew how much that costs, but I honestly do not. It cannot be very much. It has to be less than $15 or $20 or $30 at the most. All of our information is available and is in the public domain and is requested constantly. We give it out constantly. The DMA tapes, which the Geological Survey has and put into distribution through the NCIC, are an interesting set of data to us, because we continually get requests for information which even DMA agrees was not the cleanest, not the best, but it was the first, and it is available. We have many, many people asking for that information. I have the statistics on it, and it amazes us how many requests, how many repeat requests we have for those tapes from various entities, agencies and commercial people as well. So, people are using that data.

With respect to planimetric information, we are collecting that on a somewhat unorderly fashion -- and I will say "unorderly" from the aspect, as I mentioned, we are going after the development of the digital cartographic data base at the same time we are doing research, and also doing production work. We have a series of pilot projects, those categories that Mr. Southard mentioned this morning: land net, hydrography, transportation net; some of those things are available for some quadrangles. I would hope that someday when the job gets further down the line, somewhere near the percentage of completion of the 24,000 scale quadrangle base of the United States, that we will have most of those data categories all digitized, all ready and available for anyone who asks for them. I might say one other item. Tom Waugh talked about the work done in the British Ordnance Survey, at least partially with respect to the question that Jon addressed with respect to the costs of preparing a map digitally to produce another graphic; I think their estimate, we have found, is pretty good. If you are going to digitize graphic data to produce another or digitize planimetric map data to produce another graphic, it is going to cost you from 15 to 25 percent more to do it that way. The big advantage, as I perhaps only mention slightly, but I will say once again, the big advantage is the thing that Peter Willerup addressed, and that is all of the management uses that that information could be put to if it were available. I think that even if we had the digital cartographic data base, of the one to 24,000 scale maps available, I think you would be glad to get them. But we still have the same problems. Your specific use is going to require larger scale, higher resolution digital data than the one to 24,000 scale base will allow you to use. But, as a planning tool, I think it will still serve the same purposes that the 24,000 graphics do today. It would be the base from which you may further build a digital base for your specific purpose.

We know we are not going to devise the digital cartographic data base that is going to answer every user's needs. We could not afford to wait that long, and we could not afford the cost of developing a cartographic data base that has the answer to every single request that every single user would have, because there are some mighty strange strange requests sometimes for cartographic data. Thank you.

MR. LEVERENZ: I want to personally thank the panel, for the presentations, for their answers to questions, and for the questions from the floor.