DISCOVERING AND EVALUATING SOFTWARE

MR. DEAN EDSON: In order to cover one of the really dynamic dimensions in computer-assisted cartography we have to, of course, address the subject of software. The organizing committee has called upon one of the foremost experts in the field of software to organize and bring to you a look at the present and the future in software. Professor Marble is currently on the faculty at the State University of New York at Buffalo, and has been teaching at various institutions and has had a number of teaching assignments in engineering, business, regional science and geography, and is currently the U.S. member of the IGU Commission on Geographical Data Sensing and Processing. Professor Marble received his Doctorate in Geography from the University of Washington. We are very pleased th have Professor Marble here to help us look at where we are going in the way of software. Professor Marble?

DR. DUANE F. MARBLE: Thank you, Dean. I will say one or two things at the start about the organization of the software sessions today. We are dealing with essentially 90-minute periods. The first hour of each period will be devoted to formal presentations by members of the panel. The last third of the time period will be given over to open discussion. We hope that the members of the audience will join the members of the panel in the discussion. There are several explicit topics set forth. The sesions themselves are ones that I have tried to develop in a focused fashion. They deal, first, with the question of evaluating and developing software in the field of computer cartography and geographic information systems. The two following sessions deal with specific research topics, things that are not yet major and active parts of the field of computer cartography. One of these deals with raster-based approaches to cartographic processing, and the other to problems of management of large volumes of spatial data.

I would like to begin the session on discovering and evaluating software by talking a little bit about the development of geographic software. I have been hooked on computers for a long time, and since it is one of those games people play, to say, "How far back do you go?", I will note that I was once the author of a facetious little pamphlet entitled "How to live with an IBM 604 Calculating Punch," which was a delightful device, and our super-extended installation had, I believe, 34 characters of memory attached to it. We have progressed a great deal since those days. One of the things that we tend to gloss over is how fast we have progressed, particularly in the field of software. This has become evident to us because of an effort that was undertaken about two years ago by the IGU Commission on Geographical Data Sensing and Processing as part of the larger study for the U.S. Geological Survey that Rupe discussed in his keynote address yesterday.

One of the things we did was to prepare a draft inventory of computer software for spatial data handling. This was an attempt to provide fairly comprehensive descriptions of program units, giving enough information so that the reader could find what the unit did and could discover whether it was transferable, or not, in terms of the parameters of his or her own installation. Our effort uncovered about 320 program units. The program unit was a rather loose definition, ranging from things that, on the one hand, looked to be on the order of magnitude of the Canada Geographic Information System, which is a comprehensive system covering all phases of input, storage, manipulation, graphic and other types of output, and constituting something on the order of 120 to 130,000 lines of code, down to specific subroutine modules, many of which were written to assist in cartographic operations. One of the reasons for doing the inventory was to try and find out what was going on, because if we look at the published literature in cartography we find very little dealing with the types of things that we must know in order to progress in software development. Many of the things that we need are relatively unknown. This seems a strange thing to say, but if you cast your mind back on the kinds of things you do when you start to write a program, you will find that there are several critical factors. You need to know something about your data and its data structure. You need to know something about the algorithms; the processes that are used. One of the things that we found in the inventory was an incredibly high level of redundancy in many areas. The simple physical problems of carrying out the inventory were complicated by the fact that we ran out of six letter acronyms for contouring programs. There are more contouring programs and interpolation programs than one would reasonably expect. There is also a great deal of misinformation about how these work.

In many cases there is no information about how they work. Many of the software modules were and still are real black boxes, their operation understood not by the users or the proprietors, but in some cases only by system analysts and programmers who have long since disappeared from the scene. At one time in the course of the draft inventory, we facetiously decided we were going to try and present an award for good documentation. This soon became in my mind an attempt to present an award for the poorest documentation, but we were overwhelmed with candidates, and decided not to present it at all. Most of the systems and program units are very poorly documented. This is one of the factors that has come to light in practically every case that we have looked at. One of the things that contributes to the high level of redundancy is that, when one undertakes software development, one is faced with the problem of how to do it and finds that there is no library of algorithms for spatial data handling that one can turn to.

Suppose you want to find out how to write a contouring program. Where do you go to find out what the prior experience has been, and what is the current state of the art? You will find articles on contouring algorithms scattered here and there in the literature, some in geophysics, some in geology, one by John Davis in the proceedings of AUTO-CARTO II, and others in places that are not normally likely to be found by people interested in cartography.

The common interest in the display and presentation of space and time dependent data covers a variety of disciplines. One of the activities of COGEODATA at the present time is an examination of the methods for handling space and time dependent data in a variety of disciplines such as geography, geology, meteorology, soil science, space science, chemistry, physics, and certain areas of mathematics which are particularly susceptible to graphic display. But the literature in these fields is not really open to people in other fields. If I wanted, for example, to examine the soil science literature to try and find out what they have done on the display of spatial data, I would, quite frankly, not know where to start. One of the things we hope to do in the course of the current inventory operation is to point out where things are happening and to try and identify some of the more interesting existing algorithms.

The draft inventory was completed in March, 1976 and with the sponsorship of the U.S. Geological Survey, the Commission is currently updating and extending the inventory. Outside the door there is a small information sheet which discusses the structure of the previous inventory and the kind of things we are trying to do in the present one.

It is also an invitation to assist us. We need help, because the only way we are going to find the types of information that we require is through individual contact, hopefully with each and every one of you. You are here because you are interested in computer software and interested in spatial data handling. I am sure that in this audience there is probably a volume of software undiscovered, at least as large as that reported in the original inventory. We have been working on the inventory for several months, and have already identified enough new entries to cause us to considerably expand the scope of the final presentation. We had originally thought we would publish a volume, and that now begins to look as if we may have some difficulty in publishing it in three volumes.

Another thing that we are trying to do on this pass through the system is to cover an allied area which is not programs, but rather, cartographic bases in digital form. We received many requests from people interested in cartographic base files, typically something on the order of World Data Bank One. There are a lot of organizations and individuals engaged in producing these files today, and many of them are essentially in the public domain or could be placed there with little effort. But no one really knows where they are or what their characteristics are. So, in addition to the programs, we are going to attempt, at least in passing, to cover those cartographic data bases that have come to our attention.

The inventory results, as I said, will be presented in a series of published volumes which will be available about the end of next year. We are also working with an interagency advisory committee on the operations of the inventory, and after we have completed our initial efforts, there will be a special workshop held in Washington, D.C. for staff people from a number of the federal agencies to examine and discuss our results. I would like to invite your cooperation in this inventory since I think it is an effort that is valuable to all of us. If we can eliminate some of the redundancy and if we can make it easier to find out what others are doing in the area, I think we may begin to progress far more efficiently than we are presently. We have gone through a long, slow period of development. The development path in time follows the typical S-shaped curve, and we have now gone past the bottom inflection point, and we see the field of computer cartography developing rapidly in depth and complexity. Without some central source of information such as the inventory, it is going to be very easy for us to waste significant quantities of resources in the future.

Our panel members today were chosen to talk about some of the problems that people face today in trying to find out about software and how it can be incorporated into a system design. The first speaker is Mr. Carl Reed. Carl is with the Western Governors' Policy Office in Colorado, a 14-state organization which is currently carrying out a system design study for the U.S. Fish and Wildlife Service. Carl will talk to us about some of the experiences they have had in trying to examine existing software and evaluate it in the light of their systems needs. Carl?

EVALUATION AND SELECTION OF EXISTING GIS SOFTWARE FOR THE U.S. FISH AND WILDLIFE GIS

ABSTRACT

The purpose of this paper is to present the results of and lessons learned from the evaluation of geographic computer software as part of the development and implementation of a U.S. Fish and Wildlife Geographic Information System. The main emphasis of the evaluation was on cartographic software, since many of the analysis functions are unique to the U.S. Fish and Wildlife Service. The evaluation was done between March and July 1977. The evaluation criteria were based on a five-month user needs assessment. Originally, 85 systems were discovered. Lack of documentation narrowed this field to 52. Detailed descriptions were prepared for these 52 systems. Each system was then evaluated in terms of 1) operational characteristics, and 2) functional characteristics. This initial evaluation further narrowed the field to 11 complete systems and 14 partial systems. The next phase of the evaluation centered on such things as 1) in-line code, 2) functional characteristics, 3) interface difficulties, and, 4) level of documentation. From this evaluation, we have been able to obtain some of the software (about 30%) required to implement the U.S. Fish and Wildlife Information System, which is now known as MOSS (Map Overlay Statistical System).

1.0 INTRODUCTION

1.1 Goal of Project

This Geographic Information System project is sponsored by the Western Energy and Land Use Team (WELUT) of the U.S. Fish and Wildlife Service (contract #14-16-0008-2155) to promote more effective consideration of the impacts on fish and wildlife resources from land, energy, mineral and water development.

The goal of this two-year project is to develop an operational capability within the U.S. Fish and Wildlife Service (FWS) to accept, store, manipulate and output spatially-related data for use in a variety of FWS programs. This includes not only the data that has been and will continue to be collected by the FWS, but also includes data available in computerized and non-computerized data files of other federal and state natural resource management agencies. This goal is to be achieved by attempting to minimize development of new computer software for the display and analysis of map data. The project started on a prototype basis within selected test applications and will broaden to other applications.

The primary users of this system in its developmental stages are in the Billings Area Office (BAO), WELUT, and the Region Six office. The biologists in these offices are faced with the weekly task of assessing the wildlife resource impacts of various land use changes.

1.2 Description of Major Tasks of the Project

It is helpful to outline the seven major tasks of this project. This report falls within Task II.

Task I Assess the spatial data needs of three groups of users: 1) the Denver Region Six offices of FWS, 2) the Billings Area Office within Region Six, and 3) Special Projects of the Office of Biological Services. Development of a preliminary system design based on these needs.

Task II Survey, assess, and compare existing computer software systems and geographic data bases which are relevant to FWS determined needs. This may include federal, state, and private software and data bases.

Task III Develop an interim software system and test data bases(s) covering the pilot test area(s). (WELUT Montana-Wyoming test area).

Task IV Benchmark-test and evaluate the most promising geographic information system software as determined from Task II.

Task V Integrate and implement the selected software system on a government computer as determined by FWS-WELUT (presently, it is a CDC CYBER 172).

Task VI Test and debug the new FWS-WELUT geographic information system and document it with both users and technical manuals.

Task VII Train FWS personnel in the applications, use and limitations of the system. This task will be on-going throughout the project.

As we shall discuss later, for a number of reasons, Task IV has been dropped.

1.3 Purpose

This report presents the results of the initial evaluation of the "off-the-shelf" computer software for possible inclusion in the U.S. Fish and Wildlife GIS. This evaluation was based on three previous efforts:

1) A five-month User Needs Assessment (Project Report 1.1)
2) A General GIS System Description (Project Report 1.2)
3) A Detailed GIS System Description (Project Report 2.1).

Based on the user needs assessment, the GIS is visualized as containing four major sub-systems. Each sub-system in turn is comprised of other modules (Figure 1). The FWS-GIS must operate under certain operational constraints and must perform certain logical functions. This initial evaluation of existing GIS software was based on 1) operational criteria, such as programming language and documentation, and 2) functional criteria, such as, does the software do polygon intersection. Both operational and functional criteria had to be considered. Suppose a piece of software were not operational on a favored computer, but the function it performs is vital to meet FWS requirements. This software package then received a higher rating.

2.0 THE CRITERIA USED IN EVALUATION

As mentioned above, two sets of criteria were considered. "Operational" criteria refer to the general hardware/software characteristics of a particular program. "Functional" criteria refer to the actual logical function(s) or tasks performed by a piece of software. The initial evaluation and selection process was based primarily on the operational criteria. A second evaluation was based on the functional capability criteria alone. This two-phased selection process was followed to allow the large number of GIS programs to be systematically evaluated.

Table 1 presents the operational criteria for the FWS-GIS. The definition of operational criteria was constrained by the fact that FWS (Region Six) must use either a Data General Eclipse or a CDC CYBER for a mainframe. FORTRAN was selected as the favored language because it is universally applied and generally understood in the GIS user community. The remainder of the operational criteria are based on FWS user specifications, good programming practices, or software transportability considerations. The functional criteria which define required display capabilities of the system are listed in Table 2.

3.0 THE SYSTEMS EVALUATED

Concurrent with the user needs assessment and preliminary system design, documentation was gathered on existing GIS. For the purpose of this project, a system is defined as any piece of GIS software that performs more than one unique GIS function, such as data input, data analysis, and data display. The reason for this division is to separate single-purpose software from multi-purpose GIS software in order to keep the number of systems to be evaluated as small as possible. However, some stand-alone packages were considered for unique capabilities.

Figure 1

PRELIMINARY GEOGRAPHIC INFORMATION SYSTEM DESIGN

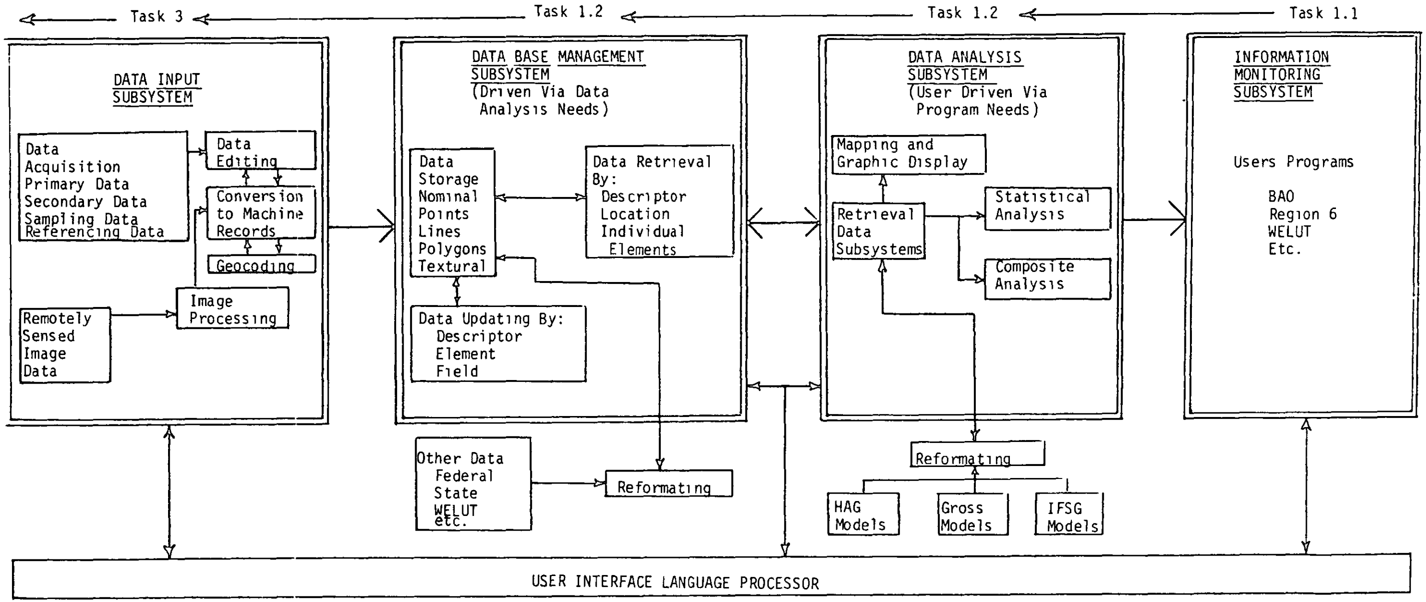

Figure 2 Operational Criteria for Software Evaluation

A. Hardware environment (most to least preferred)

1. Data General/Nova Eclipse
2. CDC
3. UNIVAC
4. IBM
5. Interdata
6. Digital Equipment Corp. PDP II or PDP 10 series

B. Programming Language (most to least preferred)

1. FORTRAN IV
2. FORTRAN V
3. BASIC
4. COBOL
5. PASCAL
6. ALGOL
7. other

C. Available Documentation (most to least preferred)

1. application, user, technical, and implementation instructions
2. application, user, and technical
3. application and user
4. application

D. Modularity of software

yes modular
no non-modular

E. Operation environment (most to least preferred)

1. interactive (end user operated)
2. batch (end user operated)
3. interactive (analyst operated)
4. batch (analyst operated)
5. interactive (programmer operated)
6. batch (programmer operated)

F. Cost of software - Given comparable levels of performance between programs, the least expensive is most preferred.

G. Machine independence - the greater the degree of machine independence of a program, the more it is preferred for further evaluation.

H. Any "off the shelf" program requiring exotic libraries will receive a low priority as to its usefulness to FWS.

I. Whether the software included all necessary modules for a "complete system" input, data base management, spatial analysis, output, and user interface support.

TABLE II

COMMAND	FUNCTION
*ACTIVE	What maps, or parts of maps, are currently active (i.e., can be manipulated and displayed)
DEVICE = LINE PRINTER PRNTR/PLTR PLOTTER SCANNER TAPE DISK	Assign a display file to a peripheral other than a CRT so that alternative hardcopy options are available for map display.
*DISPLAY 1,2,3,...N	Display a set of maps on some output device (see the DEVICE command). These may be either line or cell maps.
*ERASE	Erase the CRT
*BLOWUP	Magnify a portion of the CRT
PROJECTION	Change the map projection
*WINDOW	Manually set a viewing window for display purposes
*RESET	Reset the viewing window to the data base default
*SYMBOL	Generate a symbol map for point data. Somewhere between 20 and 35 symbols are to be available, including the most commonly used cartographic symbols (churches, swamps, and so on).
*LINE	Generate a line map utilizing different map symbologies. These are 18 dash types, railroad tracks, and thickened lines.
*SHADE	Generate a choropleth map (discrete shading) with ability to rotate crosshatch lines and either have the program or the user set the class interval information.
*CONTOUR	Generate a contour map from either point or grid data.

LABEL	Place label information on a displayed map.
LEGEND	Generate a map legend with 1) title, 2) north arrow, 3) scale, legend to label information, 4) different fonts, and 5) either tic marks or a grid overlay. (Note: LABEL and LEGEND will require software generated characters).
THREE-D	Three-dimensional block diagrams
*TESTGRID	Draw a grid overlay on a map of user-specified size.
*GRID	Point-to-grid interpolation

*Commands with an asterisk are presently operational (8/11/78).

References to different systems came from many sources, including the IGU (1975), McDonald (1975), Power (1975), and from personal experiences of the staff. For each system, documentation on actual system applications, users manuals, and technical manuals were obtained where available. The documentation search ended July 15, 1977. Eighty-five different systems had been defined. Of these 85, we obtained sufficient documentation to write two 5-page standardized descriptions on 52 systems. The standardized descriptions were used as the information base for evaluation.

4.0 EVALUATION PROCEDURE

Only the 52 systems with sufficient documentation were further considered,since undocumented software generally are not portable.

A set of the standardized system descriptions were prepared and distributed to several technical and managerial staff. Each individual was given a week to read and relate each system to first, the operational, and second, the functional criteria. Based on this evaluation each individual decided whether a system should be: 1) considered further for adoption, 2) considered only for functions or algorithms, or 3) dropped from further consideration.

At the end of the week, the group convened to compare the results of individual evaluations. Each system was discussed and voted on. A summary table was prepared of the results and is available in a project report. In some cases, local modifications to the systems will result in characteristics different from those shown in the summary table. The summary should then be viewed as an overview of some of the geographic information systems.

Originally, the evaluation was intended to be purely objective, quantitatively based on the operational criteria. However, in reality, this initial selection process was both an objective and subjective decision process, due to trade-offs in the operational and functional characteristics of each system. A quantitative number could not be derived that would adequately reflect all the components of the evaluation process. Thus, the final decision became one of professional judgement.

5.0 SUMMARY AND FINDINGS OF THE INITIAL EVALUATIONS

Based on the initial evaluation, eleven complete systems and pieces of fourteen systems have been selected for further study. The eleven complete systems are:

COMPIS	-Comarc Corporation
CRIS	-BLM
CMS-II	-Department of Commerce
EPPL 4	-Minnesota Land Management Information System
GIMMS	-University of Edinburgh, Scotland
LUMAD	-USGS Geography Program
ORRMIS	-Oak Ridge National Lab
PLUSX - PLUS2	-University of Western Ontario
WRIS	-U.S. Forest Service
CONGRID	-U.S. Forest Service
MAPDRAW	-Fish and Wildlife Service

The partial systems varied from complete modules to algorithms.

6.0 PHASE II EVALUATION

Both the eleven complete systems and the fourteen "selected functions" were then analyzed in more detail.

Actual systems architecture and program code were studied to determine the transportability, programming techniques, and efficiencies for each system. The pieces of software that rank highest in this evaluation form many of the basic units for the FWS-GIS.

6.1 Phase II Evaluation Procedure

The actual code and additional documentation were obtained for the eleven complete and fourteen partial systems. Two complete systems were immediately dropped at this point. For one, the master backup tape was not readable and for the other, because it was a commercial package (WELUT had made the decision not to purchase commercial software).

The remaining systems were then evaluated on:

1) in-line documentation
2) adherence to ANSI standards
3) user interface procedures
4) options available for a given function
5) did a given function in a given piece of software really do what the Fish and Wildlife Service needed
6) modularity of code
7) did the code look extremely inefficient
8) potential interface problems when integrating into a larger system
9) core required
10) types of data they could handle (point, network, polygon, and/or text)

Each piece of software was evaluated given these criteria. On the basis of this evaluation, it was discovered that no system fulfilled even half of the U.S. Fish and Wildlife requirements. Therefore, every system dropped to partial system status. Of the now 26 partial systems, 12 were dropped due to the lack of proper documentation and a complete disregard of both modern and standard programming conventions. We are now left with 14 partial systems from which to draw software.

7.0 PHASE III EVALUATION

Initially, the chosen systems were to be benchmark-tested. These benchmark tests were to use a standard data set to test the ease of use, efficiencies, and costs of using the different systems. However, for various reasons, the benchmark testing is not being done. These reasons are:

1) insufficient time
2) insufficient manpower
3) the systems are too diverse in their data requirements
4) budget considerations in the project.

The decision not to do the benchmarking is understandable. Given previous attempts by other groups and given the reasons above, results of any benchmark testing would have been either meaningless, disastrous or both. I can only caution others who are considering benchmarking to have the time, money, patience, personnel and endurance required of such an undertaking.

8.0 SUMMARY, LESSONS LEARNED

The major finding of the software evaluation is that no system fulfilled even half of the U.S. Fish and Wildlife requirements for a geographic information system. The second major finding is that only a small percentage of existing GIS and cartographic packages are sufficiently documented to merit the stamp "transportable". The impact on our project is that we have to do much more design and programming than we originally intended.

During the evaluation we learned several things:

1) the evaluations took much longer than expected;
2) no matter how one tries, objective evaluation is not possible;
3) personal bias and ego can almost completely block effective evaluation;
4) what the documentation says and how the system performs may be two different things;
5) much cartographic software coding is "primitive";

6) cartographic and GIS software standards are many years behind MIS and other industry software standards;
7) the political atmosphere of the organization within which one works can effect the evaluation;
8) quite often a piece of software may look very useful, but due to tricky programming, or lack of in-line comments, or lack of subroutine specifications, or machine dependencies, it cannot be used.

Based on these findings, I would like to suggest that when preparing for and doing software evaluations:

1) a detailed list of system requirements be formulated;
2) do not fall for the "my system does everything you need" hard sell;
3) have a committee with people from different cartographic, remote sensing, and GIS backgrounds do the evaluations;
4) know your organization environment;
5) prepare detailed system evaluation criteria (in case your decisions are questioned);
6) consider cost, time of transport and implementation, ease of use, and maintenance;
7) be prepared to take more time than desired;
8) be prepared not to find a complete system that meets your needs.

Lastly, and perhaps most importantly, be ever wary, do not be overly optimistic, and do not let people press you into making a hasty decision.

DR. MARBLE: Thank you Carl. I would like to underline one point that you made in your discussion, and that is the question about the availability of code from commercial sellers of software in this area. We talk to an awful lot of people, many of whom are end users of this type of thing. I will say that one of the things that seems to bother a lot of them is that they do not like buying something that they cannot see. Many people treat their code as proprietary. I think that this in the long run is probably in error, but probably not as much in error as one system salesman who is even treating his system documentation as proprietary, so that if you buy it you cannot even see the documentation

Our next speaker from the panel is Dr. David Cowen. David is with the Geography faculty at the University of South Carolina during the current year he has been on leave and attached to the Division of Research and Statistical Services of the State of South Carolina. He is in the process of initial design of the statewide information system, and an examination of other systems in the southeast. David?

DR. DAVID COWEN: Thank you, Duane. The purpose of this paper is to report on how five states are coping with the promises as well as the frustrations associated with automated methods of cartography and analysis. It will describe existing software activities in the five states. However, it will also attempt to conceptualize the process by which agencies with statewide responsibilities get involved in the business of automated cartography. The paper is based on the results of a survey of resource information systems in the Atlantic Coastal states stretching from Virginia to Florida which was conducted for the environmental affairs section of the Coastal Plains Regional Commission.

The survey, which spanned more than a year, consisted of both a mail-out questionnaire and a series of on-site visitations. My first conslusion is that questions relating to spatial data handling cannot be easily handled on a written questionnaire. Our on -site visitations often revealed things about operations that would not have been possible from the written response; both understatements and exaggerations indicated on the questionnaire became evident during the interview process. Perhaps a major problem could be solved, or at least alleviated, by correctly identifying the appropriate personnel to answer the questionnaire. Responses seemed to vary systematically between administrative, production and systems people.

It should be recognized that state government bureaucratic structures are likely to be more politically entangled than those at either the federal or local levels. In state government redundancy and overlapping responsibilities abound. Based on my experience, this is especially true in the fields dealing with natural resources. Responsibilities are rarely clearly or adequately defined. Agency decisions are based on the growth potential of the agency itself, rather than on demand or efficiency. Concurrent with the goal of self-aggrandizement, is a basic conservative nature of the agencies that mandates for failures to be avoided at all costs. Any discussion of state wide geographical data processes must be constrained by these assumptions.

Applications of automated cartography, in particular, and geographical information systems, in general, in the five Coastal Plains states are limited essentially to six groups of distinct activities. Three of these are located in Florida, with one each in Georgia, South Carolina and North Carolina. Except for a few activities at the highway department and some experiments at VPI, Virginia tends to be sitting back and observing what the other states are doing. This probably is related to Virginia's excellent USGS Cooperative program and the elimination of its Department of State planning. The six ongoing operations can be grouped as follows: two largely in-house developmental efforts at universities: these are at Florida State and my own university, the University of South Carolina. There are two commercially obtained stand alone mini-systems. One is a M & S system at the Florida Highway Department, and the other is a COMARC system at the North Carolina Land Resources Information System. There are also two operations that are closely linked to federally developed data bases and software. One is a USGS LUDA based operation at the Florida Division of State Planning, and the other is the only truly operational LANDSAT data processing center in the region. The latter is supported by the Georgia Department of Natural Resources, and is located at Georgia Tech. I have a few copies of a handout which describes these six operations in terms of concept, hardware, software and future development.

Instead of going through these descriptions, the remainder of the paper will deal with what I believe are some crucial issues in terms of automated cartography and information systems as viewed from the state government perspective.

One overwhelming conclusion derived from our survey is that any involvement of a state government in automated cartography should come only after a set of serious questions have been asked and some serious research to seek answers has been attempted. This has rarely been the case. Before setting a program, a state must ask itself why it wishes to become involved with automated cartography in the first place. Most of the people in this room may view this as a trivial question. After all, "Isn't automation necessary to get the job done better, faster or cheaper?" I suggest that any honest appraisal of the question would raise serious doubts. For all of its glamour, the actual, day to day operation of automated cartography, at the state level, has a pretty miserable track record, and consequently it still must be considered a risky business. Furthermore, institutional considerations represent considerable barriers to the successful implementation of even the best conceived plan. For example, automation is certain to disrupt interagency relationships. It may be viewed as a direct insult to existing manual operations, particularly those in powerful highway departments or geological survey offices. It also requires the sharing of data among rival agencies. There also remain the more obvious and measurable costs in terms of capital and personnel expenditures involved in automating.

It can be argued that, with but few exceptions, states have been badgered into the business of automation as a result of federal initiatives or federal demands. It has been estimated that there are now more than 130 different pieces of federal legislation that demand display and analysis of various land and water related data. When translated to the state level in the Coastal Plains Region, the requirements for the Coastal Zone Management Act, EPA 208 planning, and environmental impact statements have severely stretched the data processing capabilities and the resources of the states. Thus, states often find themselves being unwilling consumers of federally sponsored programs. When existing data, maps and analytical tools are found to be sorely lacking, automation is offered as a flashy means for overcoming deficiencies.

The next topic to be addressed concerns the manner in which a state agency actually gets started in the business of automated cartography. I suggest that there are three alternatives:

1. a push by a university;

2. a push by an ambitious individual within state government who has the proper political connections;

3. an orderly development process whereby statements of objectives and system components are a logical outgrowth of a careful assessment of needs.

The first two approaches prevail by a wide margin over the third. Computer cartography is now a common part of a university curriculum. Universities, especially state supported ones, love nice public service functions with high visibility. Appropriate agency personnel, often ex-students themselves, are easily convinced to channel some money, in the form of grants, to the university coffers. The university can easily conceal the high cost of research and development and usually it can produce some pretty good protoresearch and development costs, little or no opportunity to evaluate your products, no benchmarks, and little technical support.

The second approach to software procurement involves a search in the public domain. Geographical information system software is available from numerous sources such as those listed in the Inven. Although this approach may minimize initial capital expenditures it suffers from lack of support, poor documentation, poor evaluation procedures, high implementation costs, and a lengthy operationalization period.

The third procurement alternative involves sending out an RFP to commercial vendors. This is exactly the approach both the Florida High Department and the North Carolina Land Resources Information System followed when they obtained their M & S and COMARC systems, respectively. In fact, it may be argued that this is the only logical and legal alternative that a state may have. State law often forces agencies to put out RFP's, obtain three responses to a bid, and go through an evaluation process. Unfortunately, the use of commercial software requires considerable faith in the vendor. It also locks one into a particular method of performing functions and may be unable to manage the masses of data that frequently develop over time. Furthermore, many commercial vendors refuse to provide source code that greatly restricts the ability to modify functions or plan for future system designs. Finally, I will leave you with a question, concerning the resolution of the problems provided by the third alternative, that is near and dear to me at this time. Where does one find commercially available software that can be evaluated, installed on an existing main frame, is available in source code and will be supported? I suggest that there are presently very few alternatives on the market.

The six activities in the five states of the Coastal Plains Region are still in their infancy. I believe that they offer an interesting set of diverse case studies which should be observed carefully over the next few years. Hopefully, we will have some more light to shed on these state level perspectives on geographical data handling at AUTO CARTO IV.

THANK YOU.

(APPLAUSE.)

APPENDIX

Recent Geographical Information Systems in the Coastal Plains

1. Florida Department of Administration, Division of State Planning--Information Systems Section.

    a. Concept: The system is the only geographical information system in the region based primarily on the USGS LUDA data base. The Information Systems Section has put together a hybrid set of display and analytical programs. The group is currently producing land use area calculations for each county and developing analysis of land use by soil type for drainage basins.

    b. Hardware: The system runs on the CDC-CYBER 74 Computer at Florida State University. Communication is handled via a Tektronix 4013 graphics tube and two NCR terminals. A UNIVAC printer and Tektronix 4954 digitizer, with a 30" x 40" table complete the in-house system. The system utilizes an 11" Gould 80 dot/inch electrostatic plotter and a 22" Versatec 200 dot/inch electrostatic plotter at FSU.

    c. Software: The base for this system is the automatic polygon building program from the USGS. The program takes LUDA arc segments to construct the necessary polygons. The program has been modified to detect and correct some additional errors. Other programs have been developed to create additional files, perform simple interactive editing functions, merge adjacent sheets and convert to other coordinate systems.

       Some particularly innovative software converts arcs to rasters for area calculations and polygon overlaying. Graphic display, until recently, has been limited to packages such as AUTOPLOT, however, now they have developed their own plotting functions. All programs are in FORTRAN, however, they are not presently well documented.

    d. Future Developments: The group is presently working on the development of a grid cell to polygon conversion program and examining the utility of the Defense Mapping Agency's digital terrain tapes.

2. Florida Bureau of Coastal Zone Planning and the Florida Resources and Environmental Analysis Center (FREAC).

    a. Concept: FREAC, which is part of the Geography Department at FSU, is a software subcontractor to the Bureau of Coastal Zone Planning. Using maps derived from color aerial photography from the Department of Transportation, the group is digitizing bio-physical data for the coastal zone. The purpose of the project is to produce an inventory of land use.

b. Hardware: This system is also connected to the FSU CDC-CYBER 74 computer which is accessed via Tektronix terminals and digitizers at both installations. The Gould and Versatec plotters are the basic display devices.

c. Software: Since the basic function of the system is area calculation the data areas are double digitized. For graphic display they have developed a procedure to "desliver" the overlapping line segments. Programs also exist to convert polygons to grid cells and alter coordinate systems.

d. Future Developments. There is a close working relationship between FREAC and the Department of State Planning Staff. Since programs developed by the two groups exist on the same computer there is easy interchange. Consequently, they often work together in the development of new programs that improve the system capabilities.

3. Florida Department of Transportation, Division of Road Operations-Remote Sensing Section.

a. Concept: This group maintains one of the most fully integrated systems in the Region. They have recently installed a highly sophisticated interactive graphics system. This system is used to supplement a full range of geographically related operations (e.g., stereoplotting, county highway map production, land use and vegetation mapping). The system is considered to be the final stage of a process that begins with aerial photography, and includes photographic processing and photo-grammetric engineering.

b. Hardware: The basic configuration consists of a fully integrated interactive graphics design system which was purchased from M and S Computing, Incorporated. The system is based on a Digital Equipment Corporation (DEC)PDP 11/70 mini-computer. There are two disk packs and a disk data scanner attached to the CPU. Each of the five digitizing stations is basically equipped with two Tektronix graphics terminals and Summagraphics digitizers which have extensive menu capabilities. A large flatbed, Kongsberg drafting table is the main plotting device. The office also possesses a Spatial Data 704 color image processor.

c. Software: The key part of the software is an extensive set of modular programs which are addressable through the keyboard or the menu. The programs have considerable internal documentation and conversational language commands. The key programs for geographical applications consist of: interactive construction of geometric elements, with up to 32 line weights, which can be created by digitizing or by drawing directly on the screen; graphic manipulation; geometric element grouping; selective display modes; geometric measurement, line drawing and symbology; automatic dimensioning; and an elaborate text system, with up to 255 different fonts. (Geographical applications are considered by M and S to be simply a subset of the general graphics problem).

d. Future Developments: The Department plans to add digital linkage of the color image processing system to the M and S network. This will enable them to automatically classify and digitize land cover characteristics from photography. M and S is developing additional geographical software for the Department. The major part of this involves polygon overlaying capabilities.

4. South Carolina Consortium (Coastal Zone Planning Office, Budget and Control Board--Division of Research and Statistical Services, Land Resources Conservation Commission, and USC Computer Services Division).

   a. Concept: Over the past four years the USC Computer Services Division has developed an extensive high quality digitizing, editing and plotting system. This system has primarily been employed to produce updated USGS quad sheets for the Coastal Zone. The sheets were developed from orthophoto quads and new aerial photography. The system now consists of a complex set of display and analytical procedures. By digitizing soil survey sheets, the Land Resources Conservation Commission is utilizing the system to produce composite soil maps at the quad sheet scale.

   b. Hardware: The system runs on the University's IBM 370/168, which is augmented by 7 megabytes of real core and a mass storage unit. There are two Bendix digitizers on-line to the 370. Access and manipulation functions are conducted on Tektronix terminals, Telray CRTs and a Princeton graphics terminal. The graphics hardware consists of a CALCOMP 738 flatbed plotter and a 21" Gould electrostatic plotter that runs on-line through a DATA 100 remote job entry terminal. The graphics hardware consists of a CALCOMP 738 flatbed plotter and a 21" Gould electrostatic plotter that runs on-line through a DATA 100 remote job entry terminal.

c. Software: The programs consist of about eighty modules, written in APL. Permanent data storage is contained in IMS and retrieved through APL. A key feature of this system is the ability to access the functions and edit from remote terminals via telephone. The graphics system was originally designed to digitize and display line segments. Each line was considered to be a boundary between two areas (e.g., low marsh to high marsh). Lines were stored with two labels and could be retrieved as desired to produce a set of overlays or a composite map. Symbolizations and labels were entered through the digitizer. Programs were developed to scale, window, merge, plot various line types, and perform selected editing functions. The system now has evolved into a more extensive information arrangement. At present, polygons can be formed by double digitizing. Other procedures have been developed to form polygons interactively from the existing line segment data base. An extensive set of software packages are also available. These include: SYMAP, CALFORM, SYMVU, AUTOMAP, SURFACE II, STAMPEDE, GRID, GRIDS, and POLYVRT.

d. Future Developments: The S. C. Consortium has a number of procedures in the Developmental stage. These include automatic polygon construction and polygon overlay. They are also involved in several demonstration projects with NASA. Plans are presently underway to install LANDSAT processing software and make it part of the overall system.

5. North Carolina Land Resources Information Service.

a. Concept: The North Carolina Land Resources Information Service evolved as part of the 1974 Land Policy Act. The mission of the Service is to provide the necessary geographical analysis and display capabilities for practically any conceivable application. After developing an extensive request for a proposal, the group surveyed the private market for a total integrated stand-alone system eventually deciding upon COMARC Design Systems. This system has recently been installed and has begun functioning. The service plans to use the system for numerous projects, such as EPA 208. The philosophy of the service, however, is to allow individual agencies to utilize the system themselves for their own specialized requirement. DMA digital terrain tapes have been obtained and a one degree square is being analyzed.

b. Hardware: The system is based on a Data General Eclipse mini-computer with 128 KB core storage and 96 MB disk space. Peripherials include a 9 track tape drive, 300 line/minute printer, a Data General CRT, a Tektronix graphic terminal, a Zeta drum plotter and a Talos digitizing station.

c. Software: The COMARC approach is to provide a full range of data input modes (e.g., polygons, grids, and topography). These data can be stored, manipulated and displayed in a variety of manners. The software consists of two conversational packages. The first, DBI (Data Base Implementation), handles the functions necessary for creating the file. The second, COMPIS (COMARC Planning Information System), handles the analytical and display functions. The software has extensive manipulative and transforming capabilities. Its polygon input format was based on double digitizing, however, the company has developed the ability to read LUDA arc files. The analytical aspects of the software relies on polygon to grid and grid to polygon conversions. The latter procedure being a recent addition to the system. The system also incorporated a polygon overlay system and extensive reporting procedures. Topographical data can be input from grids or directly by digitizing contour lines. Innovative programs convert the contour into grids which can be employed to calculate aspect, slope, drainage, cut and fill and view exposure. The three dimensional perspective plot has an option for overlaying polygons for reference. Polygon plots are typically enhanced manually with the aid of color markers. The company considers their software to comprise an analytical system first, and a cartographic system second. The software is licensed and not distributed in source code.

d. Future Developments: The North Carolina group has requested COMARC to upgrade some of their display programs. They also plan to incorporate LUDA and LANDSAT classified tapes as part of their system. Future plans call for several additional digitizing stations.

6. Georgia Department of Natural Resources--Office of Planning and Research, and Georgia Tech Department of Experimental Engineering.

a. Concept: These groups have established the only truly operational LANDSAT computer tape processing system with the Region, at the state level. They are presently experimenting with the use of LANDSAT as the basis for an integrated system. This system will include a wide variety of other data formats. At present, they are also planning an extensive test of these procedures for one county. The group is involved in producing statewide land cover maps and EPA 208 projects for several regional planning organizations.

b. Hardware: The system is based on a Data General NOVA 2 mini-computer, with 32 KB core storage. There are two disk packs and a dual density tape drive. The system uses a COMTAL color image processor and a Versatec electrostatic plotter. This configuration is one of the least expensive LANDSAT processing systems.

c. Software: The key components of this software relate to LANDSAT data processing. These procedures consist of a hybrid of NASA's classification and geographical referencing programs. The software permits a complete set of interactive analysis of the data on the COMTAL unit. Graphical display programs include IMGRID, from Harvard, and other plotting procedures.

d. Future Developments: The experiments planned by this group should provide excellent information regarding the comparative merits of LANDSAT and LUDA. The intensive experiment within one selected county are designed to obtain detailed cost and manpower requirements.

DR. MARBLE: Thank you, David. That was an illuminating discussion on some of the problems that are faced in a sta getting into this type of activity. One of the things tha both Carl and David have underlined is the difficulty of evaluating existing software. This is something that we originally thought of doing as part of our inventory, and soon stopped for many of the reasons that Carl outlined, because it is very difficult to design any type of a bench markwhich is usable on more than one or two systems. They have widely varying requirements for data in terms of form quality, data structures, and, in many cases, the producti of the benchmark information for evaluation would be more work than reproducing or rediscovering the software itself The evaluation of software as a computer science topic is a very recent development, and the notion of a software science is a new one. There are techniques being developed, and it is hoped that within the next few years we will be in a better position to design benchmark tests for much of the spatial data-handling software.

The final speaker from the panel is Dr. Kurt Brassel, a colleague of mine from the faculty at Buffalo. Kurt received his training in cartography in Switzerland, and has been particularly interested in the development of algorithms for work in computer cartography. He is also in cha of the section of the inventory dealing with computer cartography and computergraphics. Kurt?

FUTURE TASKS IN CARTOGRAPHIC SOFTWARE DEVELOPMENT

DR. KURT BRASSEL, Department of Geography, State University of New York at Buffalo.

The Author has participated in the activities of the IGU Commission on Geographical Data Sensing and Processing to compile an inventory of computer software for geographical data handling; in particular I have been in charge of mapping and display procedures. Based on these experiences, this paper points out some unsolved problems or problems which the author at this time does not know solutions for. I am not a forecaster; I am presenting a very personal view based on my background and my special interests in the field. I am presenting questions rather than giving answers. I would not be surprised that if during this conference someone would tell me, "Well, the future you are talking about is today."

I would like to compare the development of automated mapping with the civilization of a continent and distinguish the following three phases:

DISCOVERY
SETTLEMENT
LAW AND ORDER

Overall, I would assume that computer mapping today is in the settlement phase, and the unofficial theme of this conference: "Let us Computer Cartography Bring to Work" is a good indicator of this. Of course, discovery processes should go on simultaneously. On the other hand, some efforts to set up standards for computer graphics are under way, an indication of first elements to establish a state of law and order.

It is my contention that traditional cartography as an overall discipline has reached a state of 'law and order.' This has caused some problems in the past in that cartographers have not been entirely in charge of developments in automated map production, and non-cartographers have been active in the field. The activities of these cartographically untrained outsiders may be labelled as "map mechanics', and their products were quite often below traditional cartographic standards. But we are now in the phase of settlement, and the need for remarrying map perception and advance map mechanics is generally recognized. Thus, where do we stand today, what is needed, what are the tasks and developments ahead with respect to cartographic computer software? Our future efforts have to be directed toward problems on various levels. The following list summarizes the several points which will be addressed in this brief discussion of future tasks and developments:

- DOCUMENTATION AND COMMUNICATION
- STANDARDS
- IMPROVEMENT OF ALGORITHM EFFICIENCY
- DEVELOPMENT OF ADEQUATE DATA STRUCTURES
- IMITATION OF TRADITIONAL CARTOGRAPHIC PROCESSES
- MODELS BEYOND THE TRADITIONAL MAPPING CONCEPTS

DOCUMENTATION AND COMMUNICATION: The compilation of an inventory of cartographic computer software as mentioned above is a first effort to get an overview of the multitude of programming activities in the field. Experiences with this material show a duplication of efforts (33 choropleth shading programs and 25 contouring programs have been recorded so far) and a general lack of information exchange between the various program authors. A first step to remedy this situation is a more rigorous documentation of program packages and the establishment of channels for systematic mutual communication. This then leads to the establishment of meaningful priorities and avoids wasteful duplication. Other efforts are needed to establish reasonable institutional transfer mechanisms for graphics software: Some institutions and individuals distribute their software free of charge, others take full commercial advantage of their products.

CARTOGRAPHIC SOFTWARE STANDARDS: The special interest groups on computer graphics of the association for computing, SIGGRAPH, is in a process of establishing standards for computer graphics. This brings up the question as to whether similar endeavors should be undertaken with respect to mapping software. Should we define base rules for the definition of map design features in mapping packages and the structuring of command language elements? Is the time ready now, or has computer cartography to settle down further first? An answer to these questions will have to consider such aspects as freedom of the program authors and ease of use of cartographic software by a wide range of users.

IMPROVEMENT OF ALGORITHM EFFICIENCY: A further area to work on is the improvement of algorithm efficiency, i.e. the technical improvement of processes for which algorithms are available at the present time. They include more efficient codification of given algorithms, the development of new and faster algorithms and the design of new strategies to perform a particular cartographic task. To illustrate the last point we use isarithmic shading as an example: If the data base for this task consists of contour records of strings of coordinates without any additional information attached to them, this shading task is rather tedious, if not impossible. If, however, to each contour record some reference pointers to neighbor contours are added, the search for neighboring contours is eliminated. My point here is that for this task it is not necessarily important to develop fast search procedures, but rather, a clever and mutual scheme of algorithms and data structures which will then yield best results. This brings us to the next point of discussion.

DEVELOPMENT OF ADEQUATE DATA STRUCTURES: In the overall automated mapping process, raw data are subject to a data capture process for the creation of machine-readable information in 'input-related' data organizations. Rather than accessing this data by the display routines directly, the spatial information is restructured into a 'goal-related' organization. A display task may become trivial if it can be based on an appropriate data structure. Goal-related data organizations are dependent upon the respective applications; they may range from simple to very complex. Base files to be used for sophisticated cartographic tasks should allow access to the totality of geographical reality. Cartographic base files as virtual maps should facilitate the same mental operations as paper maps or the actual geographical reality. They should be able to provide information about the total neighborhood of a feature if we want to use them for such tasks as generalization or name placement. We may have to go even further by defining neighborhood relations in hierarchical manner, and design data structures which do not only connect map features with adjacent map elements but with significant elements at farther distances as well.

IMITATION OF TRADITIONAL CARTOGRAPHIC PROCESSES: In this phase of settlement, computer cartography has to make efforts to develop procedures for the imitation of traditional map products of sufficient cartographic quality. Being aware of the fact that highest cartographic standards as provided by manual craftsmanship may not be achieved by automated means in all respects the development of more sophisticated models may still provide acceptable map results which are economically feasible. As examples we may mention the imitation of manual hill-shading, map generalization and automatic name placement. In order to approach these problems, we have to go back to the source and find out how traditional cartographers have solved these problems, take their work as standards, and try to find automated solutions.

Other problems relating to higher standards in computer mapping have to do with efforts to improve the map design. Some of these deal with, as it seems, minor details, but they are nevertheless indicative of map quality. Each cartographer is aware of the irregular point symbol densities along boundary lines in vector type shading programs. It is a minor problem, but it needs some attention. Further, the problem of legend design must be taken more seriously by producers of computer maps in order to allow for adequate map communication. Map design adjustments in automated mapping require the computation of non-trivial global map parameters. An example would be the computation of the scaling factor for the unit circle radius in graduated circle mapping which generates an optimum symbol density. A common response would be that this can be done by interactive methods. It is my contention, however, that whenever it is technically possible and economically feasible to fully automate a task, this should be done. Interactive handling of an automatable job is a waste of human and computer resources. Interactive methods have their place where perception and design problems occur. My recipe: Produce by automated means a map which on the average is expected to be the best solution, and then adjust with interactive methods the inadequacies due to individual features on the map.

MODELS BEYOND TRADITIONAL MAPPING CONCEPTS: A further category of future tasks is the development of new cartographic methods which go beyond the imitation of representation by traditional cartography. Recent examples in this group are the design of contiguous and non-contiguous area cartograms by Tobler and Olson, and the use of Chernoff's cartoon faces for multivariate data representation. Among cartographic methods to be developed are displays, which enable the simultaneous representation of two statistical surfaces, and models for dasymetric mapping.

Let me conclude with mentioning a class of envisioned developments which clearly go beyond traditional mapping: Based on recommendations of a group of cartographers, the Defence Advanced Research Projects Agency (ARPA) has put together a catalog of desirable developments in search for maps which allow for improved access to spatial information. We should develop map methods which allow us to feed more information to the brain per time unit. They also desire mapping-by-yourself systems, where the map user can design a map for his needs and according to his map reading capabilities. They further promote real world graphics dynamic displays, which simulate real world experience by 'flying' through geographic base files. Other ideas include maps which match the cognitive abilities of the map reader by replacing the concept of accurate maps by the concept of accurate mental maps, maps which compensate for perceptual distortions. Finally, they offer to rethink the relationship between verbal and visual means to describe space: Are visual maps in all cases the most efficient means to communicate spatial concepts or would verbal description of space in certain instances be advantageous, and how can the various methods be more efficiently combined?

DR. MARBLE: Thank you, Kurt. The presentations that we have had so far have been designed largely to lay a groundwork for discussion. One point I would like to make, particularly about the inventory operations and about some of the things that Kurt has talked about is that the existence of the inventory not only enables us to isolate areas of redundancy, it also enables us to isolate the gaps as well; things that people are not doing. This is very interesting in a research sense.

One general plea about software, particularly in the area of computer cartography: There is a recent book by Nicholas Wirth which is entitled Data Structures Plus Algorithms Equals Programs. It is a good book and I recommend it to your attention. Here we have the converse problem in that we have programs, and from them we must deduce the algorithms and data structures. This is devilishly hard to do. So, one plea I would make to you is that you document your work so that others can benefit not only by your bright ideas, but by your mistakes. In very few of the programs encountered do we see explicit discussion of either data structures or algorithms, and to try to pull them out of existing code is very, very difficult. This is one of the things that we need to do if we are to improve the information transfer in this area.

I would now like to throw the floor open for discussion. You can, as far as I am concerned, make individual points, address questions to members of the panel, or to the panel as a whole. Please, when you speak come to the microphone and identify yourself and your organization.

MR. SID WITTICK: I do not believe that we should forget the benefit of experience that has been brought forth today from the panel members -- these are a set of rules which are going to be useful in our own planning. I think it is perhaps worthwhile to add an encouraging note to some of these comments, and that is that there are some exceptions. At least one system that is attempting to come a ways in this direction. I speak of the GIMS system. There will be a bit of a display outside. I think there are on the order of 20,000 lines of code, including a lot of in-line documentation within those lines. But there are also 10,000 lines of algorithm description that are also associated with that system. It provides an example of a university environment where there has been some continuity, where they have produced a product that is being maintained. It is an example, I think, of a dynamic system that is working towards many of the futuristic things that are being asked for.

DR. MARBLE: Sid, before you go away, let me ask you a question: You have mentioned the documentation that has been developed by you and Tom in Canada. Is it intended to make this widely available? Can people write and get copies?

MR. WITTICK: I remember that you did not get the copy you asked for. (Laughter). We received a request from the director of the program library at the University of Edinburgh, where the program was or is resident, asking whether or not this documentation is available to them. We more or less replied that we would like to make it available to the Program Library Unit so as to make it available to others, but added the catch that they not charge for it.

DR. MARBLE: Do we have other comments or inquiries from audience?

MR. FRED BROOME: Fred Broome, U.S. Bureau of the Census. I would like to ask Mr. Reed or Mr. Cowen if they have found any automated cartographic systems in use in a policy making mode, in a daily activity? If so, would they mention them.

MR. REED: I am aware of one system that is used in a policy mode. The San Jose Police force, about two years ago, got together with IBM to utilize a system called GADS, which is a geographic analysis and display system. The used GADS to work up beat scheduling for the different precincts in the city. I think they are still using it. It is a totally interative system that uses a geographic base file, a street network associated with the police beat, crime and other information, and it uses a refresh CRT. They got all the police officers and the management involved in doing this beat assignment procedure. It is the only one that I am aware of right now.

MR. COWEN: Speaking from strictly the state government level in the five states that we were involved in, I would have to at first glance say, no, I do not see anything that is working on a daily basis in a policy decision role. I think actually some of the work that we have going on in South Carolina comes closest to that in terms of a series of updated maps of seven and a half minute quadrangles and wet lands inventories and land uses that have been developed for the Coastal Zone. Presently those materials are being put into a form where they can be used to make actual decisions about permitting land use activities in the State of South Carolina, in the Coastal Zone.

Part of the evaluation that we are going through right now, to change what essentially was a cartographic system into an information system, is trying to address exactly that need. People are beginning to realize that we are not just interested in pretty maps, we are interested in a lot more than that. We are interested in the area calculations and inventory and overlays and other things that are essential to come to real decisions about things like getting a permit. You have to realize that in most of the states that we are talking about in the Southeast there has traditionally been -- "Well, if you did not tell somebody he could not do something. . ." So now we are faced with the problem if we are going to say, "No, you cannot do that particular development," we need good information to back that up. Otherwise we are going to be in a lot of trouble.

MR. REED: I just thought of two other systems as well. Boulder County in Colorado has the Boulder County mapping project where they digitize a lot of their land use and demographic information and use it to help win arguments in the Common Council to get more bucks. Is Carl Youngmann here? He has been doing some stuff in Washington on the coastal survey and assessment, that is also going to be used, I think, if I remember correctly, in some policy decisions.

MR. AL GORNY: Al Gorny from Central Intelligence. Just a few points. In discussing GADS, which was being used, we had looked at GADS, and GADS was always considered from what we could find to be an R & D effort on the part of IBM and has never been actively marketed or pushed. I agree with the speakers, that it is very difficult to find some of the geographic information systems which are available. As a point, I noticed that Carl had mentioned he had surfaced about 85 originally, and Kurt's Vu-graph mentioned he had found 22. We have also experienced that, when you write away you get back "person not found, system not found, laboratory disappeared," or something like that.

We have also come to the conclusion that it is much easier to evaluate the hardware and the software in the systems of others than it is to define the perfect mix for yourself in a system and to objectively evaluate yourself. In-house development usually requires coordination between various offices within an agency, and sometimes you end up trying to make system analysts or programmers out of geographers and cartographers or vice versa. In many cases current programs or projects may not allow you to get the proper manpower mix or even the manpower at all. You also run into a lack of experienced people within certain agencies in using some systems, and that when system availability, as is in our case, is imperative, that with a mix of hardware and software, it is just much easier to pick up the telephone and make a single call for maintenance versus trying to identify the exact problem yourself and then trying to get the people to come in and agree whose problem it is. Thank you.

DR. MARBLE: Thank you.

MR. AVI DEGANI: My name is Avi Degani, Department of Geography, Tel Aviv University. I was listening with great interest to the three speakers. By listening I could relate much of what was said to my experiences, and I think I would like to share some of this with you. I think that one problem that I have been facing all the time is the increasing recognition that what at one time was a map user has turned out to be a map maker by the aid of computers. I think that we tend to overlook or underestimate the severe problems that arise because of this. What I mean is very simply in the past many people who make use of maps, such as the planners and many other people, used to just refer to existing knowledge in the map making sciences, and prepare just those types of maps that they were asked to prepare and had to use, or else they would go to the map maker and ask him to do one for them.

At present, when so many software packages are available for sale, I think that many people buy the packages and are able to use them as they are, but are not able to understand the algorithms, partially because we do not have the write-ups or the analyses of algorithms, and partially because they are not in the business of doing this, they are just in the business of using maps. There is a great gap developing, and a great many of the maps that are produced today -- and, ironically, by good computers, terrific hardware -- are just very bad maps. I think this trend is increasing and this is very bad.

Another interesting problem which is related somehow is how government at various levels is utilizing the type of thing that we are able to produce in terms of automated cartography. We tend to forget sometimes that a map is only a tool, and cartography is only a technique, and of course, a computer is only a piece of hardware. Because when we go to the government at various levels and we try to promote usage of what we are creating, they most times are unable to define what their problems are. It tends to be a procedure, from my experience, at least, and I think I have heard something of this from Dr. Cowen's remarks and also in Mr. Reed's remarks -- it tends to be a procedure whereby we go to the field, we ask the people what actually do you have to do, what actually are your problems, and they find it very difficult to define.

I have been working for better than a year in Israel on a developmental, what we call "ISRAMAP," which is "Information System for Regional Automated Mapping Analysis and Planning," for the Ministry of Interior. It is supposed to handle regional as well as urban levels building a data bank and so on. We have been spending the better part of the last year going from one mayor to another mayor, from one city official to another city official, and trying to ask them what really are your problems. It turns out that we think we can do more for them than they can appreciate at the moment. I would suggest very seriously that we devote in the next meeting more discussion along this line, because this is quite a gap we have to bridge. Thank you.

DR. MARBLE: Thank you very much. I would like to take an opportunity to underscore your comments. We are somewhat off the question of software per se, but we are getting into the critical area of what constitutes adequate system design. Too often we are concerned mainly with things like software and hardware, and do not pay enough attention to the things that you have mentioned just now and the type of things that Rupe mentioned in his discussion yesterday. In many cases we have found in our examination of systems, not only mapping systems but other types of geographic information systems as well, that the major reasons for failure in the system have not been technical. The hardware has been adequate, the software has been adequate; the system is nearly unused. This is a common scenario, and most frequently it arises out of the fact that system building has been viewed as a technical design problem, and it has been constructed by technicians to do what they think is most useful. It turns out that the system is a perfect tool for answering questions that no one particularly wants to ask. We must be very careful to avoid that. The system design model developed by Hugh Calkins provides a sound basis for this.

One other problem, of course, in the software area is the tendency that if something is there and can be used, then pick it up and use it, whether it is really appropriate or not. We see many cases of that. I think your suggestion about the emphasis in the next AUTO CARTO program was a good one.

MR. TOM WAUGH: I am Tom Waugh, University of Edinburg. I have been a bit distressed by the notes of gloom and despondency that have been passed around this morning. I think I would like to bring a slightly more optimistic or sunny note. I am going to relate it completely to the United Kingdom, and it relates back to Fred Broome's question, which systems are there that are in existence and are being used? And Carl thought one, maybe two, maybe three or something that he knew about. I can give some examples from the United Kingdom where in fact there are systems that are running and have been running, are well documented, the software is available, and are used in a day-to-day production and policy environment. Probably the most obvious is the work of the Ordnance Survey, who produce up to 3,000 maps per year, one to 1250 scale in a production environment by computer methods. They are working on a one to 10,000 scale, the one to 25,000 scale, and they have now started on the one to 50,000 scale. If there were somebody here from the Ordnance Survey I am sure he would say they were all still pilot projects, but I think that they are really being quite serious about it. The Department of the Environment runs a system called LINMAP, which produces fairly crude line printer maps. They produce up to 700 maps a year. It is decreasing at the moment, since the use of the '71 census is dropping. That is used day-to-day in production with fairly well documented software and is used in a policy environment by central government in London.

In my own town, in Edinburgh, the Department of Geography runs a service bureau which services central government agencies in the Scottish area, particularly the Scottish Tourist Board and the Scottish Nature Conservatory, the Scottish Development Department, the Department of Forestry; there are about three or four. They run at least three different sets of software on a day-to-day production environment, two of them being mapping, one coarse mapping, one medium quality and high quality, and they also run SPSS and other facilities. That is day-to-day and is used in a policy environment. These maps and charts and everything are used in committees up the national level. Now, it comes down to whether or not you believe these maps are useful or the tables of statistics or whatever are useful. But I think it should be made quite clear that there is software available which is being used in a production environment, and it is not quite as bad as perhaps has been painted this morning.

MR. REED: I would like to add a little note. I was not trying to be overly gloomy. The reason for that final 30 percent figure was that the U.S. Fish and Wildlife Service does have a fairly unique set of requirements, especially spatial analysis. I should append my little talk by saying that well over half the cartographic requirements are going to be fulfilled by existing software. The most problems we have had are in such things as spatial searches, such as proximity, the kind of thing Wildlife people call interspersion and stuff like that, that just does not exist anywhere in any usable format that we have found. The cartographic software does seem to be in much better shape than that in spatial analysis.

DR. BRASSEL: I would see this problem in a slightly different light. It is not that the products that are produced are not necessarily good for the task which they could be used for, but maybe it is a public relations problem, that government or the agencies are afraid or maybe they are not introduced properly to the new tools. Maybe we should look at that. But a careful introduction and a long process of making these people aware of these tools is probably important.

MR. COWEN: I would like to respond to that also. I have no doubt as to the technological capabilities of a number of systems. Part of my work in terms of giving advice to people, say in South Carolina, has been to look extensively through the inventory to see what is going on. We are well aware that there are a number of places where things are working. The next question, though, is somebody says here is some amount of money, acquire that material and make sure that it works. Now, how can you go to a university setting or even public domain, ask them, "Are you willing to respond to an RFP? Are you willing to do a benchmark test for us? Will you come and install your system and train us in how to use it?" I think there is the big dilemma that one is faced with -- given the constraints in a governmental setting where they think they can go out and buy what they want to off the shelf, they can have somebody install it and give them some training; it does not exist in the field of automated cartography.

MR. TONY VAN CUREN: I am Tony Van Curen from San Bernardino County. We have an application which is one I think is fairly common among government agencies. We are trying to institute a mapping program to handle an enormous data base that was never intended to be mapped. In setting system standards, I would like to emphasize something that I think we are all aware of, and that is, quite often mapping systems are going to have to be integrated into an environment which was not intended for mapping. I hope to see in the future people in computer sciences, people who are more familiar than we geographers, planners and various user groups; put more effort into coming up with means by which we can interface these relatively incompatible data sets. This has been a burning issue with us because we end up having to write a lot of software that we would much rather buy, but we do not have anyone offering it to us.

MR. WITTICK: Just a couple of short comments. With regard to being able to find firms or agencies that would be willing to do all these things in terms of installing and training and so forth; it is a matter of money. If you are willing to pay for it, most places will provide anything, especially in the private domain. We have another system for what I call reference mapping, and there are some people here from private firms, and I am sure they will confirm the fact that if I am willing to pay, they will train me until I am sick of being trained, document till I am sick of documentation.

I have had the good fortune of coming from a conference in Hawaii on management information systems. All the problems we are having here are the same for management information systems as well. We now have the technology and are trying to bridge the gap between the tools and the user. I guess I am going to pose a very simple question: What makes us thing that there are not supposed to be problems? We have tried all the advice being given by various people. We have tried to plan, and people say, "What are you thinking about '86 for? It is only 1977." We tried to get equipment in early so we would have lead time so we can train, and people say, "Well, what are you really going to use the equipment for?" What makes us think that there are not problems? If there were not problems, maybe we would all be out of jobs.

DR. MARBLE: There are certainly problems, Sid. One of the major problems, though, is recognizing what are the problems in the system. As a general comment about attempting to acquire software in this area, one of the things that I would say, based on personal experience and observations, is that it is absolutely disastrous to go into the market with an RFP for a large sum of money. You will get every single commercial firm that has ever done any software for anything coming out and saying, yes, we will do it for you. And I know several systems that have been developed this way at great expense by firms with no knowledge of spatial data handling which at best just "sort of run."

Spatial data is not airline reservations, nor insurance company records, nor bank accounts. We have various special problems with spatial data. These problems are ones that we tend to recognize intuitively because of our work in cartography and allied areas. They are problems that are not generally intuitively obvious to someone from computer science or engineering who suddenly takes up a spatial data handling project. The cases in this area are numerous indeed, as are the horror stories associated with them.

We must remember that in dealing with spatial data we are dealing with something that is quite different from the standard forms of data handling. Sid, and, I think, someone else also mentioned the work in management information systems. There are some commonalities, but there are also some differences. We have to be alert to both the commonalities and the differences. On that point I will close this session.