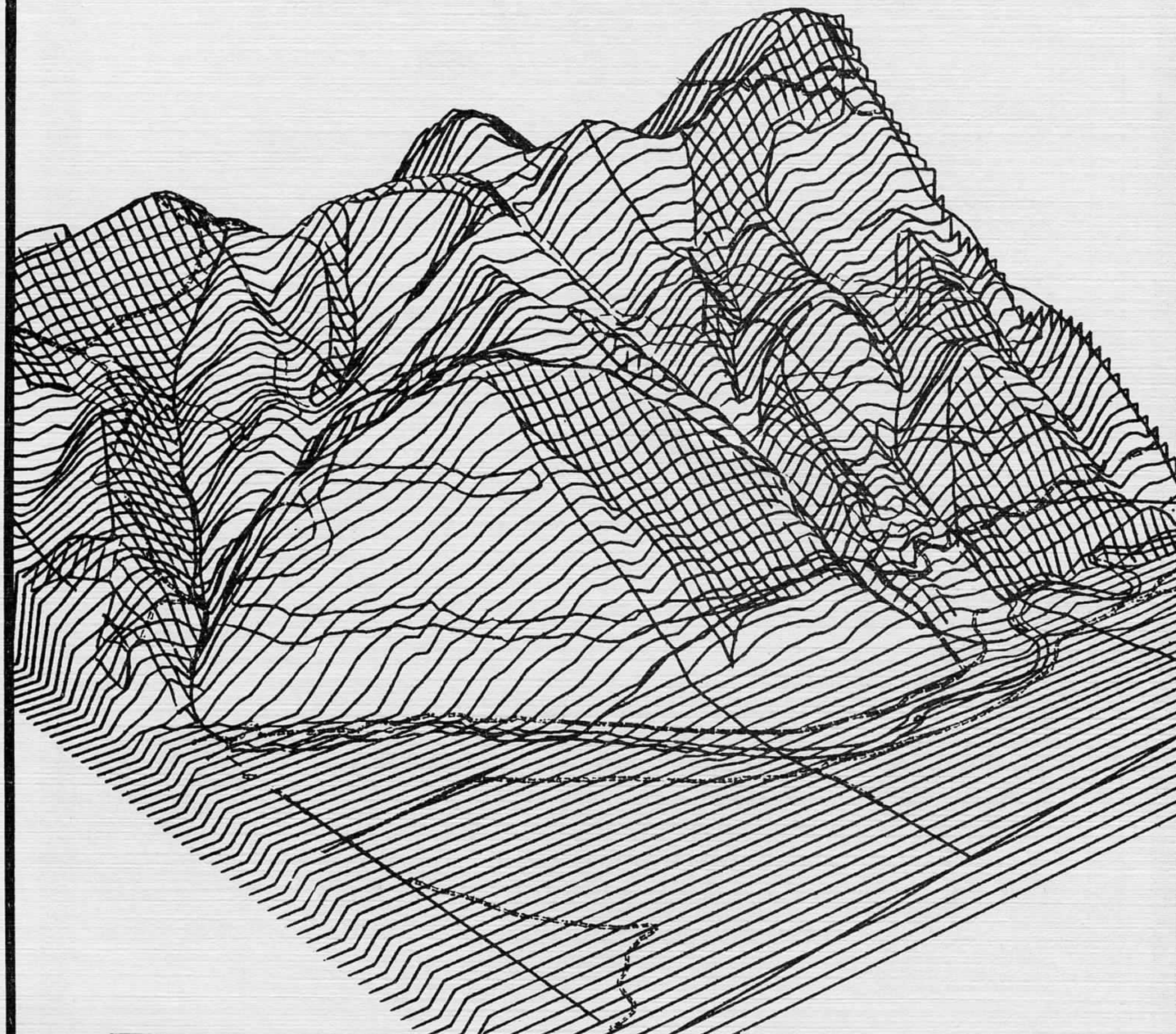

MONTANA GIS:

Toward a Better Understanding

December 4-6, 1990 Missoula, Montana

1990 Montana GIS Conference

Planning Committee

Conference Chair:
Ken Wall, University of Montana, School of Forestry

Program Chair:
Allan Cox, Natural Resource Information System (NRIS), Montana State Library

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Joan Steber-Stewart, US Forest Service, Region 1
Hans Zuuring, University of Montana, School of Forestry

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Phil Rosine, Montana Department of State Lands
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Special Thanks: The Planning Committee wishes to thank the Center For Continuing Education, University of Montana, for its administrative and logistical support, and Steven Holloway, Oikos Works, for the cover art for this program and the conference brochure.

Welcome

to the

1990 Montana GIS Conference:
Toward a Better Understanding

> ## WHAT IS GIS?
>
> An automated geographic information system (GIS) is a tool for managing geographic feature location data and data related to those features. A GIS provides the ability to input, edit, query, and output spatial data and their attributes. In a GIS, the map data are separated into common thematic data layers, and these layers can be manipulated to derive new data, to perform complex spatial analyses, and to generate maps and reports tailored to specific needs.

This third annual Montana GIS conference promises to be the best ever. The conference is sponsored by the **Montana GIS Users Group**, a statewide consortium of governmental agencies and businesses involved with GIS technology. Serving as host for this year's conference is the University of Montana, School of Forestry.

Past conferences have focused on "What is GIS?" and "What are Montanans doing with GIS?" This year's conference theme is education, with a focus on "How to make better use of GIS."

The keynote speech, *Learning, Using, and Teaching GIS*, will be delivered by Dr. Robert Rogerson, Executive Director of the Institute for GIS in Education, from Ottawa, Ontario.

More than 50 presentations have been arranged into four **plenary sessions** and **three concurrent session tracks**. The ENTRY track is designed for novice GIS users with little or no GIS experience. These people may have other professional skills and education but are new to GIS. The TECHNICAL track is for experienced GIS users who want to learn more about particular topics. The MANAGEMENT track is for managers who have or will have the responsibility of establishing and/or operating a GIS. Consult the abstracts to determine which sessions best suit your diverse needs, interests, and skills.

The conference also features several **exhibits** of GIS-related products and services, **informational posters** about Montana GIS projects, and a host of other **demonstrations, video presentations**, and **facility tours** in the Missoula area. And don't forget the **Wednesday night social**.

The Conference Planning Committee has designed an exciting and challenging program, and looks forward to your participation. Thank you for coming.

	WORKSHOPS: TUESDAY DECEMBER 4, 1990
7:30 am - 8:00 am	Registration
8:00 am - Noon	*Introduction to GIS: Basic Concepts* Ballroom A, Holiday Inn Parkside Allan Cox, Natural Resource Information System, Montana State Library
12:30 - 1:00 pm	Registration
1:00 pm - 5:00 pm	*Global Positioning System and GIS* Ballroom C, Holiday Inn Parkside Thad Mauney, Craig Bacino, and Burt Kilbourne, GeoResearch, Inc. David Dean, Electronic Data Solutions
1:00 pm - 5:00 pm	*GIS Start-up Considerations* Ballroom B, Holiday Inn Parkside Don Riemer, Foretrends Consulting, Inc.
1:00 pm - 5:00 pm	*City/County Planning GIS Applications* Ballroom A, Holiday Inn Parkside Kirsty Burt, City of Bellevue, Washington
1:00 pm - 5:00 pm	*Cartography and GIS* University of Montana Social Science Building, Room 258 Bill Carstensen, Virginia Tech and Paul Wilson, University of Montana
1:00 pm - 5:00 pm	*"Hands-on" Workshop* University of Montana Forestry Building, Room 202 Hans Zuuring, University of Montana

The abstracts are grouped by track (i.e., Entry, Technical, and Management) and session. The abstracts are indexed to the program schedule by a presentation number. The number represents the track, session, and sequential number for each presentation within a session. For example, T302 is the second presentation in the third Technical Track concurrent session. (T = Technical, 30 = Third Session, 2 = second presentation). E=Entry, K=Keynote Address, M=Management, P=Plenary, T=Technical

	WEDNESDAY DECEMBER 5, 1990		
7:00-8:30 am	Registration and Check-in		
8:15 am	OPENING AND ANNOUNCEMENTS Welcome, Janet Stevens, *Chair, Missoula County Commission* Welcome, George Dennison, *President, University of Montana* *Ballrooms A, B, C*		
8:40 am	**PLENARY SESSION I:** GIS Education **(P101 - P103)** *Ballrooms A, B, C*		
9:30 am	**BREAK** *Atrium* *Sponsored by Intergraph Corporation*		
9:30 am - 7:30 pm	**EXHIBITS** *Boussard, Dolack, Jenkins Rooms*		
9:45 am	**KEYNOTE ADDRESS:** Dr. Robert Rogerson **(K101)** *Ballrooms A, B, C*		
10:30 am	**CONCURRENT SESSION I**		
	ENTRY *Ballroom A*	MANAGEMENT *Ballroom B*	TECHNICAL *Ballroom C*
	GIS Examples **(E101)**	GIS Examples **(M101)**	Fractal Geometry in GIS **(T101)**
	Introduction to GIS **(E102)**	GIS Start-up Considerations **(M102)**	Point on Polygon Sampling **(T102)**
	Basic GIS Software Functions **(E103)**	Ignored Issues of GIS Implementation **(M103)**	Wildland Fire Planning **(T103)**
Noon	**BREAK** *Atrium*		
12:15 pm	**LUNCH** *Ballrooms A, B, C*		
1:30 pm	**PLENARY SESSION II:** Data Acquisition **(P201 - P206)** *Ballrooms A, B, C*		
3:00 pm	**BREAK** *Atrium*		
3:30 pm	**CONCURRENT SESSION II**		
	ENTRY *Ballroom A*	MANAGEMENT *Ballroom B*	TECHNICAL *Ballroom C*
	Introduction to Geographic Information System Design **(E201)**	Project Planning **(M201)** Project Staffing **(M202)** Lessons Learned After 10 Years **(M203)**	Using GPS for Digital Cartography **(T201)** Issues Using GPS for Urban Applications **(T202)**
5:00 pm	**BREAK**		
5:30 pm - 7:30 pm	**POSTER SESSION** - with No-host Bar Social *Atrium*		

	THURSDAY DECEMBER 6, 1990		
8:15 am	OPENING AND ANNOUNCEMENTS *Ballrooms A, B, C*		
8:30 am	**PLENARY SESSION III:** Future Trends: Visualization **(P301 - P302)** *Ballrooms A, B, C*		
8:30 am - 5:00 pm	**EXHIBITS** *Boussard, Dolack, Jenkins Rooms*		
9:30 am	**BREAK** *Atrium* *Sponsored by Intergraph Corporation*		
10:00 am	**CONCURRENT SESSION III**		
	ENTRY *Ballroom A*	MANAGEMENT *Ballroom B*	TECHNICAL *Ballroom C*
	Introduction to GIS Data Input **(E301)**	New Technology in Data Conversion **(M301)**	CAD as Low Cost GIS **(T301)**
	Map Digitizing **(E302)**	Automated Data Acquisition: GIS/GPS **(M302)**	Raster - Vector: Problems in Conversion **(T302)**
	Scanning Technology/Techniques **(E303)**	The Ultimate Organizational Issue: Data Sharing **(M303)**	Remote Sensing as Input to GIS **(T303)**
	Global Positioning System Basics **(E304)**		Using Landsat Data to Assess Changes **(T304)**
Noon	**BREAK** *Atrium*		
12:15 pm	**LUNCH** *Montana TWG Progress Report*, Don Luse, Chair, GIS Technical Working Group GIS User Group Business Session *Ballrooms A, B, C*		
1:45 pm	**PLENARY SESSION IV:** Future Trends: GIS Implementation **(P401 - P403)** *Ballrooms A, B, C*		
2:45 pm	**BREAK** *Atrium*		
3:00 pm	**CONCURRENT SESSION IV**		
	ENTRY **Ballroom A**	MANAGEMENT **Ballroom B**	TECHNICAL **Ballroom C**
	Map Preparation Techniques **(E401)**	Emerging Legal Issues Impacting GIS Implementation **(M401)**	Advance Planning for Quality Data **(T401)**
	Projections and Coordinate Systems **(E402)**		Automated GIS Data Conversion **(T402)**
	Map Production **(E403)**	Management Question & Answer Session **(M402)**	Remote Sensing Input to GIS **(T403)**
4:30 pm	Conference Closing *Ballrooms A, B, C*		

ABSTRACTS

The abstracts are grouped by track (i.e., Entry, Technical, and Management) and session. The abstracts are indexed to the program schedule by a presentation number. The number represents the track, session, and sequential number for each presentation within a session. For example, T302 is the second presentation in the third Technical Track concurrent session. (T = Technical, 3 = Third Session, 02 = second presentation). E=Entry, K=Keynote Address, M=Management, P=Plenary, T=Technical.

Session: GIS Basic Concepts
Moderators: Allan Cox & Michael Sweet
Organizers: Allan Cox & Michael Sweet

E101
"Agriculture, Natural Resources, and City/County Examples"

Geographic information systems are becoming standard tools for the management and administration of land information. When organizations and individuals first approach GIS, they are often unsure as to the breadth of GIS applications. An organization may initially view a GIS as a geo-referenced data management system or in-house map production facility. As the users begin to explore the analytical and display tools of a GIS and ask more demanding questions relative to land management, they quickly find that the information potential of a GIS exceeds initial expectations. This session will provide newcomers to GIS with an overview of applications in agriculture, natural resource management, and city/county planning.

E102
"Introduction to GIS"
Elizabeth D. McMullen, Geometronics Group Leader, Northern Region, US Forest Service

During the past 10 years there has been tremendous growth in the amount of graphic and map data converted to digital form. More recently there has been an increase in the amount of data collected directly in digital form (e.g. GPS data and photogrammetric data). There has also been parallel growth in the number of specialized applications software packages to manage these data. Four terms widely used today are CAD, automated cartography, GIS, and AM/FM. The definitions for these applications and the differences between them are becoming increasingly distinct. This presentation will briefly discuss these definitions and differences in layman's terms for those people new to these fields.

E103
"Basic GIS Software Concepts"
Allan Cox, GIS Coordinator, Montana Natural Resource Information System

Automated geographic information systems provide powerful methods of managing and analyzing geographic data. GIS software programs vary in cost, ease-of-use, complexity, and power. However, all programs use similar basic functions and concepts.

To perform data management, analysis, and output, all GIS programs employ simple functional concepts. These concepts, or building blocks, are combined to perform sophisticated geographic information management and analyses. This presentation outlines the basic functions to be found in an automated GIS. Basic functions to be covered include: Retrieval, Map Generalization, Map Abstractions, Map Sheet Manipulation, Buffer Generation, Polygon Overlay and Dissolve, Measurement (cartometrics), Digital Terrain Analysis, Network Analysis, Output Functions, and Cartographic Modelling.

Session: Database Design
Moderator: Allan Cox
Organizer: Dean Anderson

E201
"Introduction to Geographic Information System Design"
Dean Anderson, Environmental Systems Research Institute, Olympia, Washington

This session will introduce different design methods used to develop a geographic information system. System components and organization will be used to introduce basic GIS concepts. A general design methodology will then be discussed in some detail. The methodology will be divided into steps or tasks. Task description, input, outputs, and time commitments will be discussed. Finally, a short presentation of classic design do's and don'ts will be given.

Session: Data Input
Moderator: Steve Sherer
Organizer: Steve Sherer

E301
"Introduction to GIS Data Input"
Steve Sherer, GIS Manager, Bonneville Power Administration

GIS data input is the process of encoding data into the GIS database. The usefulness of the GIS depends to a large degree on the accuracy and cleanliness of the database, which begins with the data input process.

GIS databases typically contain two distinct components: the positional or geographical data which defines the location of features on the surface of the Earth, and the non-spatial attributes of the features. A summary of common GIS data input methods, focusing on the geographical component of the database, will be presented as well as some basic GIS concepts and data structures. This will serve as an introduction to presentations on manual digitizing, scanning, and global positioning systems.

E302
"Map Digitizing"
Robert G. White, GIS Specialist, Advanced Data Concepts, Inc.

Accurate and up-to-date information is the basis of any GIS and often the only means to obtain that data is through manual digitizing. Using an xy coordinate table and cursor, hard copy manuscripts are converted into digital coordinates by tracing the desired geographic information.

The digitizing process begins by selecting an appropriate source document and deciding how the data will be organized. Designing a data dictionary that will hold information about the data file is also useful. Next, the digitizing environment is established which sets any necessary tolerances and a digital file is created to accept the data. Finally, the manuscript is taped to the digitizer, registered, and bounded. The registration process involves entering the location of tics that have precise geographic coordinates. Tics are used to convert the digitized data into real world coordinates, either on-the-fly or during the post processing phase. The RMS error is one measure of how good the digitized tics reflect their true position.

Following the preparatory steps outlined above, the manuscript is ready to be digitized. Depending on the data layer, the information on the manuscript is usually captured as one of three types: points, lines, or polygons. The boundaries of geographic areas (polygons) can be digitized using several techniques, including whole polygon digitizing, spaghetti digitizing, or discrete digitizing. The advantages and disadvantages of each will be discussed in depth, as will other terms and concepts related to the digitizing process.

The final phase in the digitizing session involves checking the positional accuracy of the captured data. The most common method entails laying a plot of the data over the original manuscript and looking for any deviations. Other errors (undershoots, overshoots, and misplaced labels) are frequently detected by the software and, in some cases, automatically corrected. Similarly, any attributes attached to the geographic features need to be verified.

Once the errors have been identified and corrected with an editing session (usually an iterative process), the data file is ready for any post-processing such as vector to raster conversion, coordinate transformation, or projection change.

E303
"Scanning Technology/Techniques"

Earl Nordstrand, Marketing Specialist, Environmental Systems Research Institute

Many advances are being made in scanning technology, based primarily on the need to include graphics in documents and to convert scanned text into an editable form for your word processor. This same technology can be used in your GIS, but a scanned document is not a GIS database. Scanned documents, if geographically referenced, can provide useful information to GIS users. Scanning can also be used to reduce the data conversion costs of creating GIS databases from paper maps.

Many factors affect the usefulness of scanning in the data conversion process. The quality of the source map, the resolution of the scanner, the raster to vector conversion process tools available, the costs of editing the resulting data, and the cost of attaching attributes to the data all must be considered. Many tools and scanner systems are now available, and the choice of which tools depends upon many organizational factors as well.

This presentation will introduce the basic concepts of scanner technology and its use. Illustrations of the benefits and problems inherent in using scanners will highlight their potential impact on GIS users. Reviews of some of the scanner technology and conversion software will also be presented.

E304
"Global Positioning System Basics: What is it and how can it be used?"

Butch Fitzpatrick, Forester/GIS Coordinator: Lewis and Clark National Forest

This presentation is intended for those people who have had very little or no experience with the Global Positioning System (GPS) receivers. There will be two segments:

1) A fundamental explanation of how GPS receivers work.
2) Field applications of GPS receivers in natural resource management.

The first segment will explain the basics of the Global Positioning System and how the receivers work. This will help give the audience a better understanding of how GPS receivers can be used to help determine coordinates of spatial data and enhance geographic information system capabilities.

The second segment will cover field use of portable GPS receivers on the Lewis and Clark National Forest. Various applications will be reviewed giving the limitations and advantages of the equipment. Use of the receivers for remote sensed data (aerial and Landsat MSS) field verification and validation will be covered, as well as using the system in geo-referencing. Ideas will be presented on possible uses for the equipment in the management of various natural resources.

Session: GIS and Cartography
Moderator: Kris Larson
Organizer: Kris Larson

E401
"Map Preparation Techniques--Making Maps from Other Maps"

Russ Michel, Senior Project Manager

Numerous problems exist in developing digital map data from multiple map source materials. Over the project area, existing maps typically are not consistent for input to a geographic information system. In general, these problems are very similar to any mapping operation that synthesizes a new product from a variety of input documents. Map update and preparation procedures create a consistent input product. This source map document is paramount to the success of any project and GIS applications that will be supported by the data.

This paper will address these problems and how they were solved using the City of Seattle Joint Automated Mapping Project as a case study. The approach that will be discussed can be applied to any GIS automation project.

E402
"Projections and Coordinate Systems"

Paul Wilson, Professor of Geography, University of Montana

An understanding of the properties of map projections and map coordinate systems is essential to the construction of internally compatible map databases. The potentially preserved properties of distance, shape, direction, and area inherent in some map projections are of particular importance in dealing with data sets which are to be overlain or otherwise manipulated with GIS software. These properties of map projections will be considered in this presentation along with consideration of the classification of map projections into families based upon the type of geometric developable surface involved. The relationship between projections and the globe (case and aspect) will be reviewed, as will be the problem of distortion. Map coordinate systems will be considered briefly as they relate to map projections and to the planning and development of a geographic information system.

E403
"Map Production"
Laurence W. Carstensen, Associate Professor of Geography, Virginia Tech

This presentation will address the issues in basic map design as found in the cartographic method, commonly referred to as generalization. Map generalization consists of three stages: simplification (the selection of features to be on the map and the alteration of their form if necessary), classification (the grouping together of items deemed similar and the separation of items deemed different), and symbolization (the assignment of visual codes to represent categorical differences). Though these topics are normally rather lengthy in a full course, this presentation will give a good idea of the basic concepts of successful map production.

Session: Keynote Address
Moderator: Hans Zuuring
Organizer: Hans Zuuring

K101
"Learning, Using, and Teaching GIS"
Robert Rogerson, Executive Director, Institute for GIS in Education, Ottawa

In common with many other advanced skills which are technically based, GIS is best learned in a hands-on environment. At the same time, the proper use of GIS requires considerable appreciation, on the part of the learner, for GIS concepts, analytical, and statistical techniques. Traditionally, GIS concepts have been best taught in university or college GIS courses, while thorough, hands-on experience has been available from training courses offered by individual software vendors.

The Institute for GIS in Education (IGISE) has created concept-based, hands-on, interactive materials which combine these two elements. These materials form the Curriculum Development Toolkit which has been extensively reviewed by academics, particularly in Canada and the United Kingdom. The interactive nature of the GIS learning experience using the Toolkit is one which will probably be emulated by many GIS software vendors. Independent of the specific Toolkit described, the formula behind it is of great value in defining and designing GIS learning materials in the 1990s.

But the real test of GIS will be in whether it is readily adopted as a valuable technique by disciplines which use spatial information but which have traditionally remained distant from spatial analysis and GIS. The Curriculum Development Toolkit is structured to encourage use in a wide range of disciplines: this structure will form a blueprint for GIS penetration into such arenas.

Session: GIS Start-Up
Moderators: Michael Sweet & Don Cromer
Organizers: Michael Sweet & Don Cromer

M101
"Agriculture, Natural Resources, and City/County Examples"

Geographic information systems are becoming standard tools for the management and administration of land information. When organizations and individuals first approach GIS, they are often unsure as to the breadth of GIS applications. An organization may initially view a GIS as a geo-referenced data management system or in-house map production facility. As the users begin to explore the analytical and display tools of a GIS and ask more demanding questions relative to land management, they quickly find that the information potential of a GIS exceeds initial expectations. This session will provide newcomers to GIS with an overview of applications in agriculture, natural resource management, and city/county planning.

Session: GIS Start-Up
Moderator: Don Cromer
Organizer: Don Cromer

M102
"GIS Start-Up Considerations for Managers"
Don Reimer, Foretrends Consulting, Inc.

Selection and implementation of GIS systems involves more than an evaluation of the normal business computer system factors of cost, capacity, functionality, and expandability. Successful implementation of GIS applications requires blending of traditional business computer applications skills, cartographic skills, and resource management skills. Adding a GIS system to a decision-support system requires a re-definition of virtually every existing application in the system.

Some of the topics to be discussed in this overview include project management, cost considerations, major steps for implementation, and supporting software requirements.

Discussion will be focused on direct experiences in making GIS systems work in real-world, operational environments. If you are considering acquisition of a GIS system, or have recently purchased a system, this overview is for you.

M103
"Ignored Issues of GIS Implementation"
Tom Herrick, PlanGraphics, Inc.

Most of us have seen the growing publicity surrounding GIS and the capabilities that this technology may bring to organizations choosing to implement such a system. Vendors, consultants, and other promoters of GIS tend to stress the wonders of the technology. And yes, the technology is truly wonderful. GIS technology can provide a cost-effective solution to existing problems of geographic information management and use.

On the other hand, we may read horror stories published about millions of dollars squandered on this "relatively new, unproven, and costly" technology. What most people don't hear about are the GIS implementations that are slow to provide useful applications to staff, or that cost the organization thousands of unnecessary dollars. Off to an uncertain start, these projects usually continue, but with less enthusiasm on the part of funding authorities and personnel involved.

The overall reason for shaky starts in GIS development and implementation is that organizations tend to ignore certain issues. After four years of providing GIS consulting assistance I have found recurring issues that organizations tend to ignore or underemphasize. The discussion will focus on issues that I have found to recur most often. Issues to be discussed include:

- What is the real motivation for implementing GIS: to be involved with leading edge technology, or to solve existing and defined problems in geographic data management?

- Developing an organizational structure for GIS development and implementation - Who is really going to run the system?

- GIS management and staffing - Do we really need staff from outside?

- System selection, data conversion, and translators - A chicken and egg controversy and how to keep both out of the frying pan.

- Allocation of staff time toward GIS development - If you have expectations of how much time your staff will devote to properly implement a GIS, multiply that times four.

- Application program development - What does "turn-key" really mean anyway?

Organizations that do not take or make the time to address these issues often find themselves backtracking and reorganizing, often at significant cost. Those about to launch into the world of GIS need to see through some of the myths that abound and get started on the right foot. We will discuss some of the pitfalls that can slow or stop a worthwhile project.

Session: Project Budget Planning & Staffing
Moderator: Jon Sesso
Organizer: Kevin Brooks

M201
"GIS Project Planning"
Ron Brohman, Forest Planner, Helena National Forest

Definition of a project area may involve a variety of issues and concerns. The project area we chose was the Basin-Thompson area just south of Butte on the Deerlodge National Forest. This area was chosen because of impending mountain pine beetle attack, a residential area, municipal watershed, national recreation area, Continental Divide trail system, Interstate and state highway systems, and National Forest resource concerns in relation to all of these.

Getting started was a matter of identifying the area on USGS quadrangles. A search of available data for the project was then undertaken. Work had previously been conducted for a number of years to obtain inplace, on-the-ground data for inventory purposes so there was pertinent data available, but the data had to be digitized so we could use it.

What data was needed and what had to be digitized was the next question. We determined that seven layers of data were necessary for the project; the themes are: timber stands, landtypes, existing roads, proposed roads, precipitation, watershed boundaries, and digital elevation maps. These layers were chosen because of the output we wanted to achieve and the data needed to run the resource models. Resource models associated with the project include: (a) elk effective cover model, (b) visual quality model, (c) sediment yield model, (d) mountain pine beetle model, (e) timber growth and yield model, (f) fisheries model, (g) timber sale viability model, and (h) water yield model. Hardware needs had to be accessed and at present the district uses a graphic display terminal and ink jet printer in conjunction with a DG MV8000 mainframe.

Why did we use GIS technology instead of doing the job in the traditional fashion? We needed a way to compare alternatives that was repeatable, a way to quickly look at new and additional alternatives that could be proposed by the public, and lastly we needed to have the output displayed in a very professional manner.

M202
"Staffing and Personnel Needs for GIS Implementation"
Jack Sheffy, GIS Coordinator, BLM, Utah State Office

A geographic information system, in addition to the database, is comprised of three primary components:
1. Hardware
2. Software
3. People (expertise)

This third element, our people, the expertise to utilize GIS to accomplish projects is unquestionably the most important ingredient. The ability to establish and incorporate GIS expertise into an organization that is possible as a result of GIS implementation. GIS expertise acquisition and incorporation depends first on the goals of implementation. What type of projects will be undertaken? Which aspects of GIS utilization will be needed to accomplish these projects?

First, database expertise is a prerequisite. How is digital information to be acquired? A tremendous amount of information is already available in digital format from government agencies and vendors. It must be determined if this information suits the needs of a particular project. Is the information current enough? detailed enough? of an acceptable scale? available in the proper format? at a reasonable cost? within acceptable timeframes? How exactly is the information acquired? Can the information be edited? Expertise to answer all of these database questions may be crucial to GIS implementation.

If it is intended to establish your own digital information through digitizing, expertise on preparation of information for digitizing, accuracy standards, and data standards is essential. Once the database is established, a geographic information system has three primary functions: 1) display, 2) analysis, and 3) mapping. Expertise requirements will based on what is necessary to accomplish projects with respect to these three functions.

In order to fully utilize and maximize productivity, not simply implement GIS, it is mandatory to have effective communication between its specialists, resource specialists, and management. To accomplish this, I believe the best method is to establish GIS expertise on a solid foundation of natural resource management and interdisciplinary planning expertise. In other words, start with your very best resource specialists, ones that have already demonstrated a high level of capability in a specialty and working with other resources, and have shown a strong self motivation and capacity for learning new procedures. It is far easier to teach a very competent and experienced resource specialist to also be a GIS expert that it is to begin with a GIS expert and attempt to teach natural resource management fundamentals and agency goals.

Incorporation of GIS expertise organization-wide will probably result in a shift from current staffing structure. Currently, management is usually separated from mid-level supervisors and resource specialists. To fully realize the advantages of GIS capabilities, I see a shift bringing top level management closer to resource specialists. I can visualize a reduction of mid-level management and the beginning of managers "surrounding" themselves with an elite "core team" of individuals who possess this high level of interdisciplinary resource/planning/GIS expertise as well as program and management abilities. I also see a restructuring of the rest of the staff to a more field/project orientation.

Maintaining a given level of GIS capability/expertise will be based on the value placed on that capability. There will be an ever increasing demand for these new abilities and managers must be willing to recognize this value.

Session: GIS Operations & Legal Considerations
Moderator: Jon Sesso
Organizer: Jon Sesso

M203
"Lessons Learned After 10 Years"
Kirsty Burt, GIS Manager, City of Bellevue

The current success of Bellevue's geographic information system is a product of nearly twelve years of lessons learned in the implementation and growth of an operational system.

In 1979, the city purchased automated mapping software at the leading edge of technology. By 1987, the system was no longer meeting the needs of the city effectively. The automated mapping system was headed for disaster, both technically and organizationally. The high expectations for the system in the early years no longer seemed attainable without some major changes. In 1988, a city-wide management team selected GIS software to replace the aging mapping system. All the information in the original system was converted to the GIS, making countless new applications possible for the city. GIS has become a high city priority with strong development and management support.

While new software and hardware have helped the city move forward progressively with GIS, it is the organizational changes, brought about over ten years of observation and learning, that are driving the current system's success. GIS organization and management, at all levels, form the foundation of a truly operational GIS.

There are several key areas that must be addressed in order to maintain a successful GIS. The system must respond to the customer's needs. GIS does not stand alone; it must act as a support tool for agency priorities. The system must grow quickly, and in many directions, while also allowing for the time-consuming building of base layers of data. People must have the power and ownership of the system. GIS cannot survive in the back room of an agency. There must be strong leadership in the development of the system. Over the years at Bellevue, it has become apparent that the front line users must be the champions of the system, rather than a council member or high level manager. Finally, the work environment must support the risk-taking and innovation required to build a successful GIS. A GIS is never "finished"; it is an ongoing process that must be carefully and enthusiastically managed in order to thrive.

Session: Data Acquisition
Moderator: Don Cromer
Organizer: Stu Kirkpatrick

M301
"New Technology in Data Conversion"
Monica Meyer, Business Development and Operations Manager, Merrit Tech

Scanning technology has made some significant advances recently. This technology includes more than just capturing an image, or "dumb" raster data. With certain scanners, newer to the GIS marketplace, the capability exists to do such things as capturing composite color data in real time, image enhancement, information separation, image processing, analyzing, and much more. With this comes increased image quality, accuracy, and increased production. Since data acquisition has typically been the most expensive part of utilizing a GIS, this also considerably reduces associated costs.

One of the biggest misconceptions regarding scanning quality, is the thought that the higher the resolution, the better the scan quality and accuracy. In conjunction with the user wanting higher resolution, also comes the problem of what to do with large raster files. This presentation addresses why higher resolution isn't necessarily the solution to better and more accurate images and various methods of keeping raster file sizes to a minimum without giving up quality.

High quality image acquisition is extremely important when converting raster images into vector data. The ability to separate information layers (i.e., contours, roads, hydrology, etc.) from source documents such as USGS quad maps is also very useful when mylar separates are not available. Through the use of interactive raster to vector conversion software, the data can be semi-automatically vectorized, edited, selectively layered, quality controlled, and more as the conversion process is taking place.

Many times this interactive method is as fast or faster than batch mode methods, and is certainly faster and much more accurate than hand digitizing.

M302
"Automated Data Acquisition: GIS/GPS"
Douglas Richardson, President, GeoResearch, Inc.

Global positioning system (GPS) technology offers geographic information system users with new options for data acquisition. Previously, data acquisition for GIS users has involved obtaining maps, either in hardcopy or digital format. This presents users with problems of data availability and data reliability. Often, maps are not available for areas of interest, and if available their accuracy may not be quantifiable due to error introduced during processing into digital format.

GPS collects raw data, in the form of geographic coordinates, with minimal processing. These data are then transformed into point, linear, or polygonal map features within a GIS. Accuracy is maintained at the desired level, ranging from 1 centimeter to 25 meters. The rate of data acquisition is determined by the method of transportation: walking, driving, or flying.

Interfacing GPS directly with GIS, however, enhances the power of both systems. Some of the advantages of a GPS/GIS interface include: recording attributes in the field, as well as map features; time and velocity stamped records; real-time graphic results of mapping, with inclusion of background maps; automated conversion of data into desired digital format; expanding the functionality of GIS to real-time use.

M303
"The Ultimate Organizational Issue: Data Sharing"
Hugh Archer, Executive Analyst/General Counsel: PlanGraphics, Inc.

Traditional government agencies and private sector organizations are vertically structured, with personnel, operations, and equipment budgets established and organized by topical areas. Typically, each division within a vertical organization makes decisions without necessarily obtaining concurrence from other divisions. At the same time, countless management studies have concluded that organizations can be most productive when there is an emphasis on cooperation, interdivisional communication, and resource sharing. In the world of GIS, sharing and cooperation are proving essential, and consequently, the development of GIS capability is forcing a shift toward more horizontal management structures within organizations as well as the emergence of unprecedented cooperation with entities external to the organization.

Managers considering GIS implementation must be prepared to cooperate, to share resources, to trade data, to work closely with others. No single agency or organization can afford to pursue GIS development in isolation. With this demand for cooperation comes the challenge of bringing diverse entities together, for example, to agree on data standards. To meet this challenge, local, state, regional, even national committees are being formed to intervene between and among the traditionally independent organizations.

The major issue becomes control, and this paper will focus on the role these coordinating committees play in developing and enforcing standards that foster opportunities to cooperate on GIS projects. Case studies will be presented that describe different approaches various organizations and individual states have used to get people working together on GIS implementation.

Session: GIS Operations & Legal Considerations
Moderator: Jon Sesso
Organizer: Jon Sesso

M401
"Emerging Legal Issues Impacting GIS Implementation"
Hugh Archer, Executive Analyst/General Counsel: PlanGraphics, Inc.

The presentation will be oriented to the issues of control of public access, the creation of GIS products and services for purposes of cost recovery, and interagency cooperation among multiple system sponsors.

Background: The control of public access to GIS involves a series of policy decisions impacted, directed, and limited by the current legal setting for the jurisdiction. As examined in the presentation, "Emerging Legal Issues Impacting GIS Implementation", the vocabulary of many of our current laws does not take new information management technology into account. GIS in particular presents several identifiable issues that arise from old legal principles applied to this technology. At this point in the evolution of electronic information dissemination policy, there are few models for the "right way" to manage this valuable public resource, but many common mistakes. This review and summary of the legal and policy issues facing GIS custodians must deal more with issues identification and proposed solutions. Until our local policymakers address both the potential and the Pandora's box presented by the new government-owned information resources that GIS technology makes available, GIS managers must attempt to set a course of conduct that makes sense without much formal guidance. This presentation will focus on decisions that must be made by all GIS participants in a uniform manner to have any impact, make policy recommendations for consideration, and identify alternatives.

Topics discussed will include:
- Open records/public records laws and federal FOIA status relative to electronic information dissemination issues;
- Limits on exercise of proprietary authority by government;
- Issues of undue competition with private sector business;
- Liability for information products/Uniform Commercial Code;
- Liability of GIS "services"/Negligence;
- Impact of governmental and sovereign immunity on potential liability;
- Copyright law as applied to databases;
- Use of copyright and contract law to control third party use of information;
- Establishing prices for intangible products;and
- Turning intangibles into "intellectual property".

M402
"Management Question and Answer Session"

This is a question and answer session with many of the Management Track Session presenters.

Plenary Session I: GIS Educational Opportunities
Moderator: Paul Wilson
Organizer: Hans Zuuring

P101
"Status of GIS in US Universities"
Donald A. Jameson, University Liaison, US Forest Service, Washington, DC

Over 70 US universities currently have significant capability in GIS. Probably the majority of GIS facilities are in departments of geography, but departments, schools, or colleges of natural resources and various biology disciplines are also well represented. In departments of geography, the broad area of GIS is commonly subdivided into specialized curricula such as computerized cartography. In the natural resource and biology disciplines, GIS capability is usually seen as an adjunct to the overall mission of the disciplinary area.

As viewed by non-university organizations, the university capability is often seen as an opportunity to get technical GIS services and short term GIS training. Universities are also focal points for specialized user-friendly front ends to a battery of computer procedures, including GIS; these developments are often expert systems. Many of these activities depend on contract funds, and many university administrators (and faculty promotion and tenure committees) have difficulty relating such activities to their central educational role.

However, the long term role of educational and research institutions specializing in natural resource management must include the responsibility to examine the hypotheses, theories, and paradigms that provide the underpinnings of resource management. A key element in this effort will be analyses of spatial relationships that are important in natural resource management. As educational and research institutions develop these concepts, existing commercially available GIS software will be found wanting and new capabilities in GIS technology will be required.

P102
"GIS Education Opportunities at Montana State University"
John Wilson, Professor of Geography, Montana State University

Montana State University will offer (i) GIS and remote sensing short courses for private sector and federal, state, and local government professionals, in addition to (ii) regularly scheduled GIS and remote sensing courses for undergraduates and graduate students starting in January, 1991 These training programs will utilize the computer hardware and GIS/remote sensing software acquired during the past 12 months with the assistance of the National Science Foundation and J.J. Murdock Charitable Trust. The software includes 19 copies of IDRISI (Clark University), 11 copies of PC ARC/INFO (ESRI), and 6 copies of the workstation versions of ARC/INFO (ESRI) and ERDAS (ERDAS, Inc.).

The professional short courses include two courses offered earlier this year: (i) the "Introduction to GIS" course developed by staff affiliated with the MSU Geographic Information and Analysis Center (GIAC), and (ii) the 3-day "Introduction to PC ARC/INFO" course developed by Environmental Systems Research Institute (ESRI). Additional options include on- and off-site training programs offered by GIAC staff and organized around specific themes and/or applications. The GIAC was established by the Board of Regents in March, 1989 to facilitate GIS research and instruction that spans traditional university, college, and department boundaries.

The regularly scheduled GIS and remote sensing opportunities for students consist of: (i) three new semester courses entitled "GEOG 305/Introduction to GIS", "GEOG 410/Intermediate Remote Sensing" and "GEOG 411/Technical Issues in GIS", (ii) internships and independent study opportunities for undergraduates and graduate students, and (iii) thesis programs for graduate students. The three new courses provide key inputs to the GIS/Spatial Analysis Emphasis for geography majors and GIS/Spatial Analysis Minor for majors from other departments to be offered by the Department of Earth Sciences starting August, 1991. The internships, independent study, and thesis options are enhanced by collaborative work with federal, state, and local government agencies that includes a student training component. Your continued collaboration is vital if Montana State University is to produce GIS scientists for public and private sector careers.

P103
"GIS Education at Montana's Universities--University of Montana"
Hans Zuuring, GIS Laboratory Director, School of Forestry, University of Montana

There is considerable interest in natural resource management to learn about geographic information systems because we believe that this technology promises to be an effective decision-making and planning tool. Prospective users of this technology often ask questions such as: "What is it? What training, software, and hardware do I need?", etc. In the last five years many public agencies and private companies have embraced GIS technology and are looking for trained persons to hire. Due to this increased interest and reduced software/hardware costs educational institutions such as the University of Montana School of Forestry have started teaching GIS concepts to students. At first graduate level courses are offered but soon undergraduate courses follow. This talk will describe the philosophy behind and content of GIS courses currently being taught at the School of Forestry and discuss the benefits derived from their inclusion in a natural resource curriculum.

Plenary Session II: Data Acquisition
Moderator: Joan Steber-Stewart
Organizer: Joan Steber-Stewart

P201
"US Census Bureau Tiger Line Files"
Allan Cox, GIS Coordinator, NRIS

The TIGER line files from the US Bureau of the Census are available for use in GIS and mapping programs. These files, based on USGS 1:100,000 maps, contain digital line data for transportation, hydrography, utilities, railroads, political boundaries, and other line features. TIGER (Topologically Integrated and Geographic Encoded Reference) files were released in a test version (prototype TIGER files) over a year and a half ago. The latest version--pre-census TIGER line files--are now available. For Montana, these files represent over 510mb of data. A post-census version will be released in the spring of 1991. The files come on either 9-track tape or compact disk.

The TIGER files were designed to be used by the Census Bureau for the collection and the management of 1990 census data. In addition, the line files will be used for the 1990 apportionment and re-districting process. The files were not designed to be a highly spatially accurate data set for general GIS use, but they can serve in a variety as ways as base data in a GIS and will prove valuable for incorporating future demographic data to be released by the Census Bureau.

In Montana, the TIGER files have been used in a pilot GIS project for the Department of Natural Resources and Conservation and in a water quality assessment project for the Department of Health and Environmental Sciences. In addition, the Montana Apportionment Commission will use the data in the 1990 re-districting for the state legislature. This project will result in state-wide TIGER coverage in a GIS format.

P202
"What Digital GIS Data are Available"
Lee Aggers, Special Assistant--Requirements, Rocky Mountain Mapping Center, USGS

The US Geological Survey is responsible for the administration of scientific programs through the Geologic, Water Resources and National Mapping Divisions, supported by the Administrative and Information Systems Divisions, with headquarters in Reston, Va.

The primary mission of the National Mapping Division is to conduct the National Mapping Program. This program, which involves collecting, archiving, and disseminating cartographic, geographic, and remotely sensed data, produces maps and related cartographic information in graphic and digital form.

Various mechanisms have been established for the National Mapping Division to coordinate cartographic and digital activities within the Federal and State governments. Annually the National Mapping Division solicits cartographic and geographic data requirements for the ensuing fiscal year from Federal and State agencies. The primary purpose of this coordination process is to minimize duplicative effort and costly, single-purpose mapping activities. Through this process, the National Mapping Division can more effectively plan its own programs to support emerging Federal and State agency needs. The State of Montana identifies its requirements within this process through the Montana Natural Resource Information System.

When direct Federal appropriations are unavailable to produce required cartographic data and products, other mechanisms include cost/share, work/share, reimbursable, and joint contracting arrangements.

The National Mapping Division produces a wide variety of cartographic and digital data products covering the Nation. Completion of initial coverage of all 50 States with 1:24,000-scale and 1:63:000-scale quadrangle maps is scheduled for 1991.

In addition to the production of cartographic data, the National Mapping Division is producing digital cartographic base data and distributing these data from the National Digital Cartographic Database. Two major types of digital data are produced: (1) topographic line map information as Digital Line Graphs, and (2) sample arrays of elevations as Digital Elevation Models. These data provide a framework for referencing additional information about the Earth and its natural resources.

Cartographic and digital data products produced by the National Mapping Division of the US Geological Survey are in the public domain and are available for purchase and use by private organizations and individuals.

In 1974, the US Geological Survey established the National Cartographic Information Center (NCIC) to serve as the public's primary source for information concerning the availability of cartographic, geographic, and remotely sensed data. As part of its program of providing information to the public, NCIC began, 1976, to develop a network of State affiliated offices to provide local access to this information. In a 1989 reorganization, NCIC became the Earth Science Information Center (ESIC) with expanded programs.

State managed ESIC offices are located in most States throughout the country and provide information about a wide range of cartographic and geographic products available from the Government or private sources.

The ESIC office for Montana is:

Montana Bureau of Mines & Geology
Montana Tech
West Park Street, Main Hall Rm. 200
Butte, Montana 59701
Telephone (406) 496-4167

Information and/or products available from the US Geological Survey may also be obtained from:

US Geological Survey
Earth Science Information Center
P.O. Box 25046, MS 507
Bldg 25 Denver Federal Center
Denver, Colorado 80225
Attn: Special Assistant-Requirements
Telephone (303) 236-5835

For information on cooperative programs with the US Geological Survey's National Mapping Division contact:

US Geological Survey
National Mapping Division
P.O. Box 25046, MS 507
Bldg 25 Denver Federal Center
Denver, Colorado 80225
Attn: Special Assistant-Requirements
Telephone (303) 236-5835

P203
"Availability of Earth Observation Data from the US Geological Survey, EROS Data Center"
John Faundeen, Earth Scientist, EROS Data Center

For decades Federal and State Agencies have been collecting regional, continental, and global earth observations data acquired from satellites, aircraft, and other information gathering systems. These data include photographic and digital remotely sensed images of the earth's surface, as well as earth science, cartographic and geographic data. Since 1973, the US Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC) in Sioux Falls, South Dakota, has functioned as a principal data management, production, dissemination, information systems development, and research center for these data. Currently, EDC holds over 8,000,000 Landsat satellite images and aerial images including both photographic and digital materials in its archives. Users are able to place inquiries and orders for EDC holding via a nationwide computer network. In addition to cataloging the data stored in its own archives, EDC provides users with rapid access to information on data held by other facilities.

The USGS/EDC is also contributing to the US Global Change Research Program by developing a Global Land Data and Information System (GLDIS). The intent of GLDIS is to develop, preserve, and provide improved accessibility to land-related earth science data sets (or information about the data sets) for global change research. The Data Center's current activities are focused on developing advanced data archiving, retrieval, processing, and distribution systems that permit more efficient storage and retrieval of the vast amounts of digital satellite earth observations data that will be collected during the next decade. These new systems will provide rapid on-line access to directories, catalogs, and inventories by users around the globe, custom processing of data to user specifications, and rapid electronic transmission of data and information to customers.

P204
"USDA Soil Conservation Service: Soils Information Update"
Kristin Gerhart, GIS Manager, US Soil Conservation Service

In Montana, the SCS is involved in two soils mapping programs: the state general soils map and the detailed, county-level surveys in which map characteristics and completion status vary across the state. Although SCS is committed to the eventual digitization of all our soils maps, our digitizing resources are very limited. SCS has begun several of its own digitizing projects, but seeks cooperation with other entities who wish to digitize SCS maps or influence our digitizing priorities. Regarding SCS distribution of digital soils maps and attribute tables, agency procedures will differ depending on the individual request.

P205
"The Montana GIS Data Directory"
Jon Sesso, Director, Montana Natural Resource Information System

When a state chooses to manage natural resource data in a distributed fashion, it can be a major challenge to locate data sources and maintain a current inventory to facilitate user access. At the Montana State Library, the Natural Resource Information System (NRIS) is responsible for making a distributed system work and has developed a special tool to connect data and users.

In 1989, NRIS began production of the Montana GIS Data Directory, a computerized inventory of GIS-applicable data sources. The development of the Montana GIS Data Directory is a cooperative effort coordinated by the Montana GIS Interagency Technical Working Group, and is designed to minimize duplication and promote sharing of digital data among the various resource management agencies and organizations within Montana. The Directory includes descriptive information (data themes, format, collection dates, spatial characteristics, status, availability, costs, contacts, etc.) on each data source listed.

In addition, and perhaps most significantly, the Directory has its own software--a set of adaptable, menu-driven programs with data retrieval, editing, input, and output functions. This software enables agencies to use the Directory to identify data sources quickly and as a documentation management program for in-house GIS data.

There can be major problems with data directories--primarily with updating and enlisting data holder participation. But the Montana GIS Data Directory, with its flexible software features providing in-house capabilities, makes each agency a partner in a statewide effort to keep the Directory current and effective. This presentation will describe the Montana GIS Data Directory, how it was developed, what's currently in it, how it is being used by participating agencies, and how users can gain access.

P206
"State Highway Data"
Don Cromer, Supervisor, Rural Planning Section, Montana Department of Highways

Roads are built and maintained for one major reason - to serve the public by transporting goods and people. What is moving on the road? How many vehicles are there? What kind of vehicles are they? What portions of the highway system are wearing out?

Geographic information systems are a valuable tool for the highway manager or technician because of the ability to provide a coherent and consistent reference for data acquisition and storage, as well as a visual framework for information retrieval and analysis. Geographic information systems provide both conceptual and tangible links to data acquisition and display tools. These factors are catalysts in the development of links between the highway network and the world around it, in the enhancement of data descriptions, and in provision of a link between acquisition and display of data and information. Virtually all highway data, whether it is concerned with land impacts, events, paths, or points depend on consistent labeling to be useful throughout the life of a project and also over the longer term.

GIS coupled with global positioning systems (GPS) provide four full dimensions of data location: latitude, longitude, elevation, and time. While many technical applications may be satisfied by locating points on a two-dimensional map, others can take advantage of additional spatial and temporal dimensions. A GIS will provide constant and consistent latitude and longitude coordinates for locations in its grid. One fundamental requirement placed on the source data is that the map sets used must also be consistent. When an application requires considerable data conversion, one cannot digitize one set of source data from a USGS quad map and another from a state road map of the sort normally provided to motorists. The maps must be based on the same coordinate system to ensure that the layers register properly when they are overlaid. When road network attribute data comes from several sources, a common network must be established for the GIS.

In summary, GIS has many powerful functions to offer the highway environment for location-coded information. This visual interface gives a more direct, intuitive view of data elements and aids in development and presentation of information based on their relationships. Finally, this tool can greatly improve the efficiency and the effectiveness of data acquisition, sharing, and analysis.

Plenary Session III: Future Trends: Visualization
Moderator: Michael Sweet
Organizer: Michael Sweet

P301
"Visualization: Multi-Media Imaging"
Robert Sullivan, Argonne National Laboratory

At Argonne National Laboratory and the US Army Construction Engineering Research Laboratory, we are employing the combination of realistic video imagery with the analytic capabilities of geographic information systems. We have two reasons for pursuing this research:

1. The combination of video imagery with GIS can greatly enhance the information content of GIS data presentation, thereby making GIS information more easily understandable and meaningful to intended audiences.

2. GIS analytical capabilities can be combined with video imagery to assist visual impact assessment through the creation of accurate and realistic visual simulations of proposed land management activities.

Combining GIS imagery with video image editing technology offers several advantages to the GIS users, including: the ability to combine photographic or video images with GIS images; the ability to combine GIS imagery with live video footage; enhanced design, layout and labeling of GIS graphics; the ability to paint and draw interactively on top of GIS images; convenient manipulation of colors and textures; and a convenient method to output high-quality 35mm slides, prints, overheads and narrated videotape. We are currently exploring the combination of video imagery with GRASS GIS output, and are planning projects that will combine GRASS and video imagery for GRASS database documentation and environmental impact findings presentation.

Our simulation research involves combining video simulations with GIS, computer-aided design (CAD), and global positioning system (GPS) technologies for an integrated approach to visual impact simulation. Elevation files from GRASS are ported to a CAD-based terrain modeling package. A perspective view of the terrain model can then be overlaid onto a video image of the impact area to provide guidelines for image editing. GPS technology is used to register the terrain model with the image, and to ensure accurate placement and dimensioning of the proposed visual impact. The image is then edited using simulation software.

P302
"Visualization: 3-D Volume Modelling"
David Clark, Technical Specialist

Various problems in petroleum, mining, and hazardous waste assessment require the modeling of 3-dimensional property data. That is, randomly or uniformly spaced X, Y, Z, and P data where X, Y, and Z coordinates define the location of the property value, P. Dynamic Graphics, Inc., of Alameda, CA, has developed a software package, Interactive Volume Modeling (IVM), which is being used to calculate and analyze 3-D volume models of physical properties (e.g., temperature, pressure, concentration) occurring within media such as air, water, and soil.

IVM utilizes a 3-D minimum tension gridding technique to create a uniform, regularly spaced 3-D grid model having a calculated property value at each grid node. This 3-D grid model is then used to generate a series of user defined "iso-surfaces", or surfaces of equal value, representing the input data. IVM, deployed on specialized 3-D graphics workstations, enables users to rotate, zoom/pan, slice through, and peel back layers of the calculated volume model. Analytical functions include 3-D volumetrics, 3-D grid operations, vertical truncation using 2-D structure grids, and lateral truncation with user specified polygons.

This presentation will briefly describe the functionality of Interactive Volume Modeling and highlight its future applicability to 3-D GIS. Model creation, visualization/display, manipulation, and analytical operations will be described using diverse data sets as case study examples.

Plenary Session: Future Trends: GIS Implementation
Moderator: Michael Sweet
Organizer: Michael Sweet

P401
"GIS Implementation: A User's Perspective-- Where I Would like Hardware/Software to be in 1995"
Dennis Murphy, GIS Supervisor, Potlatch Corporation

The Western Wood Products Division of Potlatch Corporation purchased a geographic information system in December, 1985. Implementation activities included the preparation of a three year system development plan. The technology was also evolving over that three year period. Application design of the system identified requirements which existed only as trends in the current technology of 1985; software and hardware vendors were expanding system capabilities which would meet the requirements. With a three year implementation time-line, it was feasible to design a system for the future capabilities that would meet the requirements. With a three year implementation time-line, it was feasible to design a system for the future capabilities that would mature during that implementation period. General examples include: 1) fully integrated map and relational attribute databases, 2) interactive menu interfaces, customized by the system user, and 3) high quality cartographic production capabilities.

Managing a geographic information system involves a periodic review of the trends in the technology in the context of the organizational requirements. As Potlatch Corporation plans for the next five years of system development, several significant technology trends will impact the present production system and the expansion of that system to new applications.

TREND 1: Low cost, high performance workstations

TREND 2: The expanding role of digital data sources

TREND 3: The integration of vector and raster

TREND 4: The trends in media computing

With the innovative software and hardware technologies evolving, geographic information management will progress beyond the fast calculator, beyond the electronic draftsman, and beyond the digital publishing of paper maps and reports. Geographic information systems represent a potential electronic media to communicate land management alternatives between resource professionals and their peers, between resource professionals and their management, and between a land management organization and the public.

P402
"The Role of GIS in 1995: A Vendor's Perspective"
Pamela Sallaway, Chairman, PAMAP Technologies Corporation

An International Society of Photogrammetry and Remote Sensing (ISPRS) working group held a meeting in March of last year which focussed on the expected developments of GIS in the next four years. The meeting was attended by a combined group of scientists and major users. It began with a futuristic scenario. This, with the experience of those present, provided the basic areas of development that could be anticipated. The working group critically examined these areas in terms of whether they were relevant, which sector (scientist or user) would deal with them, and what were reasonable expectations for the next four years.

This presentation will begin with the futuristic scenario. A summary of the conclusions of the ISPRS working group will be augmented with issues which the author feels will be relevant in the next five years. From these issues, the author will endeavor to predict the significant changes to GIS software by 1995, and the influence this will have on the role of GIS.

P403
"GIS Implementation: A User's Perspective for 1995"
James E. Reid, Director, Management Systems, Northern Region, US Forest Service

Many public agencies are being asked to consider increasing complex relationships, including spatial relationships in their planning and decision making processes. Successfully meeting these requirements will require methodology, tools and users interfaces that aren't in place today.

GIS technology has the potential to provide a platform on which we can build to meet some of these needs. Achieving this potential will require careful consideration of the needs of managers, the technical and professional users, and the public.

This presentation explores a vision of how GIS technology may be used in 1995 and some of the requirements/features of GIS technology that are going to be important if this vision is to be realized.

Session: Applications I -- Natural Resources
Moderator: John Kent Riekena
Organizer: John Kent Riekena

T101
"Fractal Geometry in GIS--Uses for Wildlife and Vegetation Classification Studies"

Laurence W. Carstensen, Associate Professor of Geography, Virgina Tech

Fractal Geometry (FRACTALS) has been a topic of interest in mathematics for over 20 years. The most visible uses of fractals have been to create artificial landscapes and backdrops for motion pictures. The use of mathematically controlled random data has produced some truly spectacular results.

Fractal theory is based on two reasonable tenets: that dimensionality is not truly integral (1, 2, 3) as we have been led to believe by Euclidian geometry, and that fractal objects are self-similar across a wide range of scales. These concepts are occasionally visible in nature as in the case of flower petals and tree branches, but are more often found in statistical analyses.

Geographers and others have be come interested in fractals of late to measure irregularity of linear features and roughness of surfaces. Fractals also may be of use in determining boundary conditions. While very few geographic features have been shown to be true fractals, many do show self-familiarity over limited scales, fueling the debate as to the propriety of fractals in geography.

Unlike the image we obtain from looking at solid black boundary lines on a map (such as a vegetation or soils map), are depicted as having edges when in reality they extend out along a continuum and may have no significant edge properties at all. This paper will introduce the concepts of fractal geometry, and will suggest its use to determine positioning for "fuzzy" boundaries. It will also provide an overview of the characteristics of boundaries both in cartography and in nature.

T102
"Point on Polygon Sampling: A Wildlife Research Case History"

Joe Glassy, GIS Consultant/Programmer, Systems for Environmental Management

Spatial analysts from many disciplines are interested in calculating areal frequency distributions of polygons classified within symmetric buffer zones projected about a set of point features. We present here several GIS based methods to obtain such frequency distributions, using raster based spatial data structures, within the context of a case history from our wildlife habitat research work. Lastly, we briefly critique some of the accuracy and performance implications of using a vector (arc-node) vs. raster paradigm for this class of spatial sampling.

T103
"GIS Recipes: Ingredients for Wildland Fire Planning"

Jennifer Rechel, Geographer, USFS Forest Fire Laboratory

The majority of available data for wildland fire planning and management currently exists in the form of field notes, in noncompatible computer databases, and on hard copy maps. This data is not easily analyzed. Some ingredients necessary for making products for fire planning include documentation, data layers, previous experiences, familiarity with the GIS software package, knowledge of fire behavior and the will to experiment.

Three examples of GIS uses are defining wildfire risk zones in central Mexico, predicting movement of populations into wildfire hazard zones, and analyzing chaparral fuel properties. All require similar basic GIS ingredients but each has unique data needs. Defining wildfire risk in central Mexico is economically and operationally important to focus fire prevention efforts to those areas that have the highest probability of fire occurrence. Vegetation, climate, and historical fire occurrence map layers are combined to determine high fire risk areas for the most efficient allocation of firefighting resources. Basic GIS functions of merging and overlaying the data layers produce fire risk category maps. Predicting population movement into the urban-wildland interface requires data from county tax assessors' books, vegetation information, and environmental information. Additional GIS topographical information is obtained from Digital Elevation Models, TIGER/Linefiles, and US Department of Census data.

By querying specific transportation information systems and combining the census population data with the topographic information, it is possible to hypothesize about movement of populations into unpopulated areas. Fire is an integral part of the chaparral ecosystems of southern California. Chaparral vegetation condition depends on the equilibria of numerous environmental factors. Using GIS technology to model and spatially analyze the reactions of chaparral fuels under various drought conditions, this project deals with GIS as well as using an external statistical package and previously collected field data.

Session: GPS and GIS Perspectives
Moderator: Michael Sweet
Organizer: Michael Sweet

T201
"Using Global Positioning System (GPS) for Digital Cartography"

Fred Gerlach, Professor, University of Montana

This paper briefly describes the Global Positioning System, its current condition and expected operational completion. The capabilities of precise GPS surveying are noted. GPS navigation or low precision surveying capabilities are described in more detail. The use of both levels of capability for digital cartography is discussed.

GPS can support almost any activity requiring a position in space as a part of the information package. Accuracy standards must be set, attained and maintained in the development of a cartographic database. GPS can help to reach these goals, but the quality control of GPS data presents significant problems too. The paper describes how the use of GPS receivers is becoming important for new or revision mapping and field digitizing for direct input to digital cartographic system. Very precise ground control is now available for aerial photogrammetry. Combined with precise analytical photogrammetric instruments, GPS provides the basis for higher map accuracy standards. Other remote sensing data can be registered more effectively to map space using navigation receivers with survey accuracies exceeding pixel resolutions. Previously masked terrain information can be field digitized for map editing, revision or GIS registration purposes. Collected data or information can be digitized in the field and registered to existing map coordinates.

An important feature of the GPS is its generic coordinate system which can be transformed to other map projections or references. Coordinates derived from the map sheet or digital database can be found in the field using GPS navigation receivers. The expected accuracy for field navigation with or without selective availability is discussed.

T202
"Issues Using GPS Technology for Urban Applications"
Thad Mauney, Director of Research and Development, GeoResearch, Inc.

Global Positioning System (GPS) technology provides tools for urban area information systems in both land surveying and GIS mapping applications. Among the advantages of using GPS for acquisition of data for GIS uses are its rapidity, its high accuracy, and its conformity with geodetic coordinate systems. Among the valuable uses of GPS data collection is the development of accurate maps of newly developed areas, or other areas in which existing map data are incomplete or inadequately field checked. Additionally, ground based data such as descriptions of property usage, maintenance needs, road, curb and gutter conditions, signage, and so forth may be mapped directly without time-consuming manual sketching and transcription. Practical mapping and surveying are, however constrained by satellite visibility considerations, accessibility of features to map, and the training of the observer to record multiple feature types simultaneously.

Performance of GPS systems and their human operators will be described from experience in urban and suburban projects, with an emphasis on the practices required to maintain necessary completeness and accuracy levels while striving for high productivity. Matters of field procedure and data editing will be described in regard to GIS creation, and some examples of productivity in field tests presented. GPS receiver types will be discussed in terms of their widely different positional accuracy capabilities, and how these match the requirements of different GIS data sets.

Session: Technical Issues
Moderator: Scott Freburg
Organizer: Scott Freburg

T301
"CAD Systems as Low Cost GIS"
Mark Reller, Northwest Power Planning Council

The intent of this study is to evaluate the hydropower potential of protected stream reaches in Montana. In 1988 approximately 2200 miles of western Montana's streams were designated by the Northwest Power Planning Council to be protected from future hydroelectric development, based on their high fish and wildlife values. The designations assumed that hydropower potential existed in these areas. While there is little dispute that these stream reaches support important fish and wildlife habitat, analysis of the realistic potential for generating electricity in these areas has not been conducted. Since the designations protect the stream reaches from new hydro development, it is inappropriate to apply the designations in areas that clearly lack hydro potential. The Montana Council Office has thus undertaken a study to assess the hydropower potential of the designated stream reaches.

Study results will include flow data for gauged streams, streamflow estimates for ungauged reaches, and a detailed estimate of the hydropower potential in the protected area. The information produced will be integrated with the State Library's computerized Geographical Information System, and will benefit fisheries and water resource management. Stream reaches that have no reasonable potential for future hydroelectric development may considered for deletion from the Council's Protected Area database.

T302
"Raster - Vector: Problems in Conversion"
Pamela Sallaway, Chairman, PAMAP Technologies Corporation

There are a number of raster/vector converters available commercially today. In general, they address the technical issues quite well in that they convert information explicitly represented in one format to an equivalent in the other format. For example, the process of converting between a raster representation of a forest cover map and a vector representation of the same information is reasonable well handled.

However, this process often does not match expectations. One reason for this is that the human mind is very good at deducing information from either raster or vector displays which is not explicitly stored. For example, a small child can easily deduce closed polygons in a coloring book, even when the vectors do not meet exactly at intersections. On the other hand, special purpose computer code is required to produce a forest cover map in either raster or vector format from raw digitized boundaries which do not meet exactly at intersections. Similarly, a person can track a road through an image, even when parts of it are hidden by tunnels or bridges. Special purpose computer code is required to convert a raster representation of an image into a road center line in either raster or vector format. The expectations of a conversion program are that the requisite information be deduced from whichever format and converted into the other format.

This presentation will look at the complete process of extracting information from one representation and converting it to another representation. Through a number of examples, different technical issues will be highlighted and approaches discussed.

T303
"Remote Sensing as Input to GIS"
Don Luse, GIS Manager, Bureau of Indian Affairs

Manual interpretation of satellite imagery is a viable, cost efficient means of obtaining current spatial information for inclusion in a GIS database. SPOT imagery was used as the base for locating and mapping prairie dog towns on approximately 900,000 acres of mixed use lands in north central and southeastern Montana. The mapping was entered into a GIS which was used to determine acres by land use and ownership.

T304
"Using Landsat Data to Assess Changes in Landscape Pattern Caused by the 1988 Red Bench Fire in Glacier National Park"
Elizabeth Reinhart, Intermountain Research Station

The Red Bench fire of 1988 burned approximately 38,000 acres in Glacier National Park and the Flathead National Forest. Landsat data and GIS technology were used to assess the impact of the fire on the pattern of the landscape, and to compare the effect of large-scale fire on landscape diversity or heterogeneity inside and outside the park. Landsat TM scenes from August 1988 and July 1989, and DMA topographic data provided the database for the study. Prefire vegetation classes were developed using ERDAS image processing software and TM bands 3,4,5,6 and elevation. Fire severity classes were developed from bands 4/(3+5+6). The resulting classified scenes were used to compute indices for assessment of landscape complexity and diversity.

Session: Data Input and Evaluation
Moderator: Craig Bacino
Organizer: Craig Bacino

T401
"Advance Planning is Required for Quality Data"
Barbara Duggan, Data Analyst

The amount of time spent on planning and preparation prior to starting a project determine the quality of the end product. A pilot project on a small area helps assure that all the necessary ingredients have been considered.

Before starting, you will need to determine what data will be associated with each theme. Usually, line, symbol and polygon data need to be displayed and plotted separately and in various combinations. For instance, stream data is usually line data, lakes are usually polygon data, and often both will be displayed at the same time.

Pertinent planning procedures include: identifying line and symbol types; standardizing labels, attributes, symbols and lines; verifying data accuracy; checking line continuation across multiple map sheets; verifying polygon connection and attributes across multiple map sheets; and checking for coincident lines.

After the data is verified and standards made, data entry begins. As a quality procedure create check plots to verify that all of the data is entered and all line and symbols types, labels and attributes assigned correctly.

Pilot projects are especially important before deciding to use data that exists on another system. It is often difficult to get adequate documentation on the parameters used, projection of the data, and the classification assigned. You will need to find out how the data transfers and what needs to be changed after it is imported. Because data entry and data handling techniques vary, data from a foreign system may not be compatible or readily accessible, can require extensive editing which may prohibit its use.

T402
"Automated GIS Data Conversion"
Mickey Fain, President and CEO, Smartscan, Inc.

Modern scanning technology was introduced in the early 1980s. At first, it was hailed as a miracle solution that would magically turn data conversion into a totally automated process. Automatic raster to vector conversion and automatic character and symbol recognition promised to eliminate the expensive, labor-intensive aspects of conversion projects.

Unfortunately, these initial claims seemed inflated and "scanning" technology began to conjure up images of hours at an edit station correcting "automatically vectorized" drawings. Then unintelligent raster and incremental conversion systems were developed, but it was found they did not offer the analysis capabilities typically required by a Geographic Information System (GIS). Costs decreased, but at the same time, so did the intelligence, quality and value of the resulting systems.

These disappointments were caused by two understandable errors. First, scanning technology was incorrectly oversold as a cure-all. Second and more importantly, scanning both provides and requires a whole new approach to conversion. Scanning is only one ingredient; many technologies must be effectively integrated to allow the entire operation to be successful. This presentation will review the new technologies which have been integrated to form a highly automated, very accurate conversion process which has been successfully employed in AM/FM and GIS conversion projects.

T403
"Remote Sensing Input to GIS"
Jim Reid, Cartographic Technician, Flathead National Forest

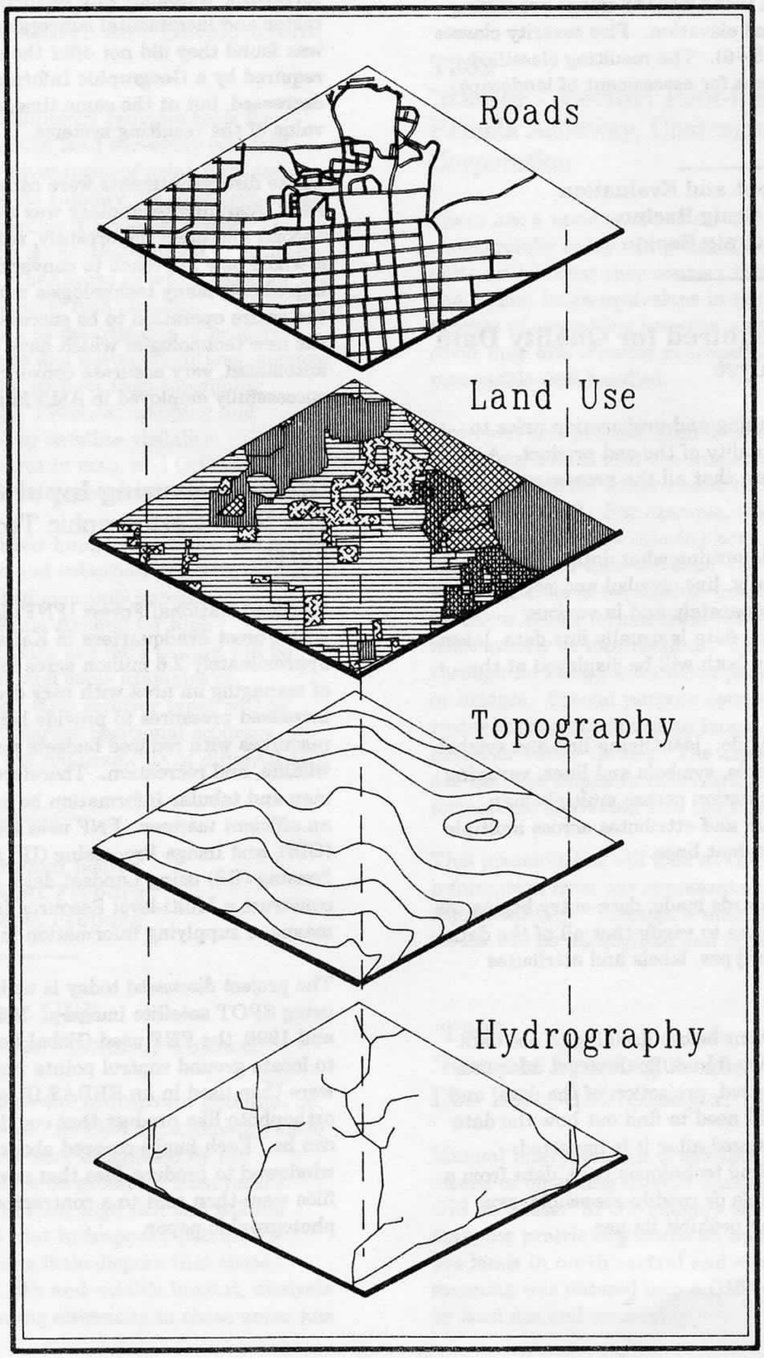
Flathead National Forest (FNF) is located in northwest Montana with Forest headquarters in Kalispell. The FNF encompasses approximately 2.6 million acres and is confronted with the problem of managing an area with very diverse concerns. There are increased pressures to provide better management of Forest resources with reduced budgets and to balance the needs of timber, wildlife, and recreation. Therefore, it is increasingly important that map and tabular information be available to resource managers in an efficient manner. FNF uses Geographic Information System (GIS), and Image Processing (IP) technology along with Remote Sensing (RS) using Landsat data, and existing databases, to construct a Multi-level Resource Information System (MURIS), as a means of supplying information in a timely and economical fashion.

The project discussed today is updating our GIS information layers using SPOT satellite imagery. Utilizing 7 SPOT images from 1989 and 1990, the FNF used Global Positioning System (GPS) receivers to locate ground control points visible on the images. These points were then used in an ERDAS IP rectification program to produce an orthophoto like product that could be used much like a quad map can be. Each image covered about 40 square miles, images were windowed to produce files that covered qual map boundaries. These files were then sent to a contractor to produce a print on photographic paper.

The final prints are being used to update our timber stand maps. The stand information will be much more accurate than before and will reflect recent cutting, fire activity, or other disturbances. The data also will be used to gather information on non forest service lands. An area only recently included in cumulative effects analysis. In this case, the final products are used as a guide, the stands are traced onto an overlay, the overlay is scanned, and the output of this becomes our new GIS stand layer.

Another use for the final files is to update road information. By using the ERDAS ARC/INFO live LINK, we can visually identify information on the screen, digitize by tracing with a mouse and cursor, and the updates or corrections go directly into our GIS files. This technique can be sued for any layer in our GIS.

While there are some technical limitations, this technique offers timely, reasonably accurate data for updating our GIS layers. Upcoming software advances should greatly improve the rectification and the updating process.



Notes

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EXHIBITOR LIST

Booth Number	Exhibitor	Phone
1	***Boller Geodetics*** 1214 Lincoln Parkway Missoula, MT 59802	(406) 549-1772
2	***Data General Corporation*** 50 South Cole Road Boise, ID 83709	(208) 375-6510
3	***ERDAS Inc.*** 430 Tenth Street, NW Suite N206 Atlanta, GA 30318	(404) 872-6789
4	***Environmental Systems Research Institute (ESRI)*** 380 New York Street Redlands, CA 92373	(714) 793-2853
5	***GeoResearch, Inc.*** 2815 Montana Avenue Billings, MT 59101	(406) 248-6771
6	***Great Divide Graphics*** 324 Fuller, Suite C3 Helena, MT 59601	(406) 442-3559
7	***HCS Corporation*** 1575 South Highway 150, Suite J Evanston, WY 82930	(307) 789-1120
8	***Hunter GIS*** 13805 Bear Creek Road Woodinville, WA 98072	(206) 885-4868
9	***IBM Corporation*** 100 North Park Avenue Helena, MT 59601	(406) 444-5000
10	***Intergraph Corporation*** 6041 South Syracuse Way, Suite 300 Englewood, CO 80111	(303) 220-9010
11	***PAMAP Technologies Corporation*** 301- 3440 Douglas Street Victoria, BC V8Z 3L5	(604) 381-3838
12	***Positive Systems, Inc.*** P.O. Box 1551 Kalispell, MT 59903	(406) 257-7745
13	***Trimble Navigation, Ltd.*** 585 North Mary Avenue, P.O. Box 3642 Sunnyvale, CA 94086	(408) 730-2900

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