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Communicating with Users: The "Art" of Program Composition and Teaching Techniques in a Multidisciplinary User Environment

Forestry, hydrology, fisheries, and engineering are just a few of the many disciplines represented within our GIS user environment. The GIS analyst/programmer has the knowledge of ARC/INFO and ArcView GIS to build, query, and produce required analyses for users. But more often the request is "show me how I can do this myself." This paper discusses:

1. How to communicate effectively with users.
2. How to build a GUI (graphic user interface) or program that will satisfy the user's needs according to their abilities.
3. Techniques for teaching users to use ARC/INFO and ArcView GIS programs effectively.

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INTRODUCTION

"Good geographic information systems education is not simply a series of exercises aimed at mastery of one or many software packages. Rather, good geographic information systems education is good geography education."

-- Daniel P. Donaldson, Professor of Geography, University of Central Oklahoma

As a Geographic/technical Information Specialist at the Roseburg, Oregon District of the Bureau of

Land Management (BLM) (<http://www.or.blm.gov/roseburg/>) I interact daily with and support a fantastic group of scientists and specialists from varied and diverse disciplines. Geographic Information System technology serves many scientists as a tool for developing complex analyses, cartographic production, tools for management of natural resources, and many other useful applications. Most of the major disciplines that encompass management of natural resources are represented within the BLM: Forestry, Silviculture, Hydrology, Fisheries, Wildlife Biology, Soils, Botany, Engineering, and of course GIS - all speciality sciences conducted by highly qualified and highly educated individuals.

The company I work for is Averstar, Inc. (<http://www.averstar.com>) which provides rapid, cost effective information technology services and products designed to meet all the needs of large, mission critical information systems. Averstar contracts with the Oregon Bureau of Land Management to provide technical expertise in GIS, network integration, software development, and computer facility management in support of BLM's core mission, land management.

There are 10 field offices (<http://www.or.blm.gov/fieldoff.htm>) in the BLM Oregon/Washington management region. The Portland, Oregon BLM State Office (OSO) employs an expert group of GIS Analysts, programmers, and technical experts who develop region-wide data standards, applications, and other protocols, which are then transmitted to district GIS coordinators. This process has resulted in one of the most comprehensive, secure and consistent large-scale GIS databases in the world.

I think of myself as a "in-the-trenches" GIS specialist. All the really hard work involving data standards and major application creation is handed down from the state office or our district GIS shop. This allows me, at the field office level, "in the trenches", to concentrate on what I enjoy the most:

- Teaching users to use ArcView, Arc/Info and to access the data they need for analyses.
- Building tools and custom applications so specialists can use GIS efficiently.
- Developing advanced GIS analysis techniques.

The Roseburg Field Office BLM consists of approximately 200 employees, 2/3 of which are natural resource field specialists. Since June of 1996, my job has involved many hours in GIS support and teaching. I have had the opportunity to analyze the teaching techniques I have used, which have been interrelated with the development of GIS tools and custom applications for users. Within the past 3 years due to our GIS team's teaching efforts, supported by management, the number of Arcview users at Roseburg BLM has tripled from 10 in 1996 to a current level of approximately 30 users.

COMMUNICATING WITH USERS

Our specialists are eager to use GIS. Initial training in Arcview GIS is usually obtained through introductory ESRI Internet courses via the Internet (<http://campus.esri.com/campus/home/home.cfm>) or BLM organized group training sessions. These beginning courses provide users with a basic knowledge of accessing data, overlay of data, map production, and some basic spatial concepts. However, the advanced concepts of proper database construction, relational databases, and consistency of item definitions and attributes are not necessarily intuitive or easily learned.

The importance of the initial training course, such as an ESRI Internet-based course, cannot be stressed enough. In a professional work environment users must have a basic understanding of the software and GIS concepts for individual teaching or 'coaching' sessions to be worthwhile. Advanced GIS spatial analyses belong in the realm of the GIS specialist. Users must be respectful of the experience and knowledge of the GIS experts. GIS is based on Geography, a Social Science, and computer-based GIS,

(is there any other kind these days?), is a complex science requiring years of experience and computer-based knowledge, as well as strong logic and problem-solving skills.

Part of my job is teaching users how to use Arcview (or Arc/Info) GIS software for basic analyses of our data. During a typical session with a user I make a conscious effort to interweave advanced spatial concepts of Geography with a friendly and professional approach. I am careful to establish first of all, a sense of my interest in the user. Communicating this to a user or student is a critical first step in establishing a teacher-student confidence. The user will return to their teacher to ask questions. Without the teacher-student bond, users may become desperate for information and seek answers from other colleagues who, with all the best intentions, may not have the important background or training in Geography and GIS. This leads to what I call "user anarchy" - users develop their own techniques, not based on scientific spatial concepts, and ultimately create their own personal brands of GIS. These independent GIS' often end up consisting of "hollow" graphic representations of the landscape with no spatial or relational database constructs, or at best, are unorganized and difficult to maintain.

Here may arise a contradiction or 'catch-22'. Teaching the value and power of GIS is a desirable end. Specialists and users must be 'empowered' with the useful tools of a GIS, but time and work hours play an important factor. What is the learning curve for a particular user? How much time can a GIS specialist or coordinator dedicate to teaching users? How much time can a user allocate to learning GIS?

Another aspect to consider in working with a user is their "input-threshold". Each user will be different as far as the amount of information that they can process in a given learning session. For example, a fisheries biologist will be trying to apply their needs and science to the GIS concepts as they are presented. Information technology overload (ITO) is a common problem among our users. It is important for the GIS teacher or specialist to sense this ITO level with each individual user. At a certain point the user is thinking, "enough!...let me digest this information and you come back later when I have questions!!". Awareness of this problem benefits the user and the teacher. I am constantly checking a user's facial expressions. It is easy to see the blank expressions beginning to appear. More often than not when I suggest that the user "play with the software" and try to apply the information I have provided, a look of relief comes over the user's face. I leave the user alone to work with the software, but, I do come back later to reinforce my interest in the user's progress and to build on the correct concepts the user has grasped.

BUILDING A "HUMANE INTERFACE"

Often circumstance or situations arise that require the programmer's skills to craft a speciality tool for a user. Let's face it...most general users cannot and should not be expected to become GIS gurus or highly proficient in the use of ESRI GIS software. At Roseburg BLM our specialists perform their activities in the field - literally the outdoors. Most "office days" involve paperwork and planning for future activities. There is often not enough additional time to struggle with advanced capabilities of GIS software. GIS is a tool that our specialists need to have available for access to corporate data or simple analysis - more complex data analyses and spatial manipulations lie within the realm of the GIS analyst.

So, on many occasions I am asked to develop a custom application or program for a user. The program may consist of a simple AML which automates repetitive processes or a more complex application for manipulation of data and/or spatial processing. The task may be simple for a generic, simplistic type of AML. An example is shape_convert.aml which simply converts a poly shapefile to an Arc/Info polygon coverage. I have customized this particular AML for a number of users for tasks such as adding unique attributes, calculating acres, etc., but on most occasions the only user interaction involves simply

entering the name of the shapefile to be converted. While the user sees a simple "interface" there is, of course, the necessity for error-trapping code. When our planner, Jay Besson, forgets where his shapefiles are and tries to run the program from a different directory he receives my "Burma-Shave" (Fraser 1991) warning:

error trap code from: shape_convert.aml

```
&type ATTENTION!! MR. BESSON!!
&pause &seconds 2
&&type IT'S TIME FOR THAT DIFFICULT LESSON....
&pause &seconds 2
&type WHETHER YOU KNOW IT OR NOT....
&pause &seconds 2
&type YOUR SHAPEFILE AIN'T IN THE RIGHT SPOT!!
&pause &seconds 2
&type CANNOT FIND YOUR SHAPEFILE!!.....(Burma Shave)
```

There is a lot to be said for interjecting humor or (tasteful) "personalizations" into programs. Users will sense more of a human connection with the program, the software, and the computer technology (Wilson, et al 1997). A user who becomes comfortable with one tool (program) will most likely contribute new ideas for new tools to benefit their work and others' tasks.

The GUI should be as simplistic and practical as possible. In John C. Dvorak's recent Inside Out column (PC magazine, Vol. 19 No. 11, June 8, 1999), he talks about a large corporation's attempt to 'improve' on it's software. Dvorak sums up the problem of software that becomes too complicated for users to use: "*Simplicity and elegance turned into complexity and spaghetti code.*"

Important aspects of good human-computer interaction are accessibility, reliability, and beneficiality (Greenburg 1993).

- **Accessibility**
 - The interface should reflect a 'commonality' and be compatible for users of various backgrounds and/or specializations.
- **Reliability**
 - Inclusion of error-checking routines to insure reliable continuation/completion after user-input mistakes.
- **Beneficiality**
 - The user should feel that the use of the program has helped them accomplish their goal(s).

Controlling or limiting the amount of actual user-input. The GUI should allow the user to make as few choices as necessary to accomplish the program task. The GIS programmer controls the complex interactions such as data manipulation, spatial processing and visual outputs.

The next section of this paper outlines 3 case studies in communication and interaction with users, resulting in custom application development. The applications associated with these examples range from a simple Arcview project to a very complex modeling program. My goals in building custom Arc/Info or Arcview applications are based on my 3 "E"s:

- **ENHANCE**
 - Provide the user with a tool to access GIS data.

- EMPOWER
 - Provide the user with the abilities to actively utilize GIS software capabilities.
- EDUCATE
 - Teach the user important GIS concepts while teaching them to use the software.

REAL-WORLD CASE HISTORIES

"There is nothing quite so frustrating ... than to begin a project, suddenly need a particular tool, but have no idea where in the house to look for it."

-- Practical Homeowner's 1987 Do-It-Yourself Annual

CASE STUDY 1: WILDLIFE

The Owl Information System (OIS) Mapper/Modeler - April 1998

User: Frank Oliver, Wildlife Biologist

Goal: Enhance - give the user a tool to access GIS data.

Frank wanted to utilize the spatial capabilities of GIS but was resistant due to the complexity and learning curve necessary to use Arcview software. GUIs with multiple menus and tools can sometimes be difficult for infrequent users (Greenburg 1993). When I first met Frank in June 1996 his "database" was a small cardboard filing cabinet containing 4" x 6" cards (Figure 1). He had no computer on his desk. After a few sessions visiting with Frank I decided he was a good case for a custom Arc/Info application. My first goal, and probably the most difficult, was to get a computer on his desk....it took almost a year!

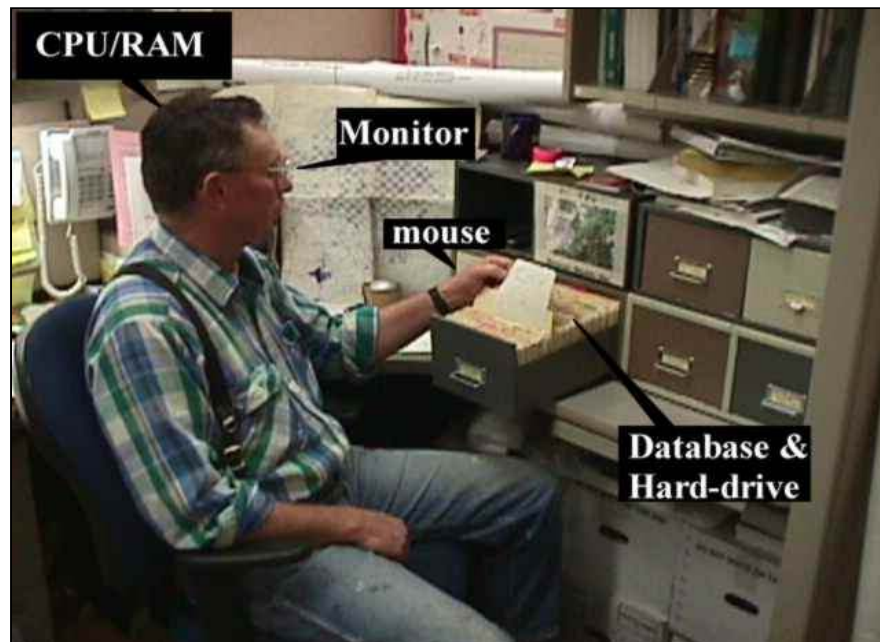


Figure 1. Frank's 'manual' Owl Information System - c. 1996

Frank wanted to use GIS to access Northern Spotted Owl (NSO) data he had been collecting for the past 10+ years. One of his needs was to be able to compute the number of acres of suitable habitat within a varying radius of an owl (point) location. Suitable habitat data was available as well as the point locations of NSO sites. Another important output of the OIS was consistent looking maps for display and for visualization by Frank and other specialists.

A first step was to identify what type of graphic user interface (GUI) would suit Frank. Remember his database to date was simplistic,..open a drawer and pull a card. The GUI for the OIS would have to be as straightforward and as uncomplicated as possible. As the OIS developed, I decided to make it a step-by-step system, with text information to assist choices and options. From my experience with Frank trying to use Arcview I sensed he would not want multiple windows popping up here and there. So, the OIS GUI became a single interface with 6 steps and options (Figure 2). All choices are right in front of the user for easy decision-making. Note: As of this writing I have succeeded in adding one popup window for printing options for the map...Frank has had only minor anxieties over it - so far!

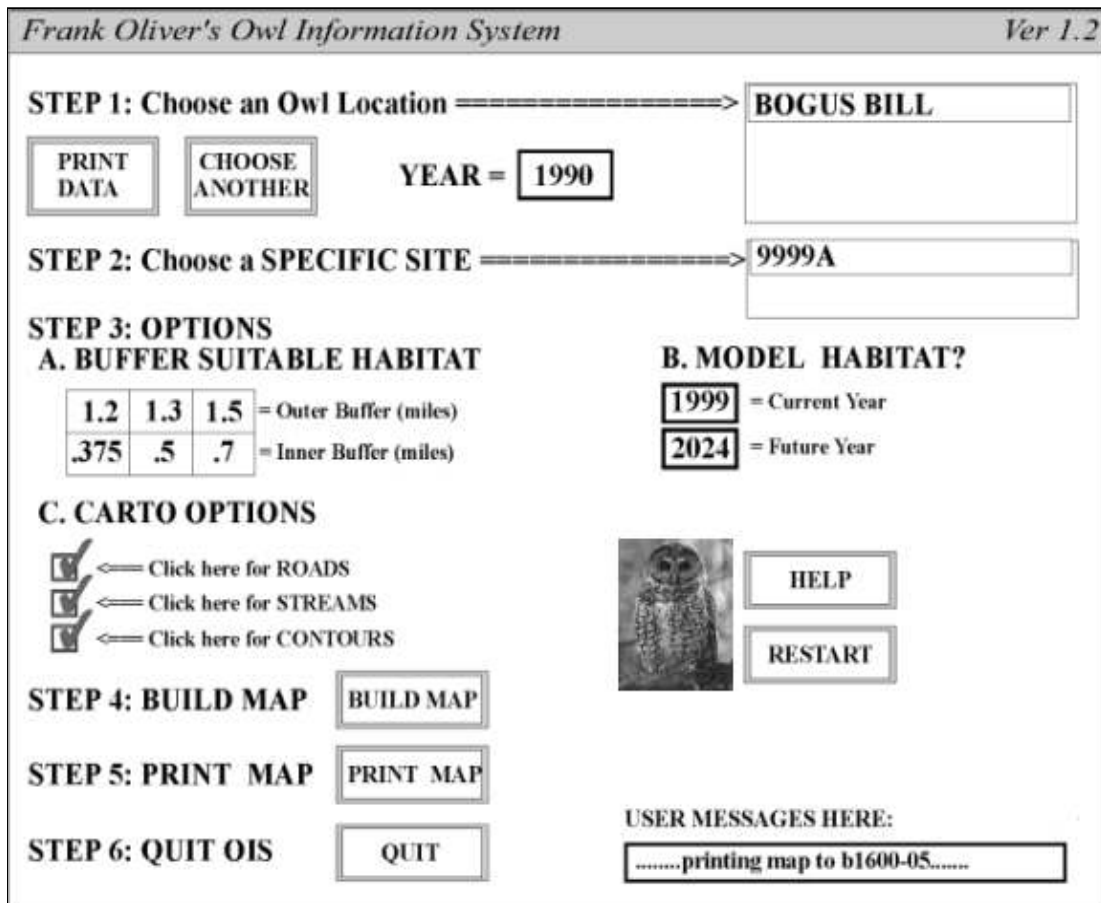


Figure 2. The OIS step-wise GUI

An interesting development in my interaction with Frank was my advancement as a programmer. As I pondered the requirement's of Frank's owl information system, I also sensed the need for more education in programming for myself. Frank and I developed an educational 'symbiosis'.....e.g. my programming

skills improved in direct proportion to Frank's access to his data, and his improved knowledge of GIS. An equitable partnership!



Figure 3. Frank's 'computerized' Owl Information System - c. 1998

Within the past year of development and use of the OIS a modeling option was added, which has proven to be the most valuable part of the tool. Our sale-planner, Jay Besson wanted to have a way to look at the forest into the future. With Jay's input I constructed an AML that advanced the birthdate of forest stands at the 5th field watershed level. Since Jay and Frank have to coordinate their planning efforts, it was only a matter of time before I was asked to make the modeling option work in conjunction with the OIS. While not an absolute indicator of suitable owl habitat, the future ageclasses of forest stands helps Frank visualize connections between owl core areas. The modeling process utilizes inputs of harvest units, reserved areas such as visual management, areas of critical environmental concern and riparian reserve (buffered stream) areas. The final map (Figure 4) provides a "look ahead" to future habitat conditions for the endangered NSO (Specht 1999). Resulting data are Arc/Info coverages which can be used by other specialists for analyses and display in Arcview GIS.

User Feedback:

"I needed a program to allow a 'non-computer person' (me) to access NSO data and visualize suitable habitat. It was somewhat like driving a car. I wanted to get from Point A to Point B, without having to know how the engine, brakes or electrical system of the car actually works. The Owl Information System is a valuable tool, simple to use, and much easier to operate than most cars!"

-Frank Oliver, Wildlife Biologist

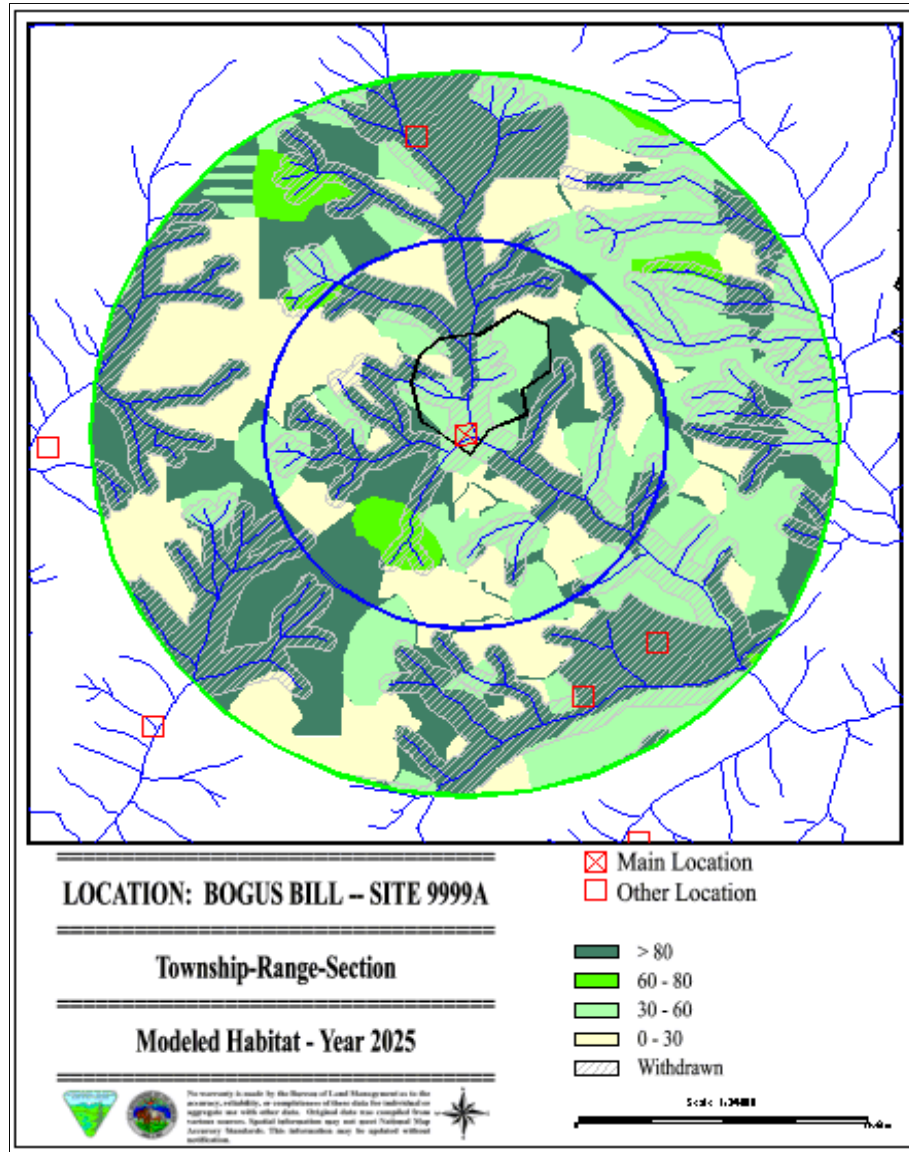


Figure 4. Map of modeled NSO habitat.

CASE STUDY 2: SILVICULTURE

Creating Spatial Data for input to Silviculture Mapper AML/GUI - August 1998

User: Trixy Diamond, Forester

Goal: Empower and Educate the user

An excellent example of empowering the user by helping her learn how to build her own Arcview geospatial shapefiles. Trixy had some background in GIS - a preliminary college course in Arcview. She was also an avid computer user in general. Trixy needed the ability to create her own data for Silvicultural mapping projects.

On a yearly basis our Silvicultural specialists are involved in planning and contracting projects requiring numerous forest treatments, including pre-commercial thinning (PCT), planting, and stand exams (inventory). Polygon data for specific forest stands are available in our forest operations inventory (FOI)

library data layer. However, in many cases, for example planting contracts, Trixy needed polygons for maps that did not necessarily match the FOI polygons (Figure 5). (Note: Obviously a good case for REGIONS structured data layers!).

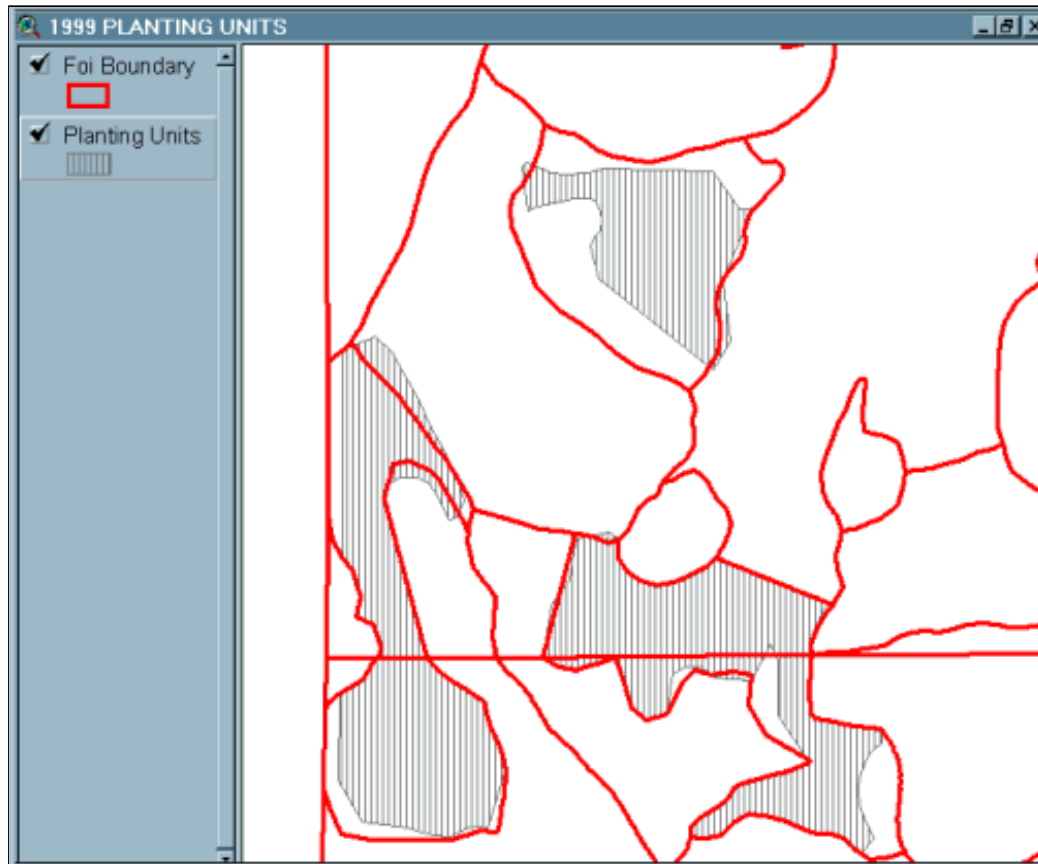


Figure 5. Planting unit boundaries do not always match forest boundaries.

It was a fairly straightforward project for me to build an AML GUI/application that produced a map with acres and unit information (Figure 6). Since our Roseburg District is divided into two field offices, it made sense that I should communicate with the Silviculture group in both field offices to come up with map layouts that satisfied everyone's needs. Once the map layout was decided upon it was necessary to provide a method for users to create their own datasets.

Since Trixy had a good knowledge of Arcview, and the learning curve for Arcedit was impractical, building custom shapefiles seemed like the optimal solution. After a few sessions working together, Trixy and I developed the following techniques so she could create her own geospatial data:

1. Convert Arc/Info FOI data into shapepolys
2. Add or adjust shapepolys to "fit" silviculture project unit boundaries
3. Add fields and input attributes into Arcview tables
4. Convert shapepolys into an Arc/Info polygon coverage (using shape_convert.aml)

5. Copy the finished coverage into a common workspace

Once the coverage is finished I simply copy it from the shared workspace and insert into the program. Trixy can then produce maps as her schedule permits. Empowering Trixy to build her own data gave her a feeling of participation and a better education in GIS. It left me time to continue with program and application development and other more complex GIS analysis.

User Feedback:

"It would seem that contract project map processing would be straight-forward, but different needs arise with varying service contracts. The Silviculture (GUIs) mapping programs are easy for me to use to build professional looking maps. Having input into the process, as well as learning how to create my own data has been a very rewarding learning experience."

-Trixy Diamond, Forester



Figure 6. GUI for Silviculture planting maps.

CASE STUDY 3: SOILS

Arcview Soils Project - July 1996

User: Dennis Hutchison - Soils Scientist

Goal: Enhance and Empower - give the user a tool to do their job

Our soils scientist, Dennis Hutchison, "Hutch", needed a simple tool for determining soil types in areas within the Roseburg Field Office region. Hutch was comfortable with using computer word processing programs and email. Hutch wanted to use Arcview GIS as a practical tool - click on a polygon and receive the soil-type descriptions for that area.

I spent some time familiarizing Hutch with the Arcview interface and demonstrating some of the possibilities of the software. This proved to be very helpful in determining what Arcview processes Hutch was or was not comfortable with.

A Wordperfect document with descriptions of all soil types within Douglas County and the Coast and Cascade ranges of Oregon had previously been created by BLM. Each description for each soil type was copied out of the main document and pasted into unique text files named in relation to soil designations, e.g. Tmsc = TMSC.txt. A HOT LINK field was added to an Arc/Info polygon coverage of soils for the link to polygon soil types. Similar procedures were conducted for geology data.

The learning curve for Hutch was moderate. Once he was comfortable with accessing Arcview it was easy for him to learn the use of the hot-link tool. The Arcview Soils Project (Figure 7) was a simple tool to build which only required about 4-6 hours of work. Hutch had waited years for a GIS tool to allow him easy access to soils data.

User Feedback:

"The power and versatility of ARC/INFO is readily apparent when working with soil survey data. Soil surveys have large amounts of data that may be used separately or grouped into an almost infinite number of combinations. Interpreting soils data for varied users can be much faster and more easily understood with custom tools or projects built in Arcview. Maps of many different types of soils related properties can be produced using these tools."

-Dennis Hutchison, Soils Scientist

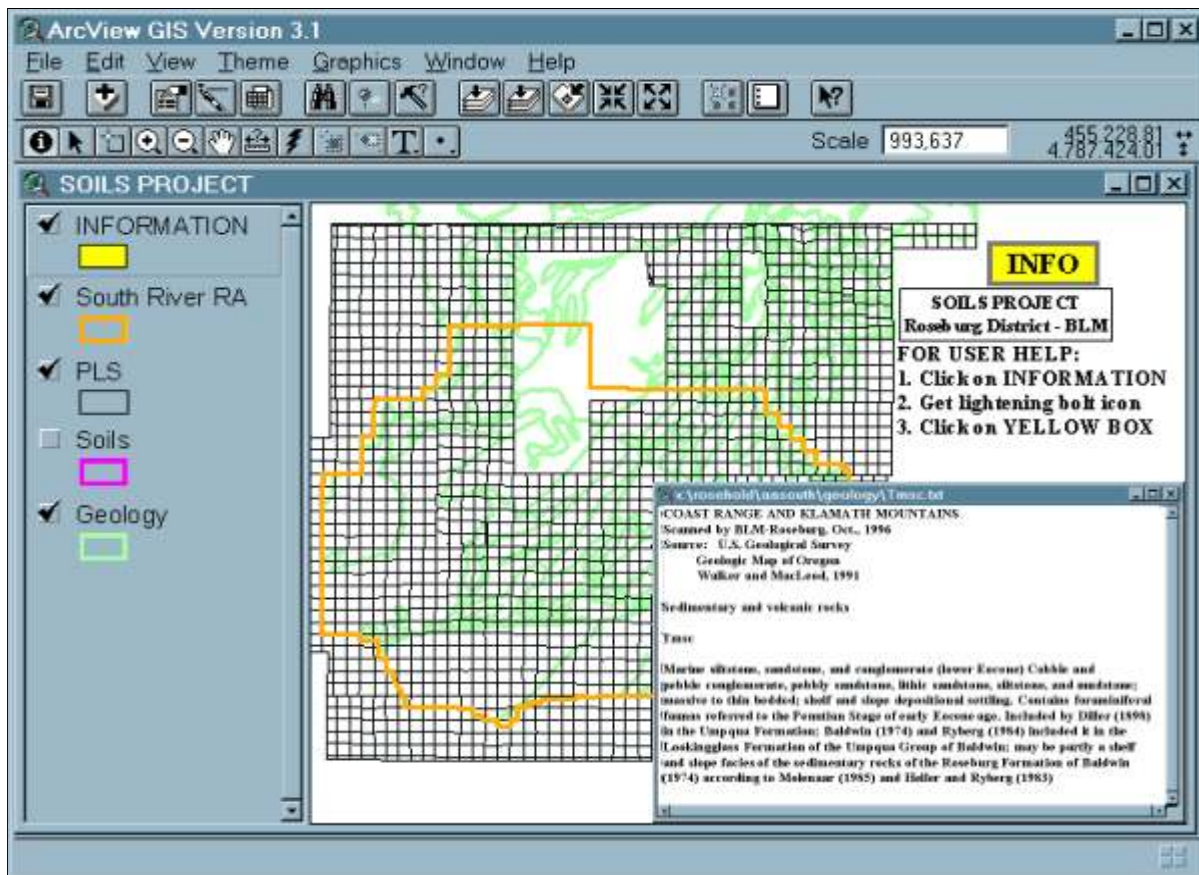


Figure 7. Arcview Soils Project.

CONCLUSIONS

In teaching Arcview (or ARC/INFO) GIS software, always make a conscious effort to interweave spatial concepts of Geography and other GIS principles. Otherwise, users may develop bad habits and create "graphic" GIS' with lots of points, lines, and polygons, but without the relational tables and attributes that make a true GIS useful and functional. Relational database concepts are important issues to talk over with users. It is always easier to spend a few hours educating a user rather than multiple hours repairing crashed projects, altering item definitions or re-naming attributes to match data tables.

It is important to sense the learning thresholds of users. Information overload is a common problem when teaching Arcview or Arc/Info software. Sensitivity to the users' learning abilities and needs makes for good teaching. Always follow up with a user on a regular basis to keep the user interested and provide them with a sense of connection with their teacher.

In all three of the application case studies the GUI was carefully crafted for simplicity. The amount of actual user input was controlled. The majority of the user actions were kept to point-and-click operations. Most important, all the main controls were kept on one GUI canvas. The only other menu to appear is the printing GUI. Keeping the menus simple and limiting choices makes the custom GUI more "user-friendly".

Ultimately the programmer should strive to *empower* the user with a tool for accomplishing tasks efficiently and easily. In certain situations the user can also be *educated* to create their own spatial data

for input into a program. The concepts of Geography can be interjected within the auspices of teaching the use of GIS software. The user is the main focus and the goal is to *enhance* the user's job skills by providing them with practical GIS tools to do their job better.

ACKNOWLEDGEMENTS

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