EDUCATION AND TRAINING IN GIS:
THE VIEW FROM ESRI

Tony Burns and Jim Henderson

(I)   GIS Training: a Voyage of Discovery

GIS education is very much a voyage of discovery, a voyage of inquiry into the fields of geography, cartography and computer technology.

To properly learn about GIS we must first learn about geography and what it implies. Geography is a science that deals with the earth and its life, especially the description of land, sea, air and the spatial distribution of geographic phenomena; plants, animals, man, his cities with reference to the mutual relations of these diverse elements.

Early in the Second World War, President Roosevelt asked his audience, during one of his "fireside chats" by radio, to look at a world map while he explained the threats to the United States of hostile encirclement if the Axis powers were to win. Similarly, President Kennedy told us of the strategic importance of an unknown area called Laos and Vietnam. In fact, both Presidents were discussing geographic concepts of location and interrelationships between parts of the earth.

More recently, as inhabitants of various cities throughout the United States, we find ourselves concerned with such matters as floods and water shortages, toxic and hazardous wastes, water pollution, earthquake risks, chaotic growth and congestion in our metropolitan area, depletion of wildlife habitats and wetlands, and legislative reapportionment. But all too seldom do we clearly understand these problems in relationship to the surrounding geography. We clearly need to understand how people and places interact.

For hundreds of years we have used maps as a visual geographic tool. Maps are the language of geography. In producing maps the cartographer sets out to accurately map geographic phenomena. In one small area of one vast country there are scores of features that are full of wonder and mystery. I want to know with precision the location of these things I see before me relative to the geography around and related to them. I want to know their shape, size, composition, and interrelationship. I want to unravel the interrelationships and understand the mystery. As part of my inquiry I want to answer three essential questions:

- Why are things located in particular places;
- How do these particular places influence our lives; and,
- How do these things interrelate and how can I better understand these interrelationships.

Today's technology has let us explore new ways to understand geography and answer our questions. We can look at a map in new ways. If we can read its language we can begin to understand our world, our cities, and our impact on them. We are shapers of the landscape both for good and bad. There are many ways of looking at places, many perspectives. I can define a place as a dot on a map; a unique mathematical coordinate on the sphere of the earth, or I can step back further and see the pattern created by many dots. At this level I see places not as isolated features but relative to one another. I see them in context; cities connected by vast networks of roads, some dots larger than others, nations of people and ranges of mountains.

I can also step closer and see that the dots are much more complex. Now I begin to see the shapes that make up cities. I see the specific mathematical features that make up my map; dots or points now represent such features as utility poles, lines are now street centerlines, property lines and utility lines, and shapes or polygons are now building footprints, lakes and easements. Computers are tools that let us effectively and efficiently deal with geography and the language of part of previous maps.

As teachers we must clearly convey the concepts of understanding a spherical world as a set of points, lines and polygons on a map. The concepts of scale, map projection, and manipulation and analysis of map features via a set of GIS software tools are essential to understanding spatial relationships. Only then can the resulting maps be of use in decision making and problem solving.

The challenge facing todays GIS teachers is to carefully balance the concepts of geography, dealing with maps as geometric features upon which mathematical functions are applied, and dealing with a technology of software tools operating on a set of electronic circuitry. Our goal is to uncover patterns and themes, making inquiries of a complex nature.

Lets look at it in another context. A Geographic Information System is:

Geographic: Spatial Data about geography; maps: the language of geographers.
Information: The analysis and synthesis of data to answer questions, solve problems, and make decisions.
System: The integration of hardware, software, people, data, and administration to operate as a whole.

At ESRI we believe we have carefully developed our training program to incorporate these elements. Let's explore the process and examine the philosophy behind our approach.

(II)   Education and Training: Background and Issues

Geographic Information Systems, in one form or another, have been around since the late 1960's, but only in the past few years have they been introduced into the mainstream of computer applications. In those few years the growth of GIS sales has been tremendous. The GIS now finds a place in many areas of business, government, and society where people not only are unfamiliar with its technology, but may also be approaching computers for the first time.

This situation poses a special challenge for the GIS vendor in training the new user. By its inherent nature, GIS technology is founded upon a set of basic geographic and spatial concepts that incorporate a holistic view of the world. These concepts are typically not part of everyone's academic training or professional practice. In order to make effective use of a GIS, one must understand these basic concepts, for they are the foundation of its functionality. On top of this, the GIS operates within the context of fundamental Automated Data Processing principles which may be foreign to many prospective users.

Traditionally, universities have prepared many people for their professions, but GIS is still an emerging discipline in search of its identity. As a result, academia has not yet fully defined the field of study or the curriculum for its preparation. This places a further burden upon the GIS vendor to address basic educational issues in training. This situation is slowly changing as the academic GIS discipline evolves.

But in the meantime, the GIS vendor is faced with several challenging issues in its training. The first is defining the relationship between technical training, fundamental concepts, and basic education. The second issue is determining the vendor's role and responsibility in providing a minimum background knowledge as prerequisite to its technical training. Finally, how to address the need for advanced and continuing training for users as they mature is an important issue for the GIS vendor who is committed to supporting its users.

What follows is the perspective taken by ESRI with respect to these issues. ESRI's philosophy of providing strong support to its users is inherent in its comprehensive approach to training.

(III)   Training vs Education

Within the general "learning environment" one can distinguish between two major divisions, "Training" and "Education." Each is based upon different principles and purpose which may represent opposite ends of the spectrum at times. Whereas education seeks to enable students to understand basic concepts, theories, and principles, training strives to make the trainee proficient in using the functions of a particular tool. Similarly, education enables students to apply concepts, principles, etc. in a wide variety of environments, while training aims to enable trainees to apply functions to specific situations. Training and education may be contrasted in other ways.

TRAINING	EDUCATION
• Specialized Instruction	• General Instruction
• Short Term Time Frame	• Long Term Time Frame
• Concentrated Attention	• Dispersed Attention
• Intense Delivery	• Measured Delivery
• Practical Emphasis	• Theoretical Emphasis
• Performance Skills	• Knowledge Acquisition
• Behavioral Change	• Synthesis of Ideas

As was pointed out in the previous section on issues, the increasing trend toward a training audience with a naive understanding of basic geographic and spatial analysis concepts forces the GIS vendor to address GIS education directly as a prerequisite to training. The vendor must not assume this prerequisite education will be the responsibility of someone else nor be acquired prior to the vendor's training. Therefore, it is imperative for the vendor to incorporate at least a minimal level of basic education in the design and delivery of its technical training. Without it the vendor's training will be ineffective and the client unsuccessful. At ESRI, we recognize the importance of education in the design and delivery of all our technical training.

## (IV)   The GIS Training Course at ESRI

(A)   What is it?

GIS training courses at ESRI are designed around four basic components. The first and most important component from the standpoint of education is that of "concept." It incorporates those fundamental ideas, theories, and principles which form the foundation for the second component, system functionality. ARC/INFO functions are the implementation of basic concepts, theories, and principles through well structured software engineering. A significant portion of technical training is concerned with

attaining a basic understanding of the system functions. This understanding is a prerequisite for the third component of the training, procedure. This part of the GIS training course concerns itself with acquiring the skills needed to effectively use the functions of the system. In order to achieve this the training must involve a great deal of hands-on exercise with the tools. It must not only demonstrate the correct use of each tool, but must also show the proper sequence of their use. A primary goal of this part of the training is the enable the trainee to make intelligent choices in the use of the system functions. Closely related to this is the last component, the application of the system. Here the goal is to prepare the trainee for the transition from the classroom to the real world. To achieve this objective the GIS training must relate the knowledge and skills acquired by the trainee to real world situations. In other words it must make the training relevant.

A well-designed and effectively delivered GIS training course will give the trainees the knowledge and skills they need to feel confident in using the system upon their return to their jobs. It will also prepare them to begin the process of learning more on their own. ESRI training courses are directed toward achieving these results.

(B)   How is it Designed?

The model for the design of ESRI training courses is based upon well established instructional design principles. Professional training developers apply these principles in the design and development of all ESRI training. The instructional design model incorporates specific "learning objectives" derived from an analysis of the "audience" and their needs. The learning objectives are expressed in terms of specific skills to be acquired or levels of knowledge to be attained. In other words, the focus of the training is based upon what the trainee will be expected to do or know upon completing the training.
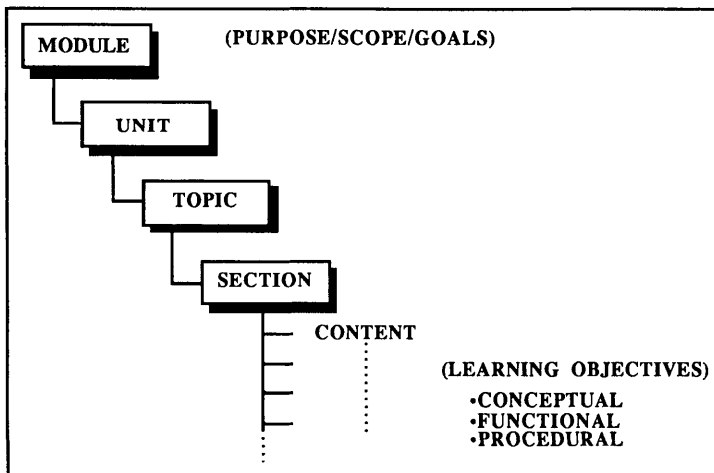
INSTRUCTIONAL DESIGN MODEL

(C)   How is it Delivered?

Just as we have a model for the design of training, we have a model for its delivery. The two basic modes of training delivery are instructor-lead/classroom and self-paced/stand alone. Each mode has its place in the overall delivery strategy for the training program.

The classroom delivery model incorporates well established and accepted techniques and media. The intent of the model is to deliver each "section" of the training course in the particular sequence and method to be most effective in achieving the learning objectives.

MEDIA		DELIVERY METHOD
Video and/or Lecture	(0)	Gaining Attention/Getting Started
"	(1)	Presentation of Concepts
"	(2)	Relevance and Relationship to Other Sections
"	(3)	Presentation of Technical Procedures ("How to...")
Exercise or Tutorial	(4)	Acquisition of Skills ("Hands-On") (a) Specific (Command Usage/ Simple Procedures) (b) Comprehensive (Integration of Knowledge/Skills)
Lecture and Discussion	(5)	Review/Discussion/Evaluation ("Transition" to Next Section)
Self Paced Materials	(6)	Job Aids/Workbooks/Guides

DELIVERY MODEL

(V)   The GIS Training Program at ESRI

The approach to planning and implementing a comprehensive training program involves a well thought out strategy for designing the curriculum. Just as there are basic differences between education and training with respect to instruction, so too are there differences in curricula.

TRAINING	EDUCATION
• Specialized Courses	• General Courses
• Narrow Focus	• Broad Focus
• Customized Instruction	• General Instruction
• Technical Orientation	• Professional Orientation
• Application	• Interdisciplinary

The training program at ESRI encompasses a curriculum of courses designed around a wide variety of client needs. The strongest emphasis is on building a solid foundation of basic system training. There are several courses devoted to the general understanding of the software modules. These basic level system training courses are normally provided with the sale of each software module.

Beyond the basic level of training are courses designed to meet the needs of clients for continuing education and more advanced system tools for specific applications or to achieve higher productivity. Typically these courses follow on several months after the basic courses and are required by a more selective audience. The basic level courses are normally required as prerequisites.

Another audience which must be considered is one which doesn't require an in-depth knowledge of the workings of the software modules. Instead, they need to know the basic concepts underlying the system, its capabilities, and some guidance in managing its applications. This audience typically includes managers, administrators, project directors, and support personnel. The ESRI training curriculum includes an "Introduction to GIS" course to address this need.

Finally, as clients mature they build a vast base of experience that can be invaluable to less experienced users. It is important to tap this tremendous resource of knowledge and skills in a way that makes it accessible and useful to others. The "Application Seminar or Forum" format is a very good way to structure this transfer of experience from one to another. At ESRI we feel it is our role to organize and implement these seminars/forums, but the instructors must be users who possess the experience in the particular application. In this way, as a vendor, we operate much like an "extension service."

In summary, the ESRI curriculum is structured on several levels, each designed to meet specific client training needs.

LEVEL 0	Introduction to GIS
LEVEL 1	Basic ARC/INFO System Training Basic TIN System Training Basic NETWORK System Training Basic COGO System Training
LEVEL 2	Database Design Applications Programming Cartographic Production Geographic Analysis Processing Techniques System Programming Systems Administration
LEVEL 3	Application Seminars/Forums

(VI)   Conclusions

In conclusion, the tremendous growth in GIS sales has placed the GIS vendor in a position of having to provide more comprehensive training than in the past. As GIS technology reaches out to a larger audience, the level of understanding of fundamental GIS concepts and computer operations becomes less sophisticated. In order to assure success in its training, the GIS vendor must incorporate basic education in its training program. As its clients mature in their experience with GIS technology, the GIS vendor must recognize the need for more continuing education and advanced training. Ultimately, the GIS vendor has a role in all levels of GIS education, training, and technology transfer.