GIS ACCREDITATION

WHAT ARE THE OPTIONS?

By Michael F. Goodchild and Karen K. Kemp

The power and imperfections of emerging GIS technology invite misuse. While licensing to ensure quality control may be premature, certification could provide a positive model.

Geographic information system (GIS) technology is here to stay. The technology is powerful, attractive, and persuasive. Its results are visual (worth a thousand words), come from a computer (What mere mortal challenges a computer when it speaks?), and are often numerical (Numbers beat no numbers every time!). But GIS technology is far from perfect in spite of—and perhaps because of—its rapid growth.

The original research plan of the National Center for Geographic Information and Analysis (NCGIA) identified numerous impediments to the effective use of GIS software. Many of these have not yet been eliminated. Data input is often tedious, error-prone, and costly. Different data models adopted by GIS products make it difficult to transfer data among the various products or to develop common command languages or terminology. Accuracy is a problem because many data used in a GIS are of poor or dubious quality.

Despite recent progress we still lack effective tools for assessing data quality and error propagation in current GISs. GIS technology is characterized by high precision, but is often used to process data of questionable accuracy. Finally, many GISs remain difficult to use and user-interface design has a long way to go toward meeting the needs of the average user.

The inherent power of GIS technology, along with its current imperfections, also encourages misuse. Even when effective error-handling tools are available, it is possible to present results as being more accurate than they really are or to display results in misleading ways. The same impediments that create the need for continued research also open the way to the technology's abuse.

Mark Monmonier, professor of geography, Syracuse University, provides many examples of map abuse in his book, *How to Lie with Maps*. GIS technology, however, is more open to abuse than cartography because it is not self-policing and the uninitiated or devious user can easily distort results. GIS technology has no consistent terminology; such terms as "coverage," "topology," and "object" can mean different things depending on the contexts of different systems.

As GIS users begin to worry about having to defend themselves in court against charges of misuse or inaccuracy, the questions of what defines a GIS and who is qualified to use it inevitably surface. It is not clear what qualifies a software package to be called a GIS program or what the minimum requirements of a GIS program should be, or perhaps most importantly, what makes a consultant an expert in the field. Is GIS technology "not ready for prime time" or is it time to address these questions head on?

WHAT MAKES A PROFESSION?

If we wish to recognize professional expertise in GIS technology, we must first confirm the existence of the GIS profession. In an article in *Public Administration Review*, D.L. Pugh identifies five criteria that a field must meet to be regarded as a profession:

1. Existence and growth of a unique body of knowledge and expertise. We can measure how well this criterion has been met by considering the quantity and quality of related literature. Recent years have witnessed an explosion of new GIS magazines, journals, and books. *Computers and GIS*, *GIS World*, the *International Journal of Geographical Information Systems*, and ACSM's *Cartography and Geographic Information Systems* are examples of GIS journals produced by commercial publishers and professional organizations. Proceedings from national and international conferences such as Auto Carto, the International Symposium on Spatial Data Handling, and GIS/LIS have for several years provided technical reference materials for GIS technology. New textbooks on GIS technology and such related topics as urban information systems are appearing almost monthly, and publishers confirm that the flood of GIS books will increase in the next few years.

2. A formal organization of members. This criterion has been much more difficult to achieve in the multidisciplinary arena of GIS technology. In the United Kingdom, the Association for Geographic Information (AGI) has formed a coalition of groups in the GIS community, including academics of various disciplines, individuals, companies, and government agencies. AGI's governing body has taken on such responsibilities as publishing a yearbook of commissioned articles, organizing an annual conference, and lobbying for data access issues.

No comparable organization exists in the United States. Perhaps the closest approximation is the consortium of five organizations—ACSM, the American Society for Photogrammetry and Remote Sensing (ASPRS), the Association of American Geographers (AAG), the Urban and Regional Information Systems Association (URISA), and AM/FM International—that organize and sponsor the annual GIS/LIS conference. However, this group meets only to organize the conference and has not

yet taken on other initiatives.

On the other hand, most organizations for professionals working with spatial information in the United States have spawned large subgroups of GIS specialists. AAG's GIS Special Interest Group is now the largest special interest group in the association. Such groups communicate pertinent information among members through newsletters and organize special sessions at annual conferences.

While there may be no formal umbrella GIS organization in the United States, an informal but extremely important international grassroots organization of people working with and interested in GIS technology is thriving. People associated with universities, federal agencies, and some large commercial organizations now have access to GIS-L, an international electronic communications network dealing with GIS issues.

GIS-L provides instantaneous delivery of messages from any individual to all members. Registration is free and unlimited. Recent discussion has included how to get a particular brand of printer to work with a specific GIS program, what interfaces users prefer, and whether GIS use should be restricted to those who have sufficient education to understand the technology's pitfalls.

While GIS-L is an informal organization, it has begun to conduct many of the communication functions of more traditional professional organizations. Its open membership policy has also helped bridge gaps among different disciplinary groups.

3. The evolution of a shared language. Although "raster" and "vector" are reasonably understood, there is little doubt that the GIS field suffers from lack of a well-defined language and terminology. In a recent paper distributed with *GIS World* magazine, David Sinton looked back on 25 years of GIS development and concluded that the field has yet to develop a consistent, shared terminology.

The lack of a vocabulary is certainly due not only to the newness of the profession, but also to its multidisciplinary nature. Spatial concepts have evolved in many disciplines independent of similar concepts in other areas. For example, "patch" is a widely understood concept in landscape ecology, but might be called an "inclusion" in geology. Both of these may be referred to as "objects" by the computer scientist.

4. Development of a professional culture and lore. Pugh's fourth criterion covers such overt symbols and totems of professionalism as logos as well as more subtle indications of belonging. At the 1992 AAG conference, Nancy Obermeyer, assistant professor of geography at Indiana State University, suggested that a hall of fame would be one such indication of the emergence of a GIS profession and wondered who might be named to it. Where to locate the hall of fame might be an equally important issue: Could it be a placeless node on an electronic mail network?

Again, GIS-L may be an important vehicle for developing GIS culture and lore. Personalities and significant points of view are becoming apparent, even through the electronic filter. It is not uncommon to overhear conference attendees reminiscing and chuckling about a recent episode on GIS-L.

5. Foundation of a code of ethics. Pugh's fifth criterion takes us back to the beginning and the need to develop standards and procedures that discourage the misuse and abuse of GIS technology. While there is a growing awareness of the need for a code of ethics, there have been few attempts to define a specific GIS code.

Of these five criteria, GIS technology currently meets only the first—the existence and growth of a unique body of knowledge and expertise. It lacks a single representative organization and its shared language is full of ambiguity and confusion. Its professional lore is accumulating, but has not yet reached the level of development of more mature professions. Finally, it has no code of ethics.

ACCREDITATION OPTIONS

Many professions have responded to situations similar to that currently faced by GIS technology by developing systems of accreditation. Accreditation provides a framework for defining minimum requirements for entry and practice in the profession, as well as procedures for ensuring the quality of results. In the broadest sense, accreditation provides at least five models, each with its advantages and disadvantages in a given context:

1. Legal licensing, certification, or registration of professionals. Such professions as law and medicine require licensing as a condition of practice. These professions are often self-regulating, with powers devolved from the state legislature. Licensing of this sort allows the professional body to enforce standards of practice and expel individuals from practicing the profession for illegal or otherwise unethical activity.

To become licensed, an individual must obtain a degree from an accredited educational institution, pass rigorous post-graduation examinations, and complete an apprenticeship. Accreditation of educational institutions requires a well-funded, highly respected professional organization supported by relevant government agencies.

Perhaps GIS technology should be a profession. But realistically, GIS technology is used most often as a tool in conjunction with an application, such as surveying, forestry, civil engineering, or landscape architecture. It makes more sense to suggest that GIS technology be part of the professional qualifications of all of these professions, rather than a profession by itself or a tool licensed for use by only one of the professions.

2. Professional certification by a recognized professional body. Some professions, such as planning, offer certification of practitioners. While not supported by legislation, certificates are often awarded by examination or after the applicant accumulates several years of professional experience. Certificates may be a condition of employment or may simply place a new employee at a higher starting salary than non-certified applicants.

In the spatial sciences, a certification program for photogrammetrists has been available for many years through ASPRS. In 1991 ASPRS began to offer certification as "mapping scientist, GIS/LIS." Although ASPRS has a large membership, this effort can only address part of the overall GIS certification issue.

3. Diplomas or degrees issued by academic institutions. In the United Kingdom, several universities offer master's degrees in GIS technology, including Edinburgh and Leicester. Some universities in the United States have started developing specialized advanced professional degree programs, though we are certainly lagging some years behind. Here we find that GIS technology is becoming increasingly available as a formal area of concentration in regular undergraduate degree programs, particularly in surveying engineering and geography.

However, for the most part, GIS tech-

nology is only taught as a loose collection of two or three courses in a more traditional program. How should the professional status of students who have graduated from a full professional program compare with those who have had an informal concentration in GIS technology through course work and projects?

4. Non-degree certificates issued by academic institutions and other organizations. GIS technology has developed rapidly and there is a large demand for short courses for executives, managers, and others in the labor force who cannot afford the commitment of a degree program. These informal certificates do provide proof of participation in the courses but they will rarely be a requirement for employment or be used for salary placement.

In some cases, certificates may require completion of a series of short courses. San Diego State University is typical of many universities and colleges that are now offering GIS certificate programs for working professionals.

5. Certificates of training issued by vendors. During the early part of the GIS boom, the largest proportion of GIS training was conducted by GIS software vendors. While many universities now provide more complete GIS education programs, a certificate from a vendor is often valuable to employers who want to be sure their employees have sufficient expertise in particular software environments.

THE CURRICULUM ISSUE

Of these five options, only the first—legal licensing, certification, or registration of professionals—provides any system of policing and a clear set of sanctions for professional malpractice. The other four ensure professionalism indirectly only, through the education required as a condition for certification. While option 2—professional certification by a recognized professional body—offers the potential for well-defined standards of course content, the objectives of option 5—certificates of training issued by vendors—are clearly more specific. The content of degree programs under option 3 is entirely up to the institution and the content of existing programs varies considerably from one institution and sponsoring department to another.

Is it possible to specify minimum course content of a program in GIS technology? Probably not in the case of option 4 (non-degree certificates issued by academic institutions and other organizations) and option 5, which deals largely with short courses for professionals. The ASPRS solution (option 2) sidesteps the question of educational program content by specifying a certification process that is more heavily dependent on the judgment of referees concerning the applicant's experience than on the content of courses taken.

GIS jobs run the gamut of technical operators, cartographers, applications developers, and system managers. While all these jobs share an involvement with GIS software, spatial data, and spatial analysis, it is difficult to determine a definitive curriculum that would suit the needs of all these different careers paths. GIS users must also understand specialized aspects about the phenomena with which they are working, whether they be trees, agricultural production, utility lines, or land parcels.

A conference on GIS education held by the World Computer Graphics Foundation (WCGF), NCGIA, and the University of South Florida in 1991 provided participants a glimpse of GIS curricula being used in different disciplines. The proceedings of this conference, *GIS Curricula, Course Outlines and Lab Exercises Prepared for the GIS Higher Education Symposium*, a three-volume set of program syllabi and course descriptions, provides an overview of the wide range of approaches currently being taken. The proceedings are available from WCGF, c/o Department of Geography, University of South Florida, 4202 E. Fowler Ave., Tampa, FL 33620-8100.

Clearly, if GIS technology is to be a profession, it must be possible to define a core of knowledge. Several "strawman" curricula have been published. One is the *NCGIA Core Curriculum in GIS*, a set of 75 modular units of instruction including course notes for instructors, now widely distributed and adopted as a basis for GIS courses in universities around the world. An outline similar to that used in the NCGIA curriculum was compiled at the same time, but independently, by a working group of the United Kingdom Royal Institution of Chartered Surveyors. A more extensive curriculum for a four-year degree program in GIS technology and cartography described by Timothy Nyerges and Nicholas Chrisman in *Professional Geographer* provides an outline of the curriculum offered at the University of Washington.

Although only licensing offers a truly enforceable approach to quality control in the emerging GIS profession, agreement on an outline curriculum would provide some assurance that GIS professionals would become aware of the potential for misuse of the technology and some ways of avoiding or detecting it. A program of licensing in GIS technology seems inappropriate and premature at this time, but more modest forms of certification based on a widely accepted course content might do much to ensure a positive future image for the technology and its practitioners.

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