GEOGRAPHICAL RECORD

MAPS EX MACHINA

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A geographic information system (GIS) is software that uses maps interactively with an underlying database. Using a GIS requires mastery of theoretical and practical elements. The focus here is the stage in obtaining information when the user goes "on line." There are GISs of as many different types as there are types of computers—from those on a local area network in a traditional academic setting to those on a far-flung network of fieldworkers using laptop computers in remote areas of the developing world (Nystuen and others 1994). All environments offer an exciting view of the future of maps—digital or otherwise—in which the classical concerns of cartography join with the contemporary capabilities of computers (Moellering 1991).

In the flurry of activity in the world of maps ex machina, it seems prudent to pause to consider the broad structure of the emerging literature. One difficulty with a contemporary approach to a classical discipline is the sort of proprietary attitude of people who have recently mastered the new technical systems. One hallmark of this sort of problem is a preponderance of obfuscatory jargon; another is an unwillingness to share. If moderate interdisciplinary activity exists in the literature, then the new terms that must creep into the language are just that: after all, one person's jargon is another's technical term. If there is widespread interdisciplinary communication, the jargon is being transformed into accepted language, and the new technology is being embraced in fundamental concepts of disparate disciplines. Even a casual user of GIS technology knows that a main difficulty involves transcending software, let alone bibliographical, interfaces!

Using a simple computer search of parts of the electronic superhighway, a brief survey of the literature offers insight into contemporary mapping. The extent to which that insight is provocative may depend on one's viewpoint. Most on-line databases offer users different ways to execute searches for documents. Because these searching procedures are not standardized from one library to another, a simple search is offered to see what even the simplest strategy produces. All searches were for the subject field "geographic information system." Keyword (Boolean) searches, which can easily be limited and guided in various directions and are usually more useful than subject searches for extracting pertinent materials for specified research projects,

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were not performed because of the lack of standardization and because of the desire to retrieve materials even remotely related to the subject.

Some databases are restricted to periodicals, others to books, others to audio-visual materials, and yet others to various combined holdings of these and other sorts of documents. Even on-line card catalogs of university libraries partition their holdings in various ways, according to document type, so that these and other databases are not directly comparable.

To explicate these matters, the case study is the university library system that my students and I use most frequently. The University of Michigan on-line system has several databases available to users. One that archives various indexes, at least loosely related to the social sciences and the environmental sciences, is a database of the H. W. Wilson Company; there are numerous examples of scholarly interchange between the social and environmental sciences (Goodchild, Parks, and Steyaert 1993). The Wilson database contains 2,863,213 records from 1984 to the present. Information is drawn from the Applied Science and Technology Index, Art Index, Business Periodical Index, General Science Index, Humanities Index, and Social Sciences Index. A search, using *s* = geographic information system, of this database retrieved 605 periodical articles. A search (*s* = geographic information system) of the University of Michigan on-line card catalog retrieved 65 book titles and 2 serial titles on the Ann Arbor campus and 10 book titles and 2 serial titles on the Flint campus. The earliest document dated from 1987; the acceleration in publication about GIS is suggested when the holdings of the Michigan library are partitioned by year. The same sort of acceleration in publication over time is evident in the Wilson and other databases.

To probe the bibliographical interfaces, one might first extend this routine search to other locations throughout the world and then to a more detailed search of on-line databases at a single location, partitioning the entries by year. To extend the search to different locations, Internet, which is a heavily traveled component of the global electronic superhighway, offers connections to hundreds of on-line catalogs of university libraries throughout the world. The general acceleration of publications noted using *s* = geographic information system in the University of Michigan system appears to be present in many other on-line catalogs that were checked. This changing temporal trend seems to be constant over space. What it did show was that in a global search on Internet, most of the groupings of on-line catalogs matching "geographic information system" were in the United States—universities as well as federal agencies and medical and physics facilities—with others in Canada, Hungary, France, Norway, Australia, Austria, Belgium, Denmark, Switzerland, Germany, and Great Britain. In the United States the wider search retrieved on-line catalogs with as many as 150 matches. Generally, state universities were more likely than were private universities, with notable exceptions, to have relatively large numbers of documents that matched the subject search.

An even more detailed examination of the University of Michigan system revealed, in addition to the on-line card catalogs on the Ann Arbor and Flint campuses and the Wilson database, ten other databases available to users. They are: PSYC—Psyc INFO (American Psychological Association); NNID—National Newspaper Index; ENGN—Compendex * Plus (Engineering Information, Inc.); PHYS—INSPEC: Physics; PAIS—Public Affairs Information Service; MATH—MathSci database (American Mathematical Society); MASC—Material Science; AMOF—A Matter of Fact; MEEM—Meeman Archive; and PSDB—University Public Service. Some databases are local; only two recorded any matches to the subject search on "geographic information system." The Physics database recorded a substantial number of matches beginning in 1990; the National Newspaper Index recorded a few entries, with the first ones in 1991 (Table I). Although the Physics entries are later

TABLE I—DATABASES MATCHING THE SUBJECT SEARCH: GEOGRAPHIC INFORMATION SYSTEM

YEAR	WILSON	PHYS	NNID
1984	0		
1985	4		
1986	4		
1987	8		
1988	16		
1989	71	1	
1990	70	36	
1991	94	69	2
1992	159	52	6
1993	150	23	3
1994	29	3	6
Total	605	184	17
Database size	2,863,213	543,811	505,436
	Density of subject in database (%)		
	0.02113	0.03384	0.00336

in entering the picture, their density in the database, which includes both books and articles, is greater than is the GIS subject in the more comprehensive Wilson database—about three-hundredths of 1 percent in the Physics database and about two-hundredths of 1 percent in the Wilson database. Clearly the effect of the GIS subject is only beginning in the NNID database and needs to be nurtured.

Of the other databases in which no matches were made to the subject, the most surprising are failures in the engineering and mathematics databases. It is to these interfaces that one might look to enlarge connections; both engineers and mathematicians have considered topics directly related to GIS for many years. If one searches the mathematics database on just the name of one mathematician, 136 entries emerge that include phrases such as pattern recognition, vision geometry, digital connectivity, picture processing, cellular automata, parallel processing of linear quadtrees, image analysis, and digital geometry (Rosenfeld 1989). No doubt earlier entries

would echo interdisciplinary interaction if current databases covered substantial previous periods (Tobler 1964).

The manner in which the search is conducted is crucial, but so too is the sharing of communication, with little overlap between databases, across disciplinary boundaries. Apparently the social sciences and physics are already successful in this regard. It remains to continue to engage in and to encourage interaction across other boundaries, from the mathematical-logical to the philosophical-humanistic, because the fertile theoretical ground is likely to lie there.

FURTHER READING

Goodchild, M. F., B. O. Parks, and L. T. Steyaert. 1993. Environmental modeling with GIS. New York: Oxford University Press.

Moellering, H., ed. 1991. Spatial database transfer standards: current international status, ICA. New York: Elsevier.

Nystuen, J. D., W. D. Drake, H. Dao, C. Kolars, J. P. Meert, K. Oswalt, M. Saint-Lot, and J. M. Sherry. 1994. The UNICEF guinea worm eradication program: a GIS application. Practical handbook of digital mapping terms and concepts, ed. S. L. Arlingahus, 263–278. Boca Raton, Fla.: CRC Press.

Rosenfeld, A. 1989. Parallel processing of line quadtrees on a mesh-connected computer. *Journal of Parallel and Distributed Computing* 7(1):1–27.

Tobler, W. R. 1964. An experiment in the computer generalization of maps. University of Michigan, Department of Geography, technical report 1, Ann Arbor.