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Got GIS?

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Picture this.

Scene I:

An insurance company plagued with false claims needs a system that will help reduce insurance fraud. "You need a GIS," says the hired consultant. "That's Geographic Information System," he adds helpfully.

Scene II:

A city planner is at wit's end trying to find a suitable site for a landfill given a slew of restrictions. She is knee-deep in (no, not trash and dirty diapers) city ordinances and blueprints. The text at the bottom says "GOT GIS?"

Scene III:

Gypsy moth infestations in Michigan's forests need to be controlled by the aerial spraying of a biological insecticide. However, spraying every forest in Michigan would not be cost-effective. "We'll identify high-risk forest targets by mapping areas with susceptible tree species (oak and aspen) and overlaying field data on moth population distribution," says the natural resource manager. "How?" you ask. His response: "Got GIS!"

Location, location, location!

Insurance fraud prevention, city planning, utilities management, transit services, disaster management, business, marketing and distribution, environmental resource management, crime prevention. What, you may well ask, could these possibly have in common? The answer is that spatial patterns and relationships are integral to the functioning of these enterprises. The key to success for many such enterprises is conveyed by the oftchanted mantra "Location, location, location." For other problem-solvers success lies in finding patterns in the apparently chaotic mess of spatial information. This is where the new field of geographic information science comes in. The uniqueness of the field lies not in its basic principles but in the combination of these principles with newer concepts and technologies such as theme-based maps, satellite imagery, and most significantly, the computer revolution.

An acquaintance recently said, "Why should I care about GIS? I will never use it." I reminded her of the much quoted remark by T. J. Watson of IBM back in 1958 when computer technology was still in its infancy: "I think there is a world market for about five computers." He could not have been more wrong. As Clarke remarks in his 1999 introductory text on GIS, just as computers have done within a few years, GIS is integrating its way into everyday life, often in ways that are transparent to the public. Clarke predicts that the amazing breadth and depth of the multibillion-dollar GIS phenomenon is expected to continue well into the future and GIS courses are being taught in just about every major academic institution in the U.S. and many other countries.

So, what exactly is a GIS?

There are as many different definitions of GIS as there are applications or uses for it. These range from the concise,

> Automated systems for the capture, storage, retrieval, analysis, and display of spatial data. (Clarke, 1995)

to the comprehensive,

> A system of hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially-referenced data for solving complex planning and management problems. (Cowen, 1989)

and the expansive.

> A Geographic Information System (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on Earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies. (ESRI 1999)

None, however, captures the versatility of GIS as does this one proffered by Ron Abler in 1988:

> Geographic Information Systems are simultaneously the telescope, the microscope, the computer, and the Xerox machine of regional analysis and synthesis of spatial data.

Spatial information that is fed into a GIS database is typically in the form of thematic maps, remotely-sensed imagery, or tabular data. GIS databases are usually in the form of a series of data layers referenced to the same geographic location. Each layer holds data about a particular kind of spatial feature. For example, a GIS database that our city planner from Scene II creates might include a layer on roads, another on land parcels including ownership information, a third on land-use types such as residential or commercial, a fourth on soil type and permeability, a fifth on slope, a sixth on proximity to roads and so on. The planner can then query the GIS for areas that would fulfill certain predetermined criteria for landfill site selection.

The process of GIS begins with users who need to address a particular issue that has an underlying spatial component. Relevant data are collected, entered, stored, retrieved from, and analyzed within a GIS and output for decision-making is sent back to the users. Output from GIS can be tabular or graphic, including 3-D visualizations. GIS applications have been greatly enhanced by the development and availability of related resource and geographical information technologies such as remote sensing and Global Positioning Systems (GPS).

Major advantages of GIS include the capability of handling large and diverse datasets and the integration of non-spatial (attribute) data, such as addresses and street names, with spatial datasets. Furthermore, GIS allows for speedy handling and analysis of huge quantities of data making it possible to perform rapid updates and re-analyses for alternative scenarios and for anticipating possible results of planning and management decisions.

GIS Applications

A few real-world examples will illustrate the usefulness and increasing ubiquity of Geographic Information Systems in the corporate sector as well as in governmental and not-for-profit organizations.

Geographical Information Systems can be used to assess the risks or hazards of living in certain areas. Such systems are then used by insurance companies to determine insurance coverage rates for areas with different risk levels. In March 1997, the *Financial Times* reported on the use of GIS in reducing insurance fraud. Maps showing zipcoded weather information can help insurers understand natural hazards. Insurance companies use these maps for fraud prevention by checking the maps against insurance claims. I searched the *Financial Times* archive on the internet and found 30 articles in 1997-98 containing the term Geographic Information Systems. These ranged from applications in management of utilities, telecommunication, innovation, databases, market share, human resources, billing systems, pharmaceutical companies, as well as banking and natural disasters.

Natural resources management issues tend to be fundamentally spatial in nature. Thus, it is not surprising that in recent years most natural resources organizations in the private, public, and non-profit sector have made or are making the transition to digital processing of spatial data and decision-making through Geographic Information Systems. For example, the U.S. Environmental Protection Agency (EPA) uses GIS in Environmental Monitoring and Assessment Program (EMAP) whose goal is to monitor and assess the country's ecological resources. GIS lends itself well to what I call the three Ms of natural resource management: Mapping, Monitoring, and Modeling. For example, GIS can be used to map and monitor land-cover and land-use changes, forest fires and their impact, flood extent and impact, biomass and climate change. Such information can then be used to model or predict future changes and alternative scenarios based on specific management actions.

At GVSU, courses in the Geography Department introduce students to the field of GIS as well as provide advanced GIS training. A new GIS course is being offered through the Natural Resources Management Program in the Biology Department, titled "GIS Applications in Resource Management." In this course, students will be able to examine several case-studies in which GIS is used for the management of natural resources, including watershed analysis, mineral resource mapping, environmental impact of timber sales, habitat loss, and endangered species conservation. In my own research, I use GIS in the study of land-use change, deforestation modeling, landscape ecology, biodiversity conservation, and conservation gap analysis in India, Brazil, and southwest Michigan. GVSU's Water Resources Institute makes extensive use of GIS in topics as diverse as but not limited to groundwater resource contamination, gypsy moth infestation control, car/deer accident sites, watershed management, farmland preservation, land-use change, and hydrologic modeling of surface runoff.

Ongoing and future widespread applications of GIS include navigation systems on every car's dashboard, routing systems in emergency vehicles for determining quickest routes to accident sites, GIS systems in every police precinct for crime tracking and prediction, and GIS displays on miniature wearable computers integrated into clothing or eyeglasses.

Caveat emptor

It would be remiss of me to give a glowing endorsement of GIS and neglect to add the caveat, "User beware!" The very persuasiveness and power of GIS which make it useful can also make it potentially misleading. The "Garbage In, Garbage Out" principle holds as true for GIS as it does for any other computer technology. GIS is only as good or effective as the accuracy of the data and the knowledge of the user. Users are well advised to take results from a GIS study with a dose of healthy skepticism and check for the validity of data sources and methods used to arrive at the results. Even the most sophisticated technology cannot substitute for wisdom and common sense. As we approach the millenium and the dread that the Y2K problem might well turn computers from boon to bane of modern society, I add the caution that a society that becomes almost totally reliant on computers and GIS to navigate might well come to a standstill when major equipment failure or malfunction occurs.

Such cautions notwithstanding, the next time you ask for some help on a spatially based problem don't be surprised to be asked in turn, "Got GIS?" ◆

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