

# A New tool in IS Management: Geographic Information Systems

by

Emil Boasson  
eboasson@ithaca.edu

Vigdis Boasson  
vboasson@ithaca.edu

William J Tastle  
tastle@ithaca.edu

School of Business  
Ithaca College  
Ithaca, New York 14850

## Abstract

Geographic Information Systems (GIS) is a relatively new field that is introduced into the IS/IT/MIS environment. This paper defines and places GIS in the academic context of the business school curriculum. Examples illustrate the usefulness and importance of the technology. Although applicable to virtually any business discipline, the emphasis is on the placement in the IS part, but with linkages to finance, strategy, marketing, etc. A case is made for its inclusion into the IS curriculum, albeit it in an elective capacity.

**Keywords:** Geographic Information Systems, GIS, data visualization, spatial relations

## 1. Introduction

Geographic information systems (GIS) are a relatively new set of tools and concepts introduced to business information systems in a business school setting. However, GIS have for a long time been introduced in various other fields of sciences such as geography, engineering, and environmental studies, and GIS tools and technology have been extensively utilized in the real-world business sectors such as economic planning, market research, industrial location, intelligence gathering, military defense, and crime fighting, just to name a few. Due to the growing demand for GIS technology from the real business world and the potential for its widespread applications, a few business schools are now starting to respond to this demand by incorporating GIS into its curriculum for information technology. In addition, the availability of high-speed computers, GIS software, and spatial data sources from government and business sectors in recent years is also facilitating the introduction of GIS in business and management curriculum.

GIS uses data visualization to analyze and display data and create information for budgeting, planning and decision-making. A GIS software stores, manipulates, assembles, displays a map, and extract information from data that are referenced geographically.

In this paper we will discuss how the basic concepts of GIS can be applied to and integrated with various undergraduate business school courses such as finance, marketing, strategic management, operation management, international business, and accounting. Students can learn to use this cutting-edge technology to analyze and understand the process of decision-making in the real world, the operations and management of an organization, and visually trace down the origins of income generation and expense occurrence.

The paper is arranged as follows: firstly, we discuss some of the definitions of GIS; secondly, we introduce some of our ideas of what and how to teach GIS in a business school setting; thirdly, we present examples of how GIS concepts and tools can be utilized in making strategic and financial decisions; and finally, we conclude the paper.

## 2. What is GIS

“Good science starts with clear definitions. In the case of geographic information systems, however, definitions have sometimes been as clear as mud” (Clarke, 2001, p. 2). Nevertheless, Clarke (2001) has discussed five definitions of GIS.

*First*, a GIS is a toolbox or process. GIS can be viewed as a set of tools for analyzing spatial data, “a powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes” (Burrough, 1986, p. 6), and a set of “automated systems for the capture, storage, retrieval, analysis, and display of spatial data” (Clarke, 1995, p. 13).

*Second*, a GIS is an Information System. A GIS is a system for delivering answers to questions or queries; “an information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, and a set of operations for working with data” (Start and Estes, 1990, p. 2). Further, it is “a special case of information systems where databases consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses” (Dueker, 1979, p. 106).

*Third*, GIS is an approach to science. “The generic issues that surround the use of GIS technology, impede its successful implementation, or emerge from an understanding of its potential capabilities” (Goodschild, 1992, p. 41).

*Fourth*, GIS are a multibillion-dollar industry. Groups monitoring the GIS industry estimate the total value of the hardware, software, and services conducted by the private, governmental, educational, and other sectors that handle spatial data to be billion of dollars a year (Clarke, 2001, p. 7).

*Fifth*, a GIS plays a role in society. A GIS is an “organized activity by which people measure and represent geographic phenomena and then transform these representations into other forms while interacting with social structures” (Chrisman, 1999, p. 175).

### 3. What does the business student need to know about GIS?

Management information system students need to know the language of GIS, but not the details of the architecture of the particular software application. It is imperative to understand that data in geo-databases are referenced through geo-references. For our discussion we will look at GIS as software, in many ways a database

program, that analyzes and links information and data that are stored as records. There is one important difference: each record in a GIS database contains information used to draw a geometric shape, usually a point, a line or a polygon (Boyles, 2002).

“GIS has several advantages over traditional management information systems because it enables various discipline to share data via geographic link” (Thomas and Ospina, 2004). Traditional databases use a primary key such as customer number, social security number, city name or other common identifier, to link databases. With GIS, databases can be connected through geo-referenced identifiers in the databases such as address, city name or zip code. Actually, with 90 percent of all data having a geographic reference, most data can be accessed by using a location-based, spatially referred, or geographic identifier.

GIS also provides considerable assistance in the capital budgeting process. Most accounting and financial professionals examine budgets from the perspective of rows and columns, the traditional way this work has been done for decades. Cash flow is linked to specific activities and specific customers. Now, however, they can analyze their budget with more insight information by looking at the regions assigned to their revenue streams and expenses and recognize that most business operations are spatially related or linked to specific location.

The management information systems student needs to understand the basic concepts of geo-databases. What constitutes a geo-referenced identifier? How does one link a customer database that contains street addresses and zip codes to a map? How does one analyze financial data spatially rather than by specific activities? The student must have a prerequisite knowledge of how to prepare traditional database to be imported into a GIS, how to create a map from the data to generate useful information, and also know the basic query language necessary to seek information from the geo-referenced database. Armed with these abilities, a student will be able to create valuable information, conduct in depth financial analysis, and create new data based on the geo-referenced databases.

Lastly, the student needs to know that GIS is not a single software package. There are many developers that produce GIS software packages for desktop use as well as for enterprise wide use. However, the basic concepts learned by mastering one package can be applied to most other GIS packages.

### 4. Examples of GIS studies

GIS has been used by businesses for over 30 years. In the past, GIS was utilized indirectly through consultants and advisers. While GIS is still used in that way, it is now finding ways into the organizations and academic research, particularly in the finance and business fields.

There are numerous examples of the applications of GIS in various areas of businesses: communications, vehicle routing, site location, information management, target marketing, market research (see Boyles for additional details). Recently GIS has been used for advanced financial analysis, economic development, to identify demographics of market area, and find pockets of customers among the entire population. Retail stores have used GIS to identify where to market specific products. Producers and dealers of luxury cars have discovered the obvious fact that \$100,000 + cars sell well in places where the family income is high, and college campuses are not good markets for expensive cars. It is now common for the banking industry to use GIS for strategic planning, marketing, and research; mortgage lenders use GIS to identify their potential customers and housing markets. Municipalities use GIS for management, planning, and assessment in order to cut costs and generate revenue.

#### Classroom Applications

In the classroom students can be asked a simple question such as: Where do you come from? The responses are collected and can even be summarized, but are the data meaningful? How does a typical student comprehend the answers from their classmates? If we instead collect student home zip codes and map the answers, we might get a visual representation similar to the one illustrated in Figure 1.

The map in Figure 1 indicates that the majority of students in the business school come from the northeast. Using GIS we can explore more details at a larger scale. Figure 2 shows the same data as in Figure 1 but at a larger scale and zooms into the northeast.

The examples above are a simple use of GIS for spatial analysis. Next, we will illustrate an example of using GIS in an advanced financial study. The study investigates whether a spatial autocorrelation exists in sales, and in research and development among firms in the software industry and how this spatial autocorrelation affects the stock market performance of these software companies. To answer this question GIS is used to geocode each firm's address with its geographic longitude and latitude. Specifically, latitude and longitude coordinates are assigned to each firm. In addition, the stock market value for each firm is added as an attribute to the firm to evaluate the concentration of firms in the industry sector (Boasson and Boasson 2004). Figure 3 shows the resulting map that visualizes the spatial distribution of the 244 publicly traded software firms. Spatial autocorrelation is a special type of statistic used to determine the spatial correlation between neighbors.

Boasson (2002) develops a model for integrating GIS with economic development analyses. The study uses GIS to trace the patterns and changes of the economic and industrial development for more than 3000 counties

at the United States for over 30 year period and shows that using GIS in conjunction with econometric techniques, researchers, planners, and decision makers in business and governmental organizations can better synthesize and visualize the intelligence and information buried deep in massive data containing a vast spatial dimension within a very long time period. Boasson (2001) utilizes GIS to analyze the impacts of the spatial and temporal factors in physical proximity to the firm upon the stock market performance of the firm.

The examples above illustrate the use of GIS in analyzing important academic research issues related to economic, finance, planning, and strategic decision-making areas. However, the potentials of GIS reach far beyond what these examples can describe. Business organizations, government institutions, and agencies make numerous decisions each day, which ultimately affect consumers, investors, taxpayers, businesses, and stakeholders. Skilled professionals rely on information technology tools to develop difference solutions for delivering superior products and services. Managers and executives in the real business world frequently seek out GIS as a way to support their ideas and proposals. GIS analyses can offer multiple alternatives to aid the process of decision-making. Lastly, GIS can produce numerous graphic alternatives, enabling planners and decision-makers to review initial theories for feasibility before business proposals are made.

#### 5. GIS in the IS Curriculum

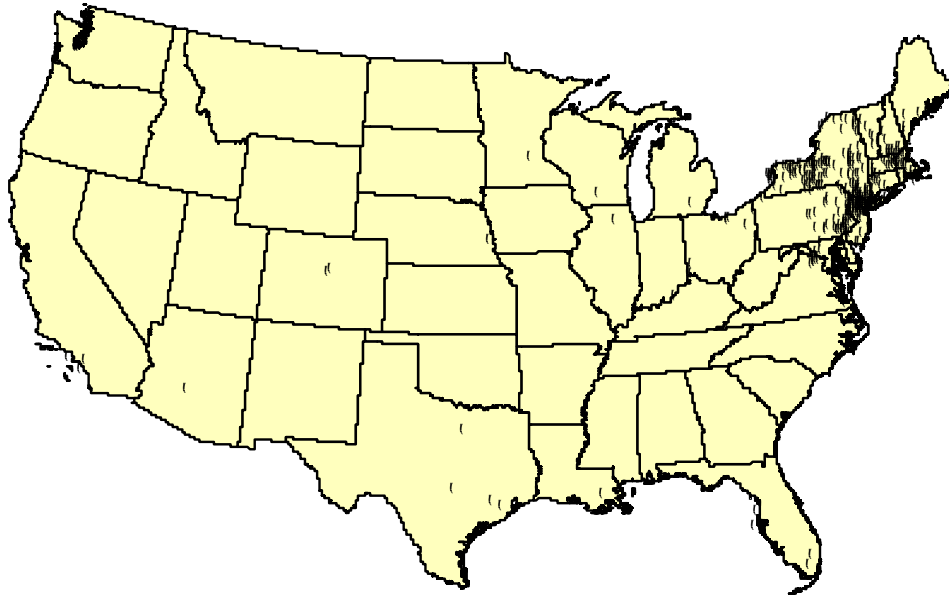
While the IS curriculum (see [www.is2002.org](http://www.is2002.org)) does not specifically support a particular set of software products, it does identify *database* as critical to the curriculum and identifies sections 1.6.9, DBMS products: recent developments in database systems, 2.2 IS Management, 2.3 Decision Theory, 2.11 Fundamental Organizational Functions, and 3.8 Information and Business Analysis, as important components of that curriculum. The extraordinary power of GIS technology into the business curriculum is such that it is rapidly becoming an emergent requirement in any serious program that deems to be current. CIS programs that seek ABET accreditation and are associated with business schools should strongly consider the inclusion of this technology. There is at least one business school, such as the Business School at the University of Redlands, California that is offering GIS as part of its curriculum for its BS in Information Systems program, as well as its MS in Information Technology. It also offers GIS as one of the concentrations in its MBA program. The School of Business at Ithaca College, NY is offering an introductory course in GIS for Business during spring 2005. And that school is anticipating to be AACSB accredited in 2005. While business curriculum requirements may be somewhat limited, forward viewing schools will continue to address relevant technologies in creative ways.

## 6. Conclusion

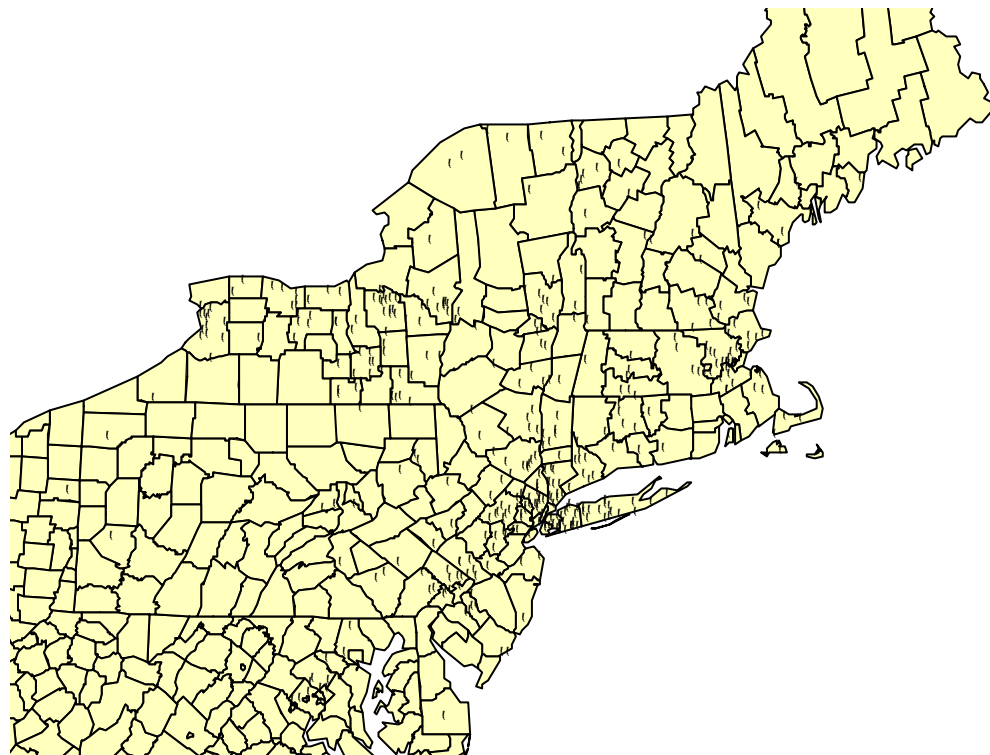
GIS is a computer-based technology capable of running multiple scenarios and options efficiently and rapidly. It helps businesses and government agencies make informed decisions and measure the impact of the decision's implementation. In addition to its capabilities of deciphering business intelligence and conducting data warehousing and data mining, GIS technology offers distinctive modeling and simulation tools that allow "what-if" scenarios from both temporal and spatial dimensions. In a nutshell, GIS is the optimal business decision support tool to improve the decision decision-making process.

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**Figure 1.** *Where is home for students in the School of Business at a comprehensive college in the north-east? Data was taken during the spring 2004 semester.*



**Figure 2.** *The same data from Figure 1, but presented at a greatly enhanced scale.*



**Figure 3.** *The Spatial Distribution of the Stock Market Value of the Software Companies in 2002*