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PUTTING YOUR BUSINESS ON THE MAP: GEOGRAPHIC INFORMATION SYSTEMS FOR SMALL BUSINESS

Ronald Rubin
University of Central Florida
ronald.rubin@bus.ucf.edu

ABSTRACT

Geographic Information Systems (GIS) are a specialized type of computer information system that allows users to display a wide range of data on a map. The increasing availability of demographic and other information in computerized form has lead to an expansion of the use of GIS into the business world. The increasing power of relatively inexpensive personal computers, improvements in user interfaces for GIS, and falling prices for an increasingly diverse range of GIS data products have all contributed to a situation where small businesses can take advantage of capabilities that were previously the exclusive domain of the large corporation. This article provides an introduction to GIS capabilities for the small business end-user and provides information to aid the reader in deciding whether GIS may be applicable to their business decision making needs.

INTRODUCTION

Geographic Information Systems (GIS) are changing the view of business computing. From multinational corporations to entrepreneurial start-ups, companies of every kind are bringing geographic analysis to bear on their business problems. By relating information to specific locations, like street addresses, ZIP codes, and census tracts and blocks, they are creating business maps that help them to identify patterns and understand relationships not apparent from traditional computerized data. Decision makers in these businesses are able to make better decisions; serve their customers better; and, at times, find new and better market opportunities.

GIS are essentially database programs like Microsoft Access or Paradox that can store the locations of map features along with conventional data such as names, quantities, dates, etc. Further, a GIS can use the data's location information to display the data on a map. Finally, the GIS 'knows' where its records are located and can query records based on their location.

GIS began as a tool of geographers, cartographers, and scientists. It has evolved over time, though, and moved from the research center to the corporate environment, from the scientist's workstation to the businessman's desktop. Recently, the development of powerful personal computers, coupled with easy-to-use GIS software packages and widely available data, has created a new breed of GIS practitioner, the small business decision maker.

This article provides an overview of the capabilities of GIS software and shows how they can be put to use in the day-to-day operations of small and medium sized businesses. Overall, the article provides information to enable a small business manager to decide if GIS capabilities can be profitably employed and provides a starting point for determining what type of software best suits the business' needs.

The next section of the article provides a brief overview of the technical capabilities that provide the specific business value inherent in a GIS. This overview is followed by an even briefer summary of the history of the technology leading to an understanding of why GIS may now be an appropriate technology for smaller businesses when they have not previously been widely used in this area. The following section covers specific business problems such as target marketing, site selection, and delivery routing, and highlights the role GIS can play in addressing these problems. The final section discusses the options and resources needed for small-scale GIS implementation. We will see that these requirements are becoming very affordable from both a dollar cost and time perspective.

GIS OVERVIEW

This section presents key information on the technological capabilities of GIS software and lays the foundation for the business value discussion that follows later in the article. The discussion here does not emphasize the syntax or interface of any particular GIS software product, but instead presents principles that are implemented in most GIS packages.

Spatial Data

Maps are a graphic representation of the real world that all of us have used. City street maps, for example, depict natural objects, such as rivers and lakes; man-made objects such as roads and buildings; and abstract objects such as city or county boundaries. These objects, whether natural or man-made, are called *map features* (Harder, 1997). Each map feature has a location, a representative shape, and a symbol that represents one or more of its characteristics. For example, a blue line may represent a river. Green areas may represent forests. A brown area may represent a building and may have a label saying "School." Dark red lines may mark highways, with smaller roads marked by thin black lines.

Features on maps are organized according to their locations relative to each other and to an underlying grid representing the earth's surface. These relationships, called *spatial relationships*, are important because understanding them helps us solve problems (Harder, 1997). For example, in order to plan a delivery route, you need to know which streets connect, which part of the city they traverse, and their relationships to other locations of interest (e.g., customer and store locations).

All map features have *attribute information*, descriptive data about each individual feature (Harder, 1997). The attributes of a shopping mall, for example, might include its name, its type, size, the names of the anchor stores, a list of tenants, and the number of parking spaces available. Unfortunately, paper maps can only display a limited amount of attribute information using the map symbols. The width and color of the symbol used to depict a road, for example, can discriminate between roads, highways, freeways, and interstate highways. Unlike paper maps though, GIS are capable of storing, manipulating, and displaying a much richer set of attribute information. Further, GIS can create maps 'on the fly' based on the features and attributes of interest to the decision maker. If the current decision requires customer locations, demographic data by census block, and store locations then the city streets

and major buildings can be omitted from the map. A GIS can also use attribute information to affect the display of the map. Symbols for stores can be colored according the store's sales volume and sized according to square feet on the sales floor.

A GIS links sets of features and their attributes and manages them together in units called *themes*[1] (Harder, 1997). One theme contains a set of similar features, such as all of the roads in the area of interest. A different theme might contain all of the shopping centers, along with the attributes for those features. A city map, for example, may contain many themes, interstate highways, surface streets, public buildings, schools, parks, etc. Each theme has its own set of attributes that make sense for the features represented in the theme.

All the themes for a geographic area taken together make up a *GIS database* (Environmental System Research Institute, 1996). Furthermore, a collection of themes viewed together forms a map and each theme is a *layer* in this map (Harder, 1997). GIS are specialized database management systems (DBMS) that permit the manipulation of themes. In particular, they allow for diverse themes to be overlaid with others so that every location on one theme is precisely matched to the same location on the other themes.

Figure 1 illustrates the data relationships for three sample themes in a GIS database. On the left of each theme is the attribute data that can include most types of fields normally found in a relational database management system (RDBMS) including numeric, text, date, boolean, etc. On the right is a depiction of the location occupied by each object, record, or occurrence. These locations can be polygons (Figure 1-A), such as city, county, or sales territory boundaries; point features (Figure 1-B), such as customer street addresses, building locations, or vending machine locations; or linear features (Figure 1-C), such as roads, rivers, or railroads.

Displaying Spatial Locations

One of the most obvious characteristics of GIS software is the ability of the program to visually display the locations of geographic objects on the computer's monitor and to print these displays. Further, the computer is capable of displaying multiple layers simultaneously with the locations of features in the various layers being precisely displayed relative to each other based on their locations.

Consider the three themes depicted in Figure 1. If theme 1-A depicts sales territory boundaries and theme 1-B represents retail outlets then the GIS can display the themes superimposed (Figure 2). It instantly becomes apparent which locations belong to each territory, even if there is no common field in the attribute data. The ability to display computer system data graphically has been shown to be an important decision making aid in any information system[2] and GIS have been particularly well suited to this purpose when the data of interest has a geographic component (Crossland, 1995).

[1] This paper uses the term "theme" to represent one layer in a GIS map. Other works may use the terms "coverage" or "layer" to represent the same concept.

[2] Benbasat & Dexter, 1985; Benbasat & Dexter, 1986; Benbasat, et al., 1986; Davis, 1989; Hoadley, 1990; Lauer, 1986; Liberatore, et al., 1988; Yoo, 1985.

Figure 1: Multiple GIS Themes

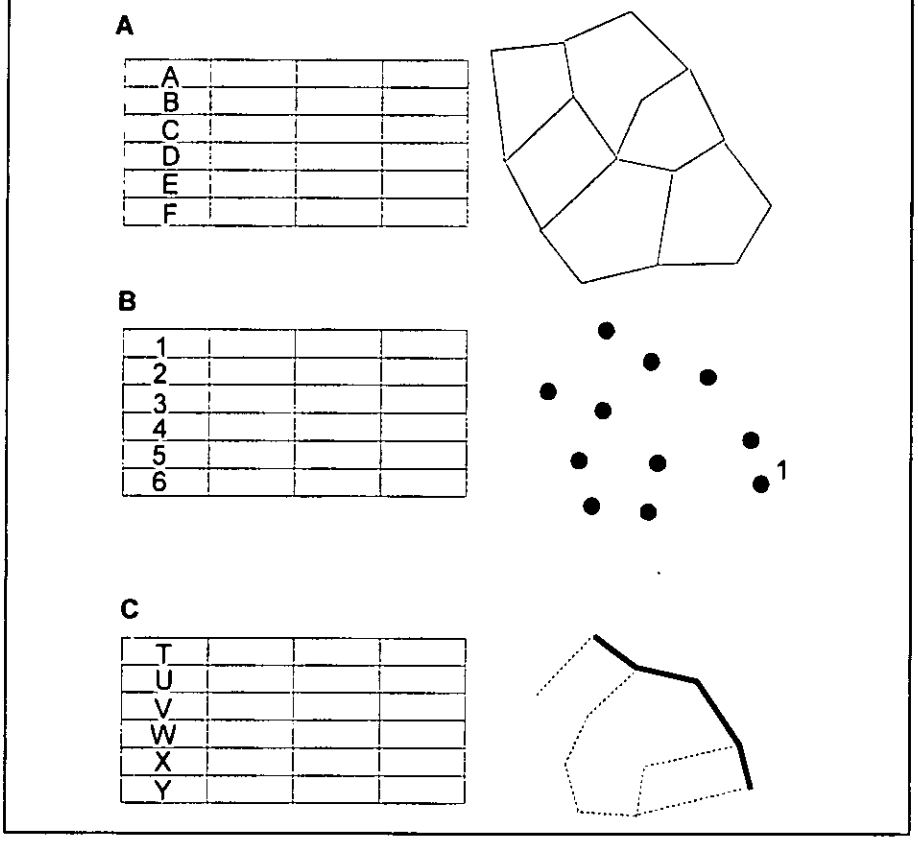
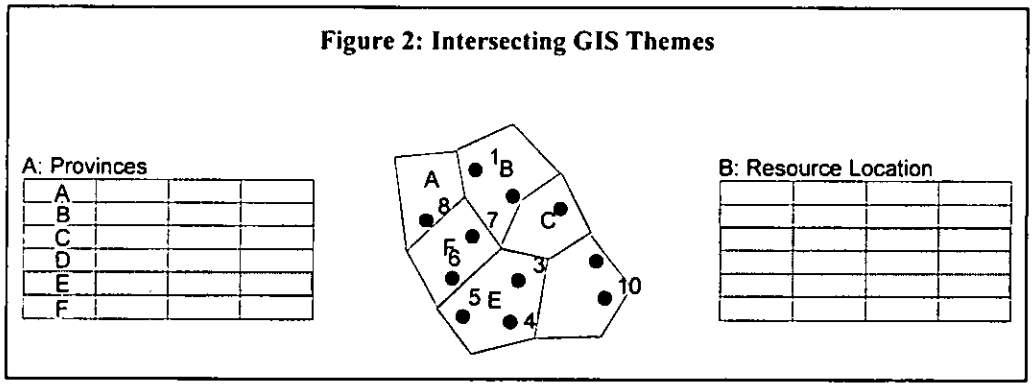


Figure 2: Intersecting GIS Themes



Determining Spatial Proximity

A second powerful capability of GIS software is also inherent in the software's ability to store the spatial locations of objects. The software can easily compare the location of two objects (in the same or different themes) and determine if:

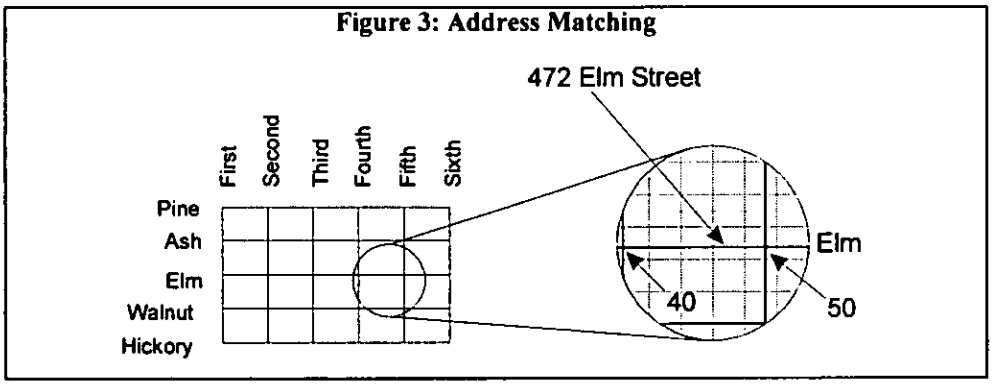
- the two objects intersect in any way (e.g., a sales territory contains any part of a city boundary or vice-versa),
- one object completely contains or is completely contained by the other (e.g., a prospective customer address falls within a particular sales territory), or
- one object is within a specified distance of the other (e.g., find all customer addresses within ten miles of a prospective franchise office location).

Further, GIS can find the closest object in a theme to another specified location. That is, if a customer address location is specified, the system can easily find the closest ATM machine, service center, or branch office.

Geocoding

Recall that GIS data consists of both spatial locations (expressed in some coordinate system) and attribute data. Unfortunately, specifying the geographic coordinates of objects of interest (customers, sales territories, delivery routes, etc.) can be both time consuming and expensive. *Geocoding* is the process that converts a regular street address to a latitude-longitude (x, y) coordinate used by the GIS. Once a latitude-longitude coordinate has been assigned, the address is then *georeferenced* and can be displayed on a map or used in a spatial search (Harder, 1997).

Figure 3: Address Matching



Consider the situation illustrated in Figure 3. The address "472 Elm Street" might come from a table of customer records. The GIS software is able to take the information from the address field and a special matchable address layer to find the street segment that contains the address. Through the application of some simple trigonometry, an x, y map coordinate for the address is calculated. These coordinates are saved with the database table which then becomes a point theme such as the one illustrated in Figure 1-B. Modern GIS software is able to geocode records one-at-a-time in an interactive system or can process thousands of records per hour in batch mode.

This section has presented some of the basic capabilities of GIS software. While interesting in their own right, these capabilities become especially important as determinants of the business use and value of GIS. Following a brief discussion of the history and availability of GIS software and data, the article will return to these capabilities in a discussion of specific applications for the small business user.

A BRIEF HISTORY OF GIS TECHNOLOGY

A complete GIS system requires computer hardware, computer software, data, and trained users. In the past, however, GIS required special hardware, software, and data that was just not available to any but the largest companies or those with specific requirements warranting the appropriate investment. This section discusses how advances in hardware and software have radically changed the feasibility of small business implementation of GISs. Further, while it is possible to construct GIS-based applications from just an organization's internal data, we will soon see how internal data combined with externally produced GIS data creates a special value for businesses. This section therefore contains a special discussion of data availability as a determinant of the usefulness of GIS to small businesses.

Hardware and Software

By 2000, a $2000 personal computer provided processing power and graphical display capabilities rivaling the performance of mainframe computers twenty years earlier. Further, improvements in processing speed (and math processing), graphical display, memory, and data storage are all directly applicable to the performance of GIS software. The bottom line is that the cost of hardware for running GIS has dropped dramatically since the capability was first introduced. What used to require an expensive mainframe computer can now be accomplished adequately on a $1,000 PC and a $2,000 machine provides superb results.

These price/performance improvements have some important market implications. The massive base of computers with the capability of efficiently managing GIS processing has led to an increase in the potential market for GIS software. This increase has lead to the ability to spread development costs over more units, leading to both lower software costs, more user-friendly interfaces, and improved user support. In summary, user-friendly GIS can now be delivered to the decision maker's desktop without investments in expensive task-specific hardware. By the mid 1990s, GIS software for PCs had become widely available with entirely new products, niche-oriented enhancements, and version upgrades being released on an almost monthly basis. The range of GIS products will be further discussed at the end of this article.

Data

As with any information system, the availability of quality data is a key determinant of GIS effectiveness for supporting business decisions. Unfortunately, producing some GIS data is an incredibly expensive proposition. Consider, for example, data used by a county deed recorder to store the legal boundaries of property (as is being done in many counties). Each of thousands of property parcels must have each corner meticulously plotted to ensure that there is no chance for error in the records. Precision measured in fractions of an inch is required. Other records need not be nearly as precise, of course.[3]

[3] Precision is a relative term. Digitized maps are used as the basis of the computer navigation systems being fielded in some new automobiles. An intoxicated man in Germany was following directions from his computer navigation system which, unfortunately, wasn't precise enough to record that a particular road crossed a river by means of a ferry, not a bridge. He and his new Mercedes ended up in the river.

Businesses are often interested in combining traditional map data, such as city limits, or streets and highways, with their internal data, such as customer or supplier locations. It is clear that most companies, and certainly small businesses, are unable to produce street maps for their own use. In the absence of this data, much of the business value of GIS is also absent.

Fortunately, firms and government agencies have been producing GIS data for public resale or use for several decades. As discussed, however, this data is incredibly expensive to produce and carried a hefty price tag for the few users with the equipment to use the data. Further, there were (and are) several competing data formats and publicly available data was not guaranteed to be compatible with the potential user's system.

The same factors that lowered the price of GIS software also served to drastically lower the price and increase the availability of second party GIS data. With installed GIS users numbering in the tens of thousands instead of in the hundreds, data vendors were willing to invest in new data products, data products created in multiple formats, and in enhancements to existing products. Further, they were able to radically lower prices by spreading development costs among more users.

At the same time, more and more governments were adopting GIS technology for vital record keeping, and many of these records are available to the public under various Freedom of Information Acts. While some GIS users obtained copies of government datasets for their own use, others obtained them for the purpose of enhancing the data, converting it to multiple formats, and then reselling it. Some government agencies themselves have become quite entrepreneurial in their efforts to satisfy demand for their GIS data.

The end result of this trend is that, in the past five years, there has been an explosion in the availability of inexpensive, second party GIS data for use by businesses of all sizes. Consider the polygon and point themes in Figures 1 and 2 again. Assume that the point theme was derived by geocoding customer addresses in a company's existing database. Now assume that each record in the polygon theme is a US Census block. Each block has as attribute data statistics (mean and measures of dispersion) on income, age, number of children, gender, ethnic background, etc., for the households in the block. With a total investment of under $5000 (including the cost of the computer—less if the computer is already available), the business now has access to a wealth of information about its customers.

This example is just one of the ways that large businesses have been using GIS data for years. In the next section we will examine how this, and a number of additional techniques, are also available to small businesses using a relatively small investment in GIS technology and data.

BUSINESS PROCESS SUPPORT

Turban (1995) synthesized definitions of decision support systems (DSS) from several authors to define DSS as interactive, flexible, and adaptive computer-based information systems (CBIS). DSS use models[4] for improving managerial decision making or to support the solution of ill-structured problems. Finally, Turban writes that DSS provide an easy user interface and allow for the decision maker's own insights. The previous discussions of GIS

[4] In this context, "model" means an algorithmic or data structuring tool that helps to organize otherwise loosely related data. A statistical regression problem, for example, is a model that relates values for decision variables, constraints, and their coefficients into a representation of a decision that can then be solved with the appropriate algorithm.

capability have illustrated their ability to use both spatial and attribute data and highlighted the use of a map as a unifying model to relate otherwise disparate data. The brief examples centered on Figures 1 and 2 have hinted at how these capabilities can be used to support decision making and how they involve managerial insights.

This section examines specific decision making opportunities centered on GIS in more detail. Each example focuses on a specific decision and the types of data needed to support the decision. Some involve the creation of additional modeling capabilities, while others rely more heavily on managerial insight. An important additional distinction is between *ad hoc* and more formal DSS. An *ad hoc* system is one that may be developed for one-time use to solve an important semistructured problem. More formal systems will be used for solving recurring problems or in other circumstances when the investment in a more complete system is warranted. Readers considering adopting GIS technologies should be alert for these distinctions in the examples below so that they can incorporate appropriate technologies in their own GIS.

Finding your Customers (and More Like Them)

Any organization that *sells* faces the problem of directing its selling efforts to the audience that is most likely to respond to those efforts and make a purchase. Advertising to an audience that is unlikely to buy is a wasted expenditure, while failing to advertise to a likely audience is a wasted opportunity. One of the most widely used capabilities of GIS in business is the ability to perform market analysis to determine the characteristics of current customers and to find concentrations of potential customers with the same characteristics.

Assume (for the moment) that the business has a database of customer addresses. Geocoding these addresses can easily produce a map with each customer's location plotted as a point (as in Figure 1-B). Now assume that the business has a polygon map of neighborhoods where each neighborhood has the demographic attributes listed in Table 1 available. A map showing customer locations overlaying neighborhoods makes it easy to see if there are clusters of customers in certain neighborhoods. If so, examining the demographic characteristics of the neighborhood makes it easy to infer characteristics of the customer base without the expense or intrusion of a survey.

Table 1: Sample Demographic Characteristics

Multiple age ranges	Household type (Family, non-family, etc.)
Race	Marital status
Number in household	Age of head of household
Number of vehicles in household	Median and per capita incomes
Employment by industry and occupation	Educational attainment

Armed with customer characteristics, it is then possible to pursue three important aspects of an advertising campaign. First, the demographic information of existing customers can be matched to the target demographics of possible media outlets. If the customers live in predominantly upper middle-class neighborhoods with two income earners in their thirties and forties then radio stations and TV programs targeting this audience can be selected as advertising outlets.

Second, demographic information on existing customers can be used to locate additional clusters of customers with similar characteristics. The demographic coverage can be displayed with neighborhoods color coded by values of a demographic characteristic (e.g., median income), or more complex multi attribute analysis can be performed. These potential customers can be targeted with direct mail campaigns, neighborhood newspapers, or even billboards.

Finally, demographic information on existing customers can be used as the starting point when designing advertising campaigns seeking to expand the customer base into new demographic niches.

What if customer addresses are not available? The techniques described above may still be applicable. If customer phone numbers are available a theme of telephone exchange boundaries may be used to show concentrations of customer locations, though not nearly as precisely as with street addresses. Even if the locations of customers cannot be inferred, observation may yield information on the ages, races, and sexes of existing customers. This information can then be used to locate neighborhoods for target marketing.

These techniques were used in one case to develop a marketing program for a small family restaurant in Ohio (Medvedkov, 1999). The researcher recorded license plate numbers in the parking lot of the restaurant as well as those of nearby competitors. The state's Department of Motor Vehicles provided the owners' street addresses and these were then geocoded. The addresses were then overlaid on demographic data. The analysis determined that many customers came from areas that contained mostly middle-aged, white, empty-nesters with incomes between $30,000-$45,000. This finding was used to design a targeted advertising campaign that increased patronage markedly.

Table 2 summarizes the system requirements needed to implement a market analysis system.

Table 2: Market Analysis System Requirements

Com-ponent	Description	Cost (approx.)
Hardware	Pentium-class PC.	$1,500
Software	Professional quality desktop GIS software.* Simple demographic analysis may be performed on lower end software packages. These themes do not support address matching.	1,500
GIS Data	Address matching theme if customer street addresses will be georeferenced, telephone exchange theme, or some other theme that enables existing customers to be mapped. Demographic theme(s). **	400
Other Data	Customer database with addresses, phone numbers, or both. Richer data, such as purchase histories, can enhance the ability to correlate demographic data with buying patterns.	Internal
* See descriptions in Table 5. ** Many vendors provide a wide range of demographic products. See the data products listing at the *Directions Magazine* web site for an up to date listing (http://www.directionsmag.com).		Total: **$3,400**

Delivery and Service Routing

Many businesses face the problem of getting a product or service (e.g., repair technician) from one point to another during a period of time. The simplest case requires the generation of directions from one place to another, while more complex problems require a vehicle to visit a series of points, sometimes in a particular order. A business with a delivery truck, for example, would like to have the truck reach as many customer sites as possible during the day (to minimize the number of trucks needed), during either the shortest period of time (to minimize driver expenses), or following the shortest route. These problems are often solved by the dispatcher or driver but with no great guarantee of efficiency.

There are many algorithmic solutions to routing problems but they become very cumbersome to solve as the complexity of the problem (number of customers, number of possible routes, restrictions on arrival times, etc.) increases. When the new problems must be solved repeatedly (new destinations each day, multiple vehicles to route), the problem can be quite burdensome. One of the most difficult aspects of this problem in a large city is just specifying all of the possible routes in the *network* needed for the computerized solution.[5]

GIS can help with this problem in several ways (Keenan, 1998). First, certain GIS packages, such as ESRI's ArcView, may be purchased with network analyst add-on modules. These modules contain the special management science network algorithms needed to solve network problems. Second, GIS that can solve network problems can use linear themes (see Figure 1-C) as the network on which to operate. In particular, the street maps available for many GIS packages can be used as the network. Third, these GIS packages make it easy to integrate existing data on customers or other destinations into the analysis. Delivery locations can be added from a point theme, from a conventional database of customer addresses, by geocoding individual addresses through an interactive dialog, or by indicating locations on the map with a mouse. When ready, the GIS can use the network analysis capabilities to select the best route to take for visiting each customer. ESRI's Network Analyst add-in, for example, can select routes to minimize travel distance between all destinations, to visit destinations in a certain order, or to minimize some other cost factor (e.g., time), if this factor is an attribute of the linear network theme (ESRI, 1996).

A typical use of this capability could be to have delivery or service orders for the next day entered in a database. The GIS software can georeference the addresses of the destinations and include them as destinations in the analysis. Based on the user's desires, the system can present the route on a map as well as print out directions between each point along the route. The system supports interactive decision making by allowing the user to update travel factors along routes (e.g., with information on road construction or rush hour congestion), by blocking routes from use (e.g., because of speed traps or load restrictions), or by removing points from consideration in a *what-if* analysis. Further, the software supports on-the-fly modification of schedules. If an urgent call comes in after a route has been started, the vehicle's current location can be indicated as the new start point, the new destination can be added, and the routing recalculated. Similar techniques can be applied to the problem of finding the closest unoccupied vehicle (e.g., taxi cab, emergency vehicle, or repair truck) to a customer location.

[5] Even a brief overview of the Management Science algorithms for vehicle routing is beyond the scope of this paper. Readers may refer to almost any introductory Management Science textbook for an overview of network algorithms. The *shortest route* or *traveling salesman problem* algorithms are most likely to be pertinent to vehicle routing.

One medical laboratory used these techniques to reduce costs by nearly $250,000 in the first full year of operation (Bob, 1997). The laboratory uses a fleet of couriers to provide pickup and delivery services for physicians and hospitals. The GIS service routing application reduced the number of vehicles in the fleet, reduced courier hours by 52%, and increased on-time delivery performance.

Table 3 summarizes the system requirements needed to implement a vehicle routing system.

Table 3: Vehicle Routing System Requirements

Com-ponent	Description	Cost (approx.)
Hardware	Pentium-class PC.	$1,500
Software	Professional quality desktop GIS software.* May require separately priced network analysis module.	2,000
GIS Data	Street map with streets represented as a line theme where each street can be treated as an *arc* in the network. The most flexible results will come when the attribute data for the street map can be modified to include cost factors other than distance to account for congestion, construction, etc. Also requires address matching theme if street addresses for destination will be georeferenced. (The same street map theme may support both the network specification and the geocoding.)	400
Other Data	Delivery point locations with street addresses. May be kept in a separate database tied to a transaction processing system or may be added to the map graphically.	Internal
	* See descriptions in Table 5.	Total: **$3,900**

Site Selection

Site selection is the process of deciding between a number of alternatives for the location of a business activity such as a store, restaurant, medical office, or warehouse. In contrast with the advertising or vehicle routing problems, site selection, especially for the small business, is likely to be an infrequent (or one-time) decision with enormous long-term consequences. As such, it is more likely to use an *ad hoc DSS* instead of a formal system, but the decision is all the more deserving of management attention because of its consequences.

The criteria for choosing an optimal business site can vary widely depending on the type of business, the business' market strategy, and the activity to be performed, but GIS can assist in many kinds of site selection problems. Of particular interest is the ability of a GIS to display multiple themes in layers for simultaneous analysis. The discussion that follows assumes that the small business in question is concerned with a relatively small area (a county or metropolitan area), but the same principles can also be applied in larger scale operations in a larger area.

Retail site selection (stores, restaurants, medical clinics, etc.) will often use analysis similar to that discussed for market analysis as discussed above (see "Finding your Customers" earlier in this section). Other factors may include size of the market, competition, site availability and zoning, traffic flow, and real estate costs. Consider the information to be had from adding the following themes to an analysis:

- A street map theme as this is the most common metaphor for analyzing urban real estate.

- A point theme of available sites created by either geocoding street addresses or by adding specific points to the theme with the mouse. Attributes of the available site theme may include the asking price, square footage, number of parking spaces, etc.

- A zoning theme from the city/county zoning commission. This theme can indicate the suitability of existing zoning of candidate sites or the need to apply for zoning variances or rezoning.

- A traffic volume theme. This theme categorizes roads by the volume of traffic they convey and can add incredibly powerful insights for site selection analysis.

- A theme of existing competitor sites. This theme may need to be created locally but can be as simple as a point theme showing existing competitor locations.

With the above themes, as well as demographic data, some interesting analysis can be performed. While it is usually desirable to locate a business near customer locations, having dispersed concentrations of potential customers can make this task problematic. The traffic volume analysis theme lets businesses determine which locations are along high-volume routes, even if the location is not near specific concentrations of customers. An ideal site, for example, may be along a route that connects multiple concentrations of desirable customers with the downtown area and which is conveniently accessed by other customers, even though it does not lie on their commuting route.

The ability to plot competitor locations also enhances the site selection analysis. This theme, in conjunction with demographic information, may serve to identify underserved markets. This analysis can be especially useful if the company targets a particular market niche. If competitors are differentiated by the market segment they serve, a visual analysis may serve to show where the desired segment is inadequately covered.

Many of these techniques were applied by a growing chain of California restaurants (Specht, 1996). The company uses census data, specialized site selection software from Scan/US, and current-year and five-year projections from Urban Decision Systems. The analysts plot areas with annual incomes greater than $50,000, population density, median housing prices and rental rates, and total existing establishments, employment, and payroll. The major advantage this company has realized is the ability to prescreen sites. They save considerable time and effort on inspection trips and are able to devote more of this time to the negotiating process.

Table 4 summarizes the system requirements needed to implement a site selection system.

ASSEMBLING A SMALL BUSINESS GIS

Unfortunately, the extensive choices available in GIS capable computer hardware, GIS software, and GIS data make it difficult to craft a simple prescription for assembling a small business GIS. The same system that will satisfactorily display basic street data and customer locations may not suit the user seeking to implement a delivery routing system. As with any system construction effort, the starting point needs to be the business decision maker's needs. In general, the nature of the spatially oriented decisions will determine the system's components.

Table 4: Site Selection System Requirements

Com-ponent	Description	Cost (approx.)
Hardware	Pentium-class PC.	$1,500
Software	Professional quality desktop GIS software.* Simple demographic analysis may be performed on lower end software packages. These themes may not support all of the capabilities described in this section..	1,500
GIS Data	Address matching theme if candidate sites or competitor locations will be georeferenced Demographic theme(s). ** Traffic volume theme. Zoning theme.	1,000
Other Data	Customer database with addresses, phone numbers, or both. Competitor locations and information.	Internal
* See descriptions in Table 5. ** Many vendors provide a wide range of demographic products. See the data products listing at the *Directions Magazine* web site for an up to date listing (http://www.directionsmag.com).		Total: **$4,000**

A specific business decision involving spatial analysis has implications for four system components: the GIS software and its processing capabilities, the spatial data, non-spatial data, and computer hardware. Of the four issues, the GIS software and data are coequal as the most important components of the system.

The best starting point for the system assembly process is to determine what commercial or government GIS themes will (or may in the future) be needed to support the business' decision making needs. An excellent source of up-to-date information on available GIS data is the Data Products page at the online *Directions Magazine* web site.[6] Since not all GIS software will process each third party data source, the need to use a particular data product may help to determine which GIS software is needed.

The second major decision pertains to the GIS software to adopt. Table 5 provides a taxonomy of GIS software along with example products in each category. While there are six specific categories in the table, for most small businesses the main decision will hinge around whether the software needs to simply display spatial data or whether it needs to manipulate and/or search the spatial component of the data. The products in the Spreadsheets, Application Add-Ins, and Entry Level Business Mapping software categories are generally suitable for data viewing while the Desktop Mapping System products are the most suitable for use by a small business for spatial data manipulation and/or searching.

[6] http://www.directionsmag.com

Table 5: Geographic Information Systems: A Comparative Taxonomy

Classification	Software Examples		Features *
Route Planners (Free to $50.00)	Street Atlas Map Quest		Plots directions from one city to another. Does not provide viewing of third-party or organizational data.
Spreadsheet Add-Ins	Excel Microsoft Map Lotus 1-2-3 Lotus Map	Wordperfect Data Maps	Works with existing applications. Allows use of organizational data but supported formats for external map data is limited.
Application Add-Ins	Visio Maps First Map (for Excel)	MapLand (for Excel)	Similar to above.
Entry Level Business Mapping ($100 - $150)	BusinessMap Pro MapLinx Express MapLinx Pro	MapPoint 2000 ProViewer	Provide a much richer access to both organizational data and to third-party map sets. Will often include maps such as state and county boundaries, though at low resolutions. Some products in this range allow limited spatial querying and summarizing.
Desktop Mapping Systems $350 - $1,500)	ArcView GIS Atlas GIS GeoMedia MapInfo Pro Maptitude MapInfo Desktop	Business Map Pro San/US for Windows Spatial Vision Power Map Tactician 4	Provide access to a much richer set of map data formats and to a wider range of corporate database formats. Usually providing programming or at least scripting capabilities.
Professional High End (Cost > $3,000)	ArcView Business Analyst ER Mapper First St.	ArcInfo Geomedia Pro	These products are for serious GIS data creation and management and generally provide far more capabilities than the small business user is likely to need.

* These features are broad generalizations. Details of specific products must be obtained from the manufacturer (see Appendix A). Technology advances are guaranteed to change these characteristics over time.

The author recommends that five factors be considered when selecting a GIS software package.

1. Does the software support a wide range of both spatial and conventional data formats. More robust software provides the most flexibility for using in-house conventional data and third party spatial data.

2. Does the software support a higher level of use than is initially expected? Experience has shown that once end-user oriented software is adopted in an organization it is usually put to many more uses than originally anticipated.

3. Is the software truly an end-user product with appropriate documentation, technical support, and even training classes. Some software (including GIS) products are so specialized that the documentation and support material are just not suitable for the average end-user. Unless the business is large enough to support a full-time GIS professional, such products should be avoided.

4. What data comes with the software. Some software comes bundled with a large set of valuable data that can save money on the purchase of third party data later.

5. Some GIS vendors offer a complete range of data conversion, training, and consulting services (or have relationships with third party groups to provide these services). It may be possible to put together a package of software and related services for a company making its first step into GIS.

Appendix A gives contact and product information for many companies that provide GIS software as well as information on two excellent sources of information on other GIS products and data.

Fortunately, the computer hardware component of a small business GIS is relatively easy to specify. Most GIS will run on a standard Pentium-class PC operating Microsoft Windows or NT. Some, though, may require a Macintosh computer or a variation of the Unix operating system. If the organization already has a rich collection of relatively modern personal computers, it is likely that these machines will support the GIS products without modification or upgrade. GIS does benefit appreciably from faster processors, better graphics cards, and higher bus or network speeds.

CONCLUSIONS

A 1995 study of several small businesses over an eight year period determined that, as with their large-firm counterparts, small business computing efforts are becoming increasingly sophisticated (Cragg & Zinatelli, 1995) and demanding. Traditional DSS research has also shown that individual decision makers, regardless of the size firm that they serve, require assistance in organizing, formatting, and analyzing information in support of their decision making efforts.

This article has shown that GIS *may* be a suitable technology for many small businesses to adopt. From a general point of view, GIS are excellent decision support tools. All GIS provide some ability to display business data in the familiar format of a map. Most GIS provide the ability to superimpose multiple map themes to visually display relationships between otherwise disjointed data. High-end (but still affordable) GIS provide all of the database management, graphical display, and many of the reporting capabilities of sophisticated DBMS, and they provide the mapping and spatial analysis capabilities that provide particular value in certain circumstances. Further, all of these systems will operate on widely available personal computers.

More specifically, this article gave three examples of situations in which a business can apply the capabilities of GIS to common business problems. Appendix B provides a list of readings that include additional examples of the application of GIS to small (and large) business problem solving.

One of the major common themes in the three examples is the value of second- or third-party produced spatial data for solving business problems. Demographic data, street maps, zoning themes, and traffic data are just a few of the themes used in the examples. The increasing availability and decreasing costs of these products will be of particular importance to the small business end-user.

The most important conclusion to be drawn from this article is that GIS are becoming more and more appropriate as end-user tools for business problem solving. Because they will operate on common PC-class computers, because their prices are coming down while features are going up, and because of the increasing availability of valuable spatial data, this technology is also becoming increasingly appropriate as a tool for the small business user.

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Ronald S. Rubin *is Professor of Marketing and Director of the Small Business Institute at the University of Central Florida. Dr. Rubin's educational background includes a Ph.D. in Business Administration with a specialty in Marketing from the University of Massachusetts. Dr. Rubin has consulted for various companies in the areas of consumer analysis, marketing research, and litigation research. He has worked in marketing research for an engineering company and the Marketing Science Institute. He has presented papers at academic and professional meetings and has contributed articles in various academic journals on such subjects as: small business management, spreadsheet analysis, marketing research, expert systems, data analysis, simulations, and educational methodology. He is the co-author of Marketing Research, 7th edition, Experiential Exercises in Marketing Research, and authored the Rubin and Luck Data Analysis Disk and PC Marketer: Computer Applications Using Lotus 1-2-3, all published by Prentice-Hall. He is co-author of Strategy and Competition, a marketing simulation published by Allyn & Bacon. He has also authored A Guide to Management Consulting. His current interests include small business management development, social and environmental concerns of marketing, marketing and litigation research, expert systems, and simulations. Dr. Rubin was a co-founder of the Consumer Credit Counseling Service of Central Florida, a United Way agency, on which he holds membership on the Board of Directors and was President. Dr. Rubin is a Fellow of the Small Business Institute Directors' Association, and a 1971 Fellow of the American Marketing Association's Doctoral Consortium.*

APPENDIX A: GIS SOFTWARE DEVELOPERS AND VENDORS

For more information on specific off-the-shelf GIS packages, all of which come with basic maps and databases (you can contact the application developers). Here are some leading players and products:

Company	Tel. Number	URL	Basic Product(s)
Caliper	617-527-4700	http://www.caliper.com	Maptitude 3.0 ($395)
DeLorme	207-846-8900	http://www.delorme.com	Street Atlas USA 6.0 ($54.95)
Earth Resource Mapping	619-558-4709	http://wwwermapper.com	ER Mapper ($4,300)
Environmental Systems Research Institute	800-447-9778	http://www.esri.com	Arcview 3.1 ($1,195) Atlas GIS ($795) BusinessMAP PRO ($149) Business MapPro Corporate ($499.95) Business Analyst ($11,995) Arc/Info ($10,000)
Intergraph Co.	256-730-2000	http://www.intergraph.com	Geomedia ($1,500) Geomedia Pro ($7,500)
MapInfo	800-327-8627	http://www.mapinfo.com	Mapinfo Deskto ($349) Mapinfo Professional ($1,295) ProViewer ($99)
MapLinx	800-352-3414	http://www.maplinx.com	MapLinx Express ($89.95) MapLinx Professional (149.95)
MapQuest	888-627-7837	http://www.mapquest.com	MapQuest
Microsoft Corp.	425-882-8080	http://www.microsoft	Microfosft Map (within Excel) MapPoint 2000 ($109)
Scan/US Inc.	310-820-1581	http://scanus.com	Scan/US for Windows ($495)
Sedona GeoServices	877-SEDONA2	http://www.sedonageo.com	SpatialVision ($495)
Software Illustrated	209-833-9898	http://softwareillustrated.com	MapLand ($59.95)
Tactician	978-475-4475	http://www.tactician.com	Powermap ($349) Tactician 4 ($1295)
Wessex, Inc.	800-24VISIO	http://www.wessex.com	First St. ($2,995) First Map (Excel Add-in) ($69)

There are dozens of suppliers of customized products to beef up the database and mapmaking capabilities of off-the-shelf GIS packages. For a comprehensive list, see the Buyer's Guide published each December by ***Business Geographics*** magazine (155 East Boardwalk Dr., #250, Fort Collins, CO 80525-9945), and ***Dimensions Magazine*** at URL: www.directionsmag.com/products.asp.

APPENDIX B: A GIS READING LIST

This appendix lists a few selected references that the author feels will benefit the reader seeking to find additional information on GIS use in business before deciding if GIS is an appropriate investment. These readings will not help the reader choose a specific GIS product. Researching vendor web sites and talking with sales representatives (See Appendix A) should be used for this purpose. Entries in this list are not listed in the references section of the article unless they support material in the body of the article.

Reference	Authors' Comments
Christian Harder. *GIS Means Business.* Environmental Systems Research Institute, Inc., Redlands, CA, 1997. ISBN: 1-879102-51-X	A compact and rich overview of examples of real-world GIS use in business situations. Includes many color plates of maps. The specific problems illustrated in the book will be valuable to readers who share these situations but will also spark imaginations. Comes with a tutorial disk for ArcView GIS.
Keith Clark. *Getting Started with Geographic Information Systems.* Prentice Hall, Upper Saddle River, NJ, 1997. ISBN: 0-13-294786-2	A comprehensive overview of GIS but not too technical. A good follow-up to this article for those interested in finding more about GIS without actually making the purchase. Not specifically oriented for business users but a good reference all the same.
Stanley Arnoff. *Geographic Information Systems: A Management Perspective.* WDL Publications, Ottawa, Canada, 1989. ISBN: 0-921804-91-1	This classic reference is somewhat dated but provides an excellent (and timeless) background in the principles of GIS, though at a more technical level than what the average end user might prefer.
Paul Longley & Grahm Clarke, eds. *GIS for Business and Service Planning.* Wiley, New York, 1995. ISBN: 0-470-23510-1	This book is actually a set of readings from multiple contributors, with each reading illustrating the application of GIS to a business situation. Most of the examples are European and refer to data that would not be available to other users, but the business cases that are illustrated will be common everywhere and similar data should be available.