# Maps for Planning

*by Thomas L. Millette, Ph.D.*

Maps are one of the most valuable and popular tools in the planning repertoire. However, like any tool, maps need to be in good repair and used properly to get a useful result. Since there are many different types of maps produced for different uses, it is useful to have a basic understanding of maps. This article is the first in a series of three that will introduce you to maps and their uses in planning. The second article will highlight topics related to map compilation — how to find and organize information that you want to put into a map — and to the types of maps most commonly used in planning. The third article will introduce you to geographic information systems (GIS), a rapidly expanding technology that integrates computer maps and database management systems (DBMS) to facilitate various types of spatial analysis.

Those of us who use maps on a daily basis know that there is something quite special about them, although it's sometimes difficult to articulate. Without getting technical, the unique quality of maps is that they allow us to visualize and think in greater detail about the places around us. For example, we have all had the experience of asking for directions to a friend's home and receiving a long sequential list of left-hand turns, right-hand turns, forks in the road and stop lights. Generally by the seventh or eighth instruction our eyes glaze over and we get the sensation that it would be easier to find Mongolia. Yet when these same directions are portrayed on the back of an envelope with several lines for major streets and boxes for key landmarks such as "left at Kelly's Restaurant" and "right at Gallagher's Plumbing Supply" our confidence is restored and we eagerly embark.

This experience highlights how maps allow us to better understand and connect the places around us. Because the simple map described above allows us to visualize which streets intersect, which run parallel and at what intersections landmarks can be found, it is possible to "see" the route to our destination in a way that is not possible with written directions.

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Maps are a multipurpose tool and serve a variety of functions in support of planning. The most valuable function is to allow visualization of specific features or areas to facilitate discussion among professional staff, planning board members and town residents. The exchange of ideas, information and opinions is fundamental to the planning process. Few mediums have a map's ability to present a wealth of detailed and complex information in a form that is easy to visualize and understand. Maps are a truly unique communication device and, as such, provide an ideal focus and catalyst for discussion.

A second important function of maps is the long term storage of spatial information. For example, comprehensive plans frequently contain a variety of maps with themes such as land use, forest types or wildlife habitat. These maps are typically used for inventory purposes and to provide a permanent record of these resources at distinct times. Since plans are typically updated every five years or so, these maps can provide a valuable record of a community's changing resources and character through time.

A third important function of maps is their use as detailed spatial databases upon which systematic measurements can be made. For example, 1:24,000 scale United States Geological Survey (USGS) topographic maps can be used to identify and measure areas of low, moderate and steep slopes in a community by tabulating the total number of contours occurring over a given distance. This type of measurement would be of value to a community developing a comprehensive soil erosion management strategy. Another example would be using a town's 1:1,200 scale parcel map to conduct a town-wide parking inventory. This could be done by measuring the linear distances of individual block faces (building fronts) less curb cuts, and dividing each block face dimension by the length of a parking space in areas where parking is to be permitted. However, you should be aware that making measurements from maps is not always a straightforward business. Due to technical concerns such as map projections, scale, and rectification procedures, not all maps are suitable for making direct measurements. Proceed carefully and seek advice from knowledgeable sources when using maps for making measurements.

### BASE MAPS

One of most useful resources for any town is a basic set of maps to support planning. These maps are often called base maps, and typically display — on separate maps or in various combinations — essential information such as roads, water bodies, floodplains, utilities, parcel boundaries, zoning districts, topography, and land use. The term "base map" is drawn from the fact that these maps are tied to a detailed "spatial base" which allows accurate location of features on the maps.

There is no single ideal set of base maps. A community's map needs are as unique as the community itself. Some suggestions that are worth considering for a basic planning collection include maps of: town parcels, hydrography (streams, rivers and water bodies), topography, soils, wetlands and flood plains, land use and land cover, building footprints, roads and municipal utilities. These maps should be drawn on translucent mylar — a plastic material — so that they will not shrink or stretch, and are easy to reproduce. Most importantly, they should be accessible. All too often maps seem to be locked up and guarded in the offices of the town clerk, assessor, building, parks, sewer or highway departments, as if they were the Holy Grail. Inexpensive duplication methods, such as blue-line diazo prints, can allow access to existing maps, while at the same time protecting the originals. Offices holding maps should be encouraged to provide duplicates for the community at large. After all, it is the community's taxpayers who are paying for the information to be acquired and mapped in the first place.

### Developing a Map Collection

When developing a planning map collection for your community there are several important considerations to ensure that the maps are of maximum use and value. The first consideration is what information should be mapped. Since planning boards do not have unlimited resources at their disposal, it is important to prioritize map needs so that essential information is mapped first, and additional information is mapped as funds become available. Essential information for planning purposes often includes: the location of parcels and structures, roads, zoning districts, land use, utility distribution networks, soils, hydrography and topography. Communities should develop a plan for map development, and encourage shared funding of mapping by all agencies or departments that will benefit from the maps. For example, a parcel map would not only be of value to the planning board, but also to the town clerk, building inspector, streets and highway department, and police and fire departments. Sharing the expense of parcel mapping makes mapping a much more affordable enterprise.

A second important consideration is the scale to be used in developing planning maps. p. 6 The scale of a map is the ratio between distances on the map and their corresponding distances in the real world. Map scale is an important consideration because it determines the level of detail that can reasonably be expected to be included in the map. For example, maps used for local planning purposes should be large scale, somewhere between 1:500 and 1:5,000. Maps with scales in this range show features such as roads, building footprints, block facings, curb cuts, drainage systems and power line easements in sufficient detail to allow accurate inventory, measurement and analysis. All too frequently, planning maps are developed at inappropriate scales. For example, many local planning maps are developed at a scale of 1:24,000 because the USGS 1:24,000 topographic map series is readily available. Although using this approach is relatively inexpensive, effective local planning usually cannot be done at a scale of 1:24,000.

A third consideration is ensuring that your maps are built upon an accurate spatial base. For planning purposes, the "State Plane" coordinate system is the most frequently used spatial base for large scale mapping. However, since each state has a unique state plane coordinate system, maps that cross state lines will frequently use "Universal Transverse Mercator" (UTM) coordinates. Maps that are not accurately registered to a spatial base can create problems if used incorrectly. For example, maps that are created by tracing aerial photographs that have not been rectified

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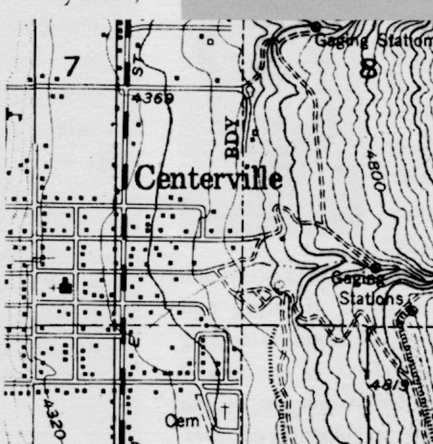


*USGS Topographic Map, Centerville, Utah 1:24,000*

## Map Rectifications

Maps are drawings of the earth's surface on flat pieces of paper. However, as we all know, the earth is not flat. Since the earth's surface is curved, and because topography causes significant distortions on the aerial photographs from which most maps are made, map "rectifications" are needed to compensate for these displacements. Map rectifications are a collection of procedures that make geometric adjustments to lines on maps so that distortions created by transferring a three dimensional curved surface to a two dimensional flat piece of paper can be removed.

## Spatial Bases for Mapping

The two most common spatial bases for planning purposes are the Universal Transverse Mercator (UTM) coordinate system, which is unique to each hemisphere, and the State Plane coordinate system, which is unique to each state. Features on base maps are located to the coordinate system within prescribed accuracy and precision limits to ensure the quality of the map. Base maps can be considered bare-bone, outline type maps which can be used for transferring information — such as soil classifications — to. However, this is only true if the map is "registered" or linked to some spatial coordinate system.

## Maps...

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and registered to a spatial base contain distortions that are transferred to the map. p. 5 These distortions reduce the accuracy of measurements made from the map.

In addition to the actual map characteristics, another important consideration is the mapping format. Although pen and ink maps are attractive because they do not require a large investment in materials and equipment, they may not be as cost effective as they seem. Considering the relatively inexpensive microcomputer hardware and mapping software available today, the labor required to create, edit and maintain manual pen and ink maps frequently makes them more expensive to produce map for map than computer drawn maps.

### Summing Up:

Maps are unique communication devices that have many uses in planning. As a tool for the visualization of spatial relationships they are unparalleled. However maps can only be used effectively if they suit the purpose for which they are being used in terms of scale and accuracy. Planning maps should be developed at appropriate scales on accurate spatial bases to maximize their potential uses. Communities should look at a basic set of planning maps as a resource to be developed and maintained over the long term. Development costs of high quality maps can be shared by several town offices making them accessible to even the smallest communities.

*Thomas L. Millette, Ph.D. is Assistant Professor and Director of the Laboratory for Spatial Analysis in the Department of Geography, University of Maryland, Baltimore County, Maryland. Dr. Millette's research interests are in the application of geographic information systems and remote sensing to regional planning and environmental management. In addition to teaching and research, Tom is an advisor to the Natural Resources Defense Council in Washington, DC and to numerous state and regional planning agencies.*

## What is A Map Scale ?

A map scale is a ratio that describes the mathematical proportions of a map. The most common form of map scale expresses the ratio of a distance on the map sheet and its real world equivalent separated by a colon. For example, a map with a scale of 1:63,360 can be understood as having for each unit measured on the map, a total of 63,360 of the same units in the real word. It is important to understand that the ratio holds irrespective of the units used. Therefore whether inches, centimeters or cigarette lengths are used as the unit of measurement, for every one measured on the map, there will be 63,360 of them on the ground in the real world.

## Essential Elements of Maps

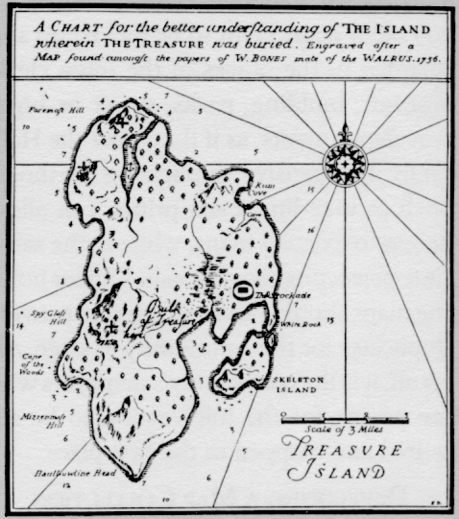
Although there are many different types of maps, all maps should have the following seven elements:

- *A title that clearly identifies the information contained in the map*
- *A scale indication represented as both a ratio and a bar to be used for making measurements*
- *Notation of the projection and rectification used to create the map*
- *A "graticule" or grid indexing system used to identify specific coordinates on the map.*
- *A designation of the source and date of the data used to create the map along with the agency responsible and map creation date*
- *An unambiguous set of map symbols with a map key for explanation*
- *A map orientation indicator such as a north arrow*

These basic cartographic elements allow the map to function both as a powerful communications tool and as a detailed spatial database from which accurate measurements can be taken.

## Resources:

If you have, or develop, an interest in learning more about maps and their use, the following are good basic texts: *Map Use and Analysis*, by John Campbell (Wm. Brown Publishers, Dubuque, IA 1991); *Applied Cartography: Source Materials for Mapping*, by Rabenhorst and McDermott (Merrill Publishing Co., Columbus, OH 1989); and *Elements of Cartography*, 5th Ed., by Robinson, Morrison and Muehrcke (J,. Wiley & Sons, New York, NY 1984).




## Maps for Pirates

[T]here fell out the map of an island, with latitude and longitude, soundings, names of hills, and bays and inlets, and every particular that would be needed to bring up a ship to safe anchorage upon its shores...There were several additions of a later date; but, above all, three crosses of red ink— two on the north part of the island, one in the south-west, and beside this last, in the same red ink...these words: "Bulk of treasure here."

From *Treasure Island*, by Robert Louis Stevenson (Abaris Books 1979). Illustration by Edmund DuLac, p. 75.

# Map Compilation:

## Planning the Perfect Map

*by Thomas L. Millette, Ph.D.*

*[Editor's Note: In the Journal's March/April 1992 issue, Tom Millette discussed basic information about maps and their use in planning. In this second article Tom covers the "nitty gritty" aspects of map compilation — the process of gathering and combining information that is put into a map. It will make you realize that there's often a lot that goes into developing the finished maps that planning commissions work with. Tom will conclude his series of articles with an overview of geographic information and database management systems — tools that are rapidly expanding in use by planning agencies].*

The process of map compilation is extremely important since the quality and usefulness of a map are the direct result of the procedures used to compile it. These procedures include the selection, assembly, processing and graphic display of the information used to create the map.

### Types of Data Used in Compiling a Map

The map compilation process requires the organization and processing of two different types of information: base data and thematic data.

*Base data* provides the "context" for a map. It includes geographic features such as political boundaries, place names, major cities, rivers and other landmark features that provide the map reader a geographic setting for the mapped information. Base data also includes the other essential elements of a map (such as the map title, scale, latitude and longitude lines, and legend) that I described in my previous article. *See page 6 of the March/April 1992 Journal.* This non-geographic base data provides valuable descriptive information that makes the map more useable.

*Thematic data* is the subject of the map. For example, the thematic information in a land use zoning map is the display of residential, commercial and industrial zones. Most maps are dominated by a single data theme. Using multiple themes in a single map often results in a confusing map because too much information is being displayed. Thematic data is drawn from a variety of sources including: field studies and interviews, satellite imagery and aerial photos, other maps, statistical abstracts and printed material.

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### The Compilation Process

*Data Selection.* Data selection is an important consideration in developing a map because the quality of the data used ultimately determines the map's usefulness. The most fundamental aspect of data selection is deciding what to include or omit from the map. Decisions must be made, for example, as to which rivers, lakes, roads and other geographic features to include. This is often related to the scale of the map — and the resulting "resolution."

To give an example: suppose you are trying to compile a land use map for Cape Cod, Massachusetts. Use of data from a 1:5,000,000 scale map of North America would not be very helpful because it would not have many of the important land features necessary to produce a useful map of Cape Cod. In other words, the scale of the North America map would be much too small to provide sufficient spatial resolution for the larger scale local map.

*Generalization and Classification.* The processes of generalization and classification are the heart of the map compilation process. It is these two processes that transform the raw base and thematic data into a useable map. Generalization is the process of distilling a complex set of data to a simpler form without losing its essence. With base data, for example, cartographers usually generalize coastlines since attempting to preserve each coastal detail on a map would not be practical. With thematic data, a related type of generalization — usually referred to as "classification" — involves consolidating categories or classes of data. For example, when Census Bureau population statistics are used, it is often important for the person compiling the map to consolidate the very detailed census information into more general categories. This sort of data classification is essential so that the mapped information can be readily grasped and understood. The processes of generalization and classification help make maps more "readable."

*Symbolization.* Symbolization involves the choice of which "symbols" to use to represent the data being displayed on the map. For example, in a population map of counties the choice might be between using different levels of gray shading or using point symbols such as proportional circles where the relative size of the circle reflects magnitude of population. This step in the map compilation process is of critical importance. A map that has a poorly designed symbolization scheme will not connect with the map reader, and will fail as a

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## Map Compilation

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spatial communication device.

Generally speaking, the greater the amount and complexity of information contained in a map, the more detailed the symbols will be. Since many planning maps are intended to be read by the general public, it is important to keep symbols as graphically simple and understandable as possible.

*Scale and Coordinate Transformations.* Scale changes and coordinate transformations are the mechanical hurdles involved in transferring and combining information from different map sources. Because maps often use different scale, projection or coordinate systems, significant amounts of time and effort can be consumed in transferring mapped information from source maps to the compilation draft.

Techniques used for transferring information between maps can be grouped into three general classes: optical, mechanical, and digital. Optical techniques involve using projectors, cameras and transfer scopes to change the sizes and shapes of map features to allow their transfer from one map to another. Mechanical techniques use some type of mechanical tracing device to transfer information from one map to another. Digital techniques use computers and digital map representations to transfer information from one map to another. Because digital techniques use mathematical transformations, they are the easiest and most flexible to use. Given the extremely accessible and affordable microcomputer hardware and software for mapping now available, digital techniques represent the best and most cost effective solution to scale and coordinate transformations.

*The Compilation Work Sheet.* The work sheet or draft map is the frame upon which the compilation process builds a map. The two most important considerations pertinent to the work sheet include its scale and its data presentation format. The most important factor in deciding on the map scale of a work sheet is the intended use of the map. If the map is intended for local use it should ordinarily be compiled at a relatively large scale (between 1:500 and 1:5,000). Maps intended for regional use should be compiled at smaller scales, somewhere between 1:20,000 and 1:100,000. *[Editor's Note: See Tom Millette's previous article for a discussion of the importance of map scale, at page 5 of the March/April issue].*

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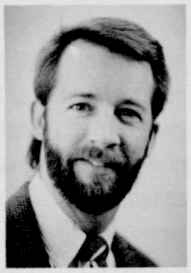
The data presentation format involves how the map maker intends to communicate the spatial data to the map reader. There are a wide variety of map presentation formats, including choropleth maps, isarythmic maps, point symbol maps and cartograms. Choropleth maps display data by political or administrative geographic unit. A map that illustrates mean family income by census tract is a typical example of a choropleth. Isarythmic maps, in contrast, depict data in zones of similar value unconstrained by political or administrative units. A topographic map that uses contours to illustrate areas of similar elevation is a commonly used isarythmic type ofmap. Point symbol maps use individual symbols placed at discrete locations to represent an occurrence or quantity of data. For example, a common point symbol map most of us are familiar with shows relative city population by displaying graduated circles proportional to population at the locations of the cities.

There are a wide variety of creative approaches to presenting data in a map. The draft map provides the opportunity to test different map presentations and data symbolizations in order to develop the most effective graphic design for a particular map.

### Summing Up:

The process of taking a map from concept to reality involves a host of considerations. Compiling a map that is geographically correct — and graphically effective — is no small accomplishment. Compiling a map takes thought and careful planning. Above all, those compiling the map must keep in mind the needs of the map users, and ensure that the map accurately conveys information in a readable manner.



*Thomas L. Millette, Ph.D. is Assistant Professor and Director of the Laboratory for Spatial Analysis in the Department of Geography, University of Maryland, Baltimore County, Maryland. Dr. Millette's research interests are in the application of geographic information systems and remote sensing to regional planning and environmental management. In addition to teaching and research, Tom is an advisor to the Natural Resources Defense Council in Washington, DC and to numerous state and regional planning agencies.*

### Getting Comfortable With Maps

The compilation and subsequent production of a map is as much art as science. Spend some time browsing through the atlas collection of your local library. By investing time thumbing through several atlases you can get a wealth of ideas provided by some of the best cartographers in the world today. For a fascinating overview of the enormous variety of maps available, take a look at *The Map Catalog*, by Joel Makower (Tilden Press 1986) — a book written for the layperson. If you have never explored the numerous types of mapping related data that are commonly available from federal, state and local government sources you may be quite surprised by their breadth and depth. Another good source is Judith Tyner's *Introduction to Thematic Cartography* (Prentice Hall 1992).

# Geographic Information Systems

by Thomas L. Millette, Ph.D.

*[Editor's Note: This is the final article in Tom Millette's three-part introduction to maps and the use of geographic information systems. In his first two articles, Tom focused on how maps are used in planning, and on the map compilation process. In this article Tom will fill you in on some of the basics of geographic information systems — probably the fastest growing new technology in land use planning].*

Geographic information systems, commonly referred to as "GIS," is a rapidly expanding technology that has become an important planning tool with numerous applications. GIS is useful for planners because it increases their productivity by allowing them to spend less time processing data and converting it into information, so that more time is available to analyze the information and assess its planning implications.

Unfortunately, there is no shortage of confusion as to what constitutes GIS — as distinct from computer mapping and computer aided drafting systems. It is not uncommon for computer software vendors to misrepresent mapping systems as GIS. Computer Mapping..., p. 15 The largest misconception surrounding geographic information systems is that they are computer software. Actually a GIS consists of three individual components of which software is only one. The other two components are computer hardware and the database. The relationship among the three components is straightforward: the software is used to instruct the hardware to manipulate the database for some desired result. Before explaining how GIS can be used in spatial analysis, and providing some examples of how planning programs are coming to use GIS, let me give you a quick "tour" of the software, hardware, and database aspects of geographic information systems.

*Software.* GIS software consists of specialized computer programs that read, manipulate, analyze and display spatial data. Geographic information systems typically integrate two separate software tools in order to manipulate the map and non-map data used by the system. The first tool is an automated mapping program for managing computer maps. The second is a database management system ("DBMS") used for managing descriptive information linked to specific features in a computer map.

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*Hardware.* GIS hardware begins with the central processing unit that is housed in a mainframe, mini, or micro computer. Recent developments in both software and hardware have allowed microcomputers to become both a powerful and popular platform for GIS. In addition to the central processing unit, specialized devices, such as digitizers or scanners, are needed for data input. A digitizer is an electronic tablet that is used to trace paper maps in order to convert them into machine readable format so that they can be used by the computer. A scanner is a device that can be used as an alternative to a digitizer. A scanner reads the lines and features on a paper map with some type of light sensitive head and converts it to a computer readable map.

Just as GIS requires specialized input devices, it also needs specialized output devices. Frequently used devices for generating paper copies of maps from a GIS are large format "plotters." Pen plotters are capable of producing maps as large as 36 inches by 42 inches with multiple colored pens. However, since plotters are relatively slow, large or complex plots can take several hours to complete. If large plots are not necessary, smaller format inkjet and laserjet devices produce high quality output quickly and inexpensively.

*Database.* The "guts" of a GIS is its database. Without it, spatial analysis would not be possible. A GIS database consists of two distinctly different components: "spatial" data and "attribute" data. The spatial data shows the location of features such as roads, parcel boundaries and zoning districts. The attribute data consists of the descriptive elements associated with particular locational features. The GIS software maintains these two kinds of data separately: the spatial data by the system's automated mapping component, and the attribute data by the system's data base management component.

In GIS vernacular, the combination of a computer map and its associated attributes is termed a GIS "layer." For example, a parcel layer would include a computer map that shows a town's parcel boundaries. Linked to the parcel map, through the data base management system, would be an set of descriptive information for each parcel. Such information might include the name of the owner, the parcel size, its tax rate, the number and

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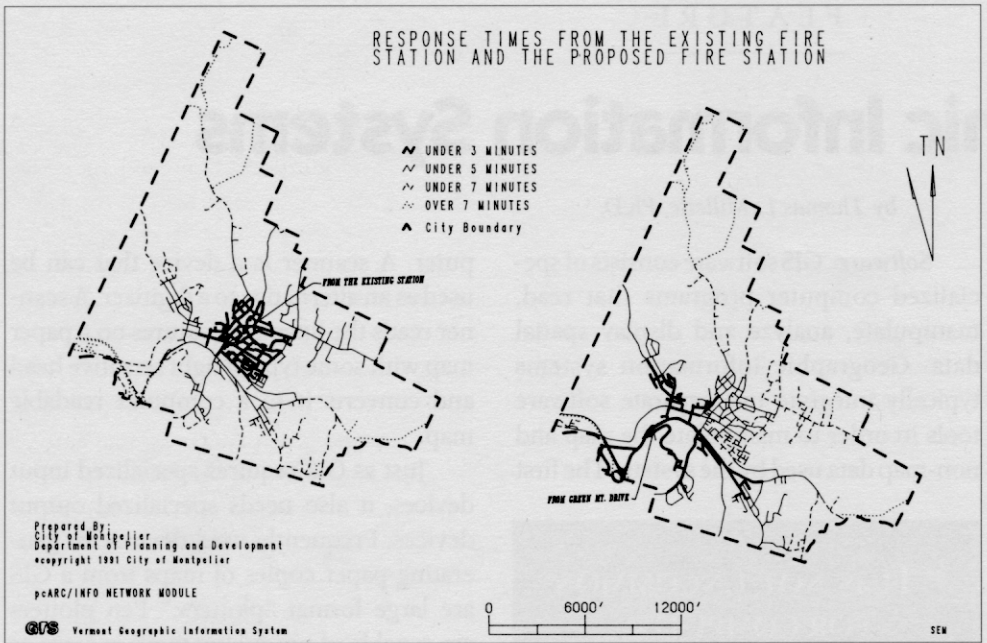


Figure 1.

## Geographic Information Systems

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type of buildings on the parcel, any variances granted — to name just some of the possible attributes.

### GIS and Spatial Analysis

The real power of GIS lies in its ability to perform various types of spatial analysis. Within the context of GIS, spatial analysis means the ability to manipulate GIS data layers for the purposes of measurement and modeling. For example, a GIS road layer is made up of a connected network of lines or arcs. Because the connections are recorded in the database, it is possible to identify and measure the shortest route between any two locations. Furthermore, because the individual roads and road segments are linked to descriptive attributes in the data base, it is possible to identify which parts of the route are divided interstate highways and which parts are unpaved town roads.

The use of GIS in spatial analysis is often best understood by seeing how it can be used. While I can't take you to an operating GIS system, I can try to do the next best thing by describing how some local communities are beginning to use GIS.

The City of Montpelier, Vermont recently used GIS to study the impact of moving its only fire station from a small downtown site, to a larger, but less central location that would allow consolidation of the fire, ambulance and police departments in a single facility. Before deciding whether to proceed, however, the community wanted to know how this change of location might affect travel distances and response times to different parts of the city. The city's GIS system enabled this kind of analysis to be done. In order to measure travel distance, a town-wide road centerline layer was used and each road segment leading to the existing and proposed sites was coded in one mile intervals. To project response times, the same road centerline layer was used together with weighting factors such as speed limits, traffic time studies, turn times and intersections inaccessible to fire equipment due to narrow turning radii. The net result was a sophisticated analysis showing projected response times from each location (the existing station and the proposed site) across all town roads. *See Figure 1.*

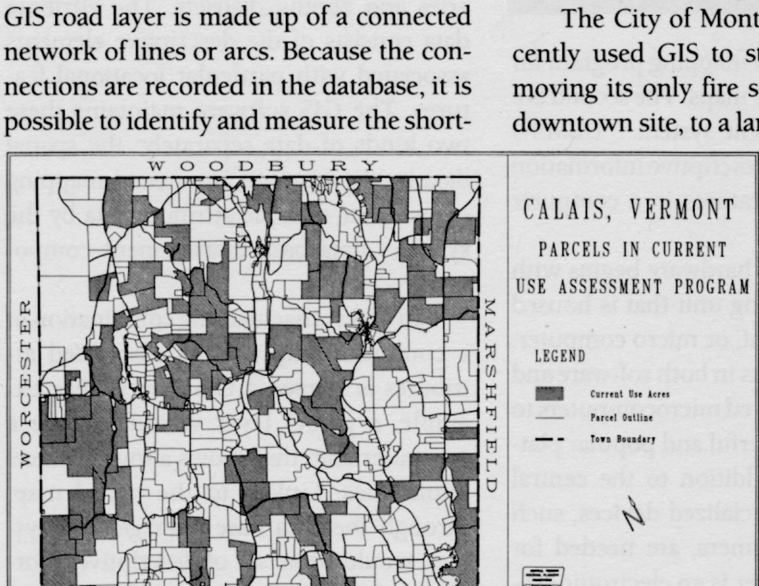



Figure 2.

A second, and more typical, planning application is the use of GIS to inventory and analyze a town's land base. Calais is a small town in the north-central part of Vermont. The Central Vermont Regional Planning Commission — which serves Calais —used its geographic information system to prepare a map that combined the town's parcel layer with data on land enrolled in the state's "current use" program (a tax abatement program intended to support agriculture and forestry). By combining the town parcel layer with the current use program areas, it was possible to get a much better picture of the town's land base. For example, through this simple analysis it could be seen that about thirty percent of the town's land was actively managed for agriculture or forestry, and that the managed areas were fairly uniformly distributed throughout the town. *See Figure 2.*

### Summing Up:

GIS is an ideal tool for planning because of its usefulness in doing a wide variety of complex spatial analysis. Once appropriate databases are developed, GIS can significantly improve the productivity of a planning organization. Town planning and zoning boards that have become familiar with the capabilities of GIS often become the most creative users and vocal supporters of such systems.

## Braintree's Build-out Analysis

GIS can also be used to conduct a "build-out" analysis. For example, the Town of Braintree, Vermont, recently wanted to examine the potential impact of development based on its current plan and ordinances, taking into account various environmental and other constraints. The basic process for the build-out analysis was organized into the following steps: (1) A town-wide GIS layer was created to reflect the currently allowed density of development (for example, 1 acre, 5 acre and 10 acre lots); (2) "Development exclusion" and "development discouragement" GIS layers were prepared; the exclusion layer, for example, included floodplains and land with slopes steeper than 25%; (3) The GIS layers were combined in an overlay in order to identify the developable portions of the town; (4) Calculations were prepared indicating the total number of parcels "available" for development, their median size, and their mean distance from town roads; and (5) Alternative scenarios were prepared, adjusting development densities in different parts of town. The GIS analysis gave Braintree residents a valuable tool for looking at the potential effects of development, as well as a means of seeing how changes in their own local regulations could affect the development potential of their town.

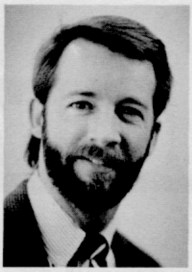
*[Editor's Note: Randall Arendt also discussed the value of conducting a build-out analysis in his article "Open Space Zoning" in our July/August 1992 issue, at page 6].*

## Computer Mapping versus GIS

While all geographic information systems include a computer mapping component, not all computer mapping systems are geographic information systems. The key distinction is that GIS integrates computer mapping with a database management system, allowing for detailed spatial analysis. In contrast, most computer or automated mapping systems are designed for map design and production, and not for spatial analysis (some uses of spatial analysis in planning are described later in this article). Automated mapping systems have more tools for designing visually attractive maps with a wide selection of map presentation formats and symbols, but have fewer tools for measurement and modeling.

## Resources:

The best introductory text on GIS is *Geographic Information Systems: An Introduction*, by Jeffrey Star and John Estes (Prentice Hall 1990). If you would like more detailed information about any of the projects described in the article, contact Tom Millette at: (413) 566-5552.



*Thomas L. Millette, Ph.D. was just appointed Director of the Geoprocessing Laboratory and Program at Mt. Holyoke College in Massachusetts. Previously, he served as Director of the Laboratory for Spatial Analysis in the Department of Geography, University of Maryland, Baltimore County, Maryland. Tom has worked with numerous state and regional planning agencies in setting up GIS programs.* *He wishes to thank Sara Moulton of the Montpelier Planning Department, Jonathan Croft of the Central Vermont Regional Commission, and Eric Edelstein of the Two Rivers-Ottauquechee Regional Commission for their generous assistance and the use of their graphics for this article.*