URBAN USES OF GEO-BASED DATA: GETTING THE TECHNICIAN OUT OF THE WAY

Dr. Joel N. Orr
President
Orr Associates, Inc.
21 Chambers Road
Danbury, Connecticut 06810

The Problem

Geo-based data is absolutely essential to the functioning of a municipality; it is its very lifeblood. Research has revealed that over 90% of the documents handled within most municipalities contain some form of geographical identification. It is therefore not surprising that cities are users and producers of many different types of maps. In fact, a recent study performed by the City of Philadelphia enumerated over 70 different series of maps being simultaneously maintained by various City departments. These included maps at a variety of scales and sizes, with different updating cycles and different combinations of features.

Unhappily, no convenient way was ever found to interrelate non-graphical geo-based data with maps - until the advent of computer graphics. Manually, maps and non-graphical collections of data are simply too different in their essential natures to tie together easily. Lists are one-dimensional, while maps are inherently two-dimensional. And, while it is not totally impossible to construct indexes and numbering schemes for cross-referencing between the two data formats, it is extremely cumbersome. Municipal users of geo-based data always want more maps, of all kinds; but these are so expensive to produce and to update that they are used only when absolutely necessary.

Computer graphics is changing all that. By having the ability to represent two-dimensional objects within the computer, techniques of information management that are not manually feasible become extremely useful. In particular, computer graphics makes it possible to use the map as an index to geo-based information. It is almost as if we can pin strings to locations on a wall map that are attached to individual geo-based records in our files, and retrieve the files, record by record, by pulling on the strings attached to them. Actually, computer graphics offers us superior techniques: We don't have to get tangled up in string (although that capability is also available...).

Maps are entered into the computer through a technique called "digitizing". This usually means using an "electronic drafting table" to enter into the computer system the end points of all the lines that make up the map, and critical points defining curves. (Automatic digitizing is almost, but not quite, commercially practical at this time.) Lines and areas are identified in the computer system's database by their usual geographic identities - e.g., streets, parcels, etc. - and can thus be linked to corresponding identifiers in other files. For instance, it is usually possible to identify a correspondence between parcel numbers and street addresses. Since lines and areas in the database are named, they can be called by name, rather than having to be identified by the coordinates of their boundary points.

Once the graphical database is constructed (with appropriate identification of lines and areas), it is relatively simple to write programs to link existing computer-resident geo-based data files - such as the tax rolls, which usually have both parcel numbers and street addresses; school board files, which have street addresses; police files, which define reporting areas in terms of bounding streets; and so on - to the maps for inquiry and display purposes. The computer graphics system then allows us to make requests like, "Show me the parcels owned by parents of children in Public School 94 that lie in Police Reporting Areas 352 and 456." The system responds by drawing an appropriate map on its graphic display; we can then request a "hard copy" of it. We can also ask that those parcels be listed and counted, rather than drawn.

The same computer system that can perform these amazing feats of informational prestidigitation is also wellsuited for automating the map-making chores of the municipal engineers and other mapmakers. It is fairly well-established that the production of maps by using a computer graphics system is at least three times as efficient as doing it manually, and that the updating of maps is more than five times as efficient with a system as without.

Furthermore, engineering tasks such as road design, generation of planimetric maps from surveying notes and cut-and-fill computations can all be performed more effectively through the use of computer graphics than without.

All in all, computer graphics seems like a useful technology for municipalities. It would appear that, if the proper funding and political arrangements could be made, this is a technology that could be pursued by almost any city, to its gain. And in fact, that is the author's opinion. However, the purpose of this paper is not to convince the reader regarding the potential benefits of computer graphics, but rather to point out a major pitfall of introducing this set of techniques into municipalities. But, if reading this far has convinced you that your city should embrace computer graphics as the solution to most of its problems, beware! You are dangerously near the edge of the pit! The paragraphs that follow make the danger - and how to avoid it - abundantly clear.

The nature of the problem is fairly simple: The only people in a municipal government likely to be able to understand the potential of computer graphics well enough to define and purchase a system are the people currently involved with computers - the DP/MIS gang. These people usually know little or nothing about mapping and graphics in general, let alone the specific policies and procedures of their own city's mapmakers. Furthermore, as the opening paragraphs above indicate, it is easy for such technology fans to be so impressed with the potential benefits of the technology that implementation details lose their proper weight in decisions about such projects. On the other hand, the noble mapmakers typically know next to nothing about computer systems of any sort, least of all computer graphics systems.

The problem emerges when the city is getting ready to actually implement computer graphics technology in some way. The city fathers and the line managers are sold on the potential benefits; money has been set aside for the equipment, based on vendors' price estimates; it is now time to define the uses to which the system will be put, in detail, and to come up with a functional system specification. Who will do this work? That is the issue wherein lies the pitfall mentioned above. Three rather obvious answers to this question present themselves:

1. The DP/MIS people should do it, because they are trained problem-solvers and know about computers.

2. The user departments should do it, because they know what their needs are better than anyone else;

3. A committee should be formed with representation from both departments, to get the benefit of both 1 and 2.

The project initiators seldom pick answer number three; everyone knows that committees never get anything done. My purpose is to show that number three is indeed the best choice.

Experience Speaks

Several years ago, I directed the planning and implementation of a computer graphics project for the Metropolitan Government of Nashville and Davidson County, Tennessee. I was associated with Data Processing. Although it was our desire to involve the users in every phase of the project, to ensure that their needs were being met, we went a little too fast for them in the selection of a system output device.

This is what happened: Having established that we needed computer graphics to cope with a number of problems - lack of drafting personnel because of Metro's wage scales, lack of a geocoding framework for traffic accident reporting, lack of certain kinds of planning maps - we wrote a functional system specification in terms of what we knew about systems available at the time. When it came to the output device, we reasoned as follows: While pen plotters come closest to reproducing the then-current graphics products of the various Metro departments, they are counter-technology devices, in two senses: The development direction of all computer technology is toward less mechanical motion and more compact means of storage. Pen plotters are complex mechanical devices, and they would tend to produce more large sheets of paper and mylar than were being produced manually.

We, therefore, decided that a graphical computer-output microfilm (COM) unit would be the best choice of output device. COM units have few moving parts, and have as their output small, inexpensive pieces of film, that are produced two to three orders of magnitude more quickly than pen plots. We knew that the engineers were used to microfilm, as all their drawings were archived on 35 mm aperture cards. So - we bought a graphical COM unit, and no pen plotter. We also purchased an aperture card "blow-back" unit, to provide us with occasional paper copies.

A few months after the system was installed and working satisfactorily, we added a pen plotter. Why? Not being mapmakers, we had neglected to take into account the need for accurately-scaled large hard-copy output; nor had we properly communicated to the mapmaking users the limitations of the COM output subsystem.

Another municipal computer graphics geo-data system was being implemented at about the same time, in another southeastern city. A consortium of users from different public and private organizations overcame tremendous political and organizational obstacles, and was well on its way to producing a system specification, when an objection was raised by the drafting manager of one of the participating organizations. He insisted that the system output device had to be capable of plotting on linen (an outmoded drafting medium, even at that time), no matter what else it was to do. No amount of arguing or reasoning swayed him, and plans were changed to include a device - a large flat-bed pen plotter - that could plot on linen. And a question was left in the minds of all observers as to whether the organization whose drafting manager had insisted on linen-plotting capabilities had any idea of the function and potential capabilities of a computer graphics geo-data system, which they were helping to finance.

A couple of years later, I was principal consultant for a similar type of project for the City of Milwaukee. Once again, the project was being initiated by a department other than the ultimate user department; this time, it was the Community Development Department, with the cooperation of the Central Electronic Data Services group. We worked with the Department of Public Works (DPW) to produce a functional system specification, doing most of the design work ourselves, but checking with DPW from time to time. At a point when we thought we had a complete understanding of the user's needs - the system design was virtually complete - we had a meeting with the City Engineer. The system was to contain all the City's quarter-section maps; we were going to resolve "edge-matching" discrepancies on input. We proudly told the City Engineer how all the maps would thenceforth fit perfectly together along their boundaries. "Forget that!" was his somewhat-less-than-pleased response. He then told us how many functions (including engineering and assessment tasks) depended on the measurements of the maps just as they were, with their inaccuracies. He also pointed out that the current referencing schemes worked, inelegant as they might seem to us. We beat a hasty retreat, regrouped, and returned to assure him that the existing inaccuracies would be preserved in the computerized system.

The Solution

None of the three situations described above turned out poorly, in the long run. However, in each there was an element of unproductive activity - "wheel-spinning" - that could have been avoided, had the proper approach to the implementation process been taken. In Nashville, in spite of everyone's good intentions, the fact that the project initiative and leadership were in the data processing department led to an improper system specification. In the other southeastern city, control by an unenlightened user led to a distorted system specification. Total failure of the Milwaukee project was narrowly averted through a barely-adequate system of project designer/user communication. All three problems were caused by the user not having been properly educated by the computer people - a result of the computer people being so involved with the technology that they did not see that proper attention was not being given to implementation details.

Through these and other experiences, I have come to some simple conclusions regarding the implementation of computer graphics geo-data systems in municipalities. I have formulated them as guidelines, below, that tend to compensate for the razzle-dazzle effect of the technology on the technicians and the innocent users.

1. Project control should not be entirely in the hands of the DP/MIS group. With the best of intentions, this group will tend to be prejudiced by technological considerations, and will tend to overlook user department needs, through ignorance of the actual nature of user activities.

2. Project control should not be entirely in the hands of the user department. The users' ignorance of computer and computer graphics technology make it very difficult for them to appreciate the full potential of automation as applied to their activities.

3. A small committee - having at most, say, five members - should be formed, with roughly equal representation from the users' departments and the DP/MIS group. This committee should be charged with producing a system design. The system design should be as detailed and formal as possible, with heavy management participation and "signed-off" documents at the end of each design phase. The design process should begin with the users educating the DP/MIS people regarding their needs, and should proceed with the computer group educating the users in applicable aspects of computer technology. Only after the educational phase should an initial system design be attempted.

   Provision should be made for the design process to be iterative. That is, at each stage of its development, the design should be submitted to a review cycle that includes both user and DP/MIS management. The final design should be agreed upon and accepted by all parties at a meeting of top-level management, to insure proper initial support for the project.

If the recommended process seems cumbersome, remember that it has evolved as the result of experience. Before attempting short-cuts in the interests of saving time, remember, "There's never time to do it right, but there's always time to do it over!" is a saying that has come into currency because of the human tendency to want to finish things as quickly as possible, often with no regard for long-term consequences. I'll risk a homily: "An ounce of prevention is worth a pound of cure."

There is no formula that can guarantee the success of any project - because formulas must be followed in order to work, and people are not always totally dependable followers. However, my experiences since I adopted these guidelines have borne out their usefulness. I trust that they will be useful to you, the reader, as well.