INDUSTRY TRENDS FOR PC BASED GIS

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Commission II, Working Group 2

KEYWORDS: Geomatics / GIS, Technology, Development, Computer, Data, Hardware, Software, Training, Project

ABSTRACT

Never before has the advanced technology sector enjoyed a higher profile in society's view than what has be witnessed this year. The hype of Windows 95, the excitement over the Internet, the reduction in component costs, the increase in system performance and the steady interest in Geographic Information Systems (GIS) technologies are but some of the elements that are fueling the continued application of high technology to solving operational spatial information problems. However, the GIS industry must be knowledgeable relative to these advancements in order to provide solutions to their clients that are state-of-the-art. This paper will describe the hardware and software improvements that are impacting the implementation of PC GIS. The paper will start with a description of the major elements driving the technological development of the PC. Next, the impacts of these developments on GIS will be described. Then, the GIS project impacts from the introductory information collection and familiarization; to the examination of the software, hardware, data and training requirements will be presented. Finally, details on key PC technologies to watch for in implementing a successful PC based GIS project will be given.

1. Desktop Technology

The introduction of Microsoft's Windows 95, which offers enhanced connectivity, improved performance and dramatic changes to the user interface, will have a tremendous effect on all computer users world wide. Windows 95 boasts dramatic improvements to the Graphical User Interface (GUI), which promises to significantly ease the interaction between users and their computers. In addition, the connectivity features of Windows 95 provides a seamless integration of the PC to peripherals, local networks and on-line communications.

Windows 95 is a large 32-bit, multi-tasking operating system. The additional demands on conventional memory configurations starts with the installation of Windows 95 and continues with the anticipated 32-bit application software that users are expected to run in order to maximize the performance of their hardware investment. Users can expect 32 bit GIS application programs to take up to 25 to 50 percent more memory than their 16-bit counterparts.

The demands of a large operating system, large application programs and large data sets, combined with high throughput demands are focusing attention on mass storage devices and high speed busses. Many developments in disk storage technology are now making previously unthinkable applications possible on PC's.

Also, during the past few years, the Internet has exploded onto the computer scene as a topic of international interest. What used to be a computer network reserved for a select few scientists, government workers, and educational institutions has become available to corporations - large and small - and even institutional users. As the Internet opened up to commercial and private accounts, people who heard about the great resources available on the Internet discovered that there are many potential GIS applications of the Internet.

2. Implementing Desktop GIS

With the introduction of low cost, user friendly PC based GIS, the interest in using GIS technology in government and industry has continued to increase over the past years. Many potential GIS users are concluding that PC GIS systems are not only a cost effective method of introducing GIS into their agencies, but once implemented, they can also provide a practical migration path to more complex systems.

Probably the least cost approach with the greatest room for migration to a higher performance system is to start with a Windows 95 based IBM compatible Personal Computer (PC). Due to the vast market for these types of computers, the cost of the basic computer, the peripherals and the system software is relatively quite low. Also due to the performance and networking enhancements that are occurring, there is now not a clear performance distinction between high-end PCs and low-end UNIX based workstations.

A desktop GIS was often a scaled-down version of the more powerful workstation-based systems, but now this is not necessarily the case. PC based systems often provided all the functions, or even if the desktop version was an unabridged one, the amount of data involved was normally reduced. Desk-top mapping systems are special types of desktop GIS, which are getting more popular these days because of their low cost and ease in use. Desk-top mapping systems do not provide the full capability of data input and spatial analysis, but are very good learning tools and provide excellent support for data retrieval and thematic mapping.

A unique feature of desktop GIS is that they are much cheaper, in the order of about one-quarter of the cost of full-fledged workstation versions. Therefore the cost of choosing the wrong system is much reduced, and the user has more freedom to "evaluate" different software before choosing the final product. Moreover, some of the vendors provide demonstration copies either free of charge or at very attractive prices. It is also easier to borrow a system from the existing users for "test driving" because these systems are often easier to use and the total system is more portable. For example, lap-top versions of them can be carried around very easily.

3. Desktop GIS Requirements

The decision to implement a desktop GIS is not necessarily an obvious conclusion to a series of judgment issues. As with any business decision, the migration to or the implementation of desktop GIS can be an unnecessarily expensive proposition if a well thought out plan has not been developed. Some of the issues that should be examined in the development of the plan should include the following questions:

- What is the purpose of implementing desktop GIS?
- Is the organization prepared to commit the necessary human, financial and management resources?
- Is the organization stable enough at this time?
- Is there sufficient staff to undergo GIS training?
- Is there a complete inventory of existing hardware, software, networks and peripherals?
- Has a user needs study been done to determine requirements?
- Has the issue of system administration, configuration and security been investigated?
- How is the desktop GIS to be technically supported?
- Has a pilot project been done and evaluated?
- Have technical leaders been identified?

4. Desktop GIS Project Elements

The development cycle of GIS is quite well-known. It starts with the definition of the internal requirements, the evaluation of systems that could perform the job, the procurement of the system, its customization, and its daily maintenance. The development cycle of desktop GIS is not very different from the classic model, except that the depth and breadth that one would pursue in each stage of the cycle would be somewhat reduced because of the smaller size of the system involved.

The lifecycle of a GIS, as with most other computer based developments, has a number of steps or stages. Most often the major steps are the following:

- information collection and planning
- system implementation
    - hardware procurement
    - software procurement
    - data procurement
    - training
    - application development
- test and evaluate
- system operation and maintenance

These steps are the most common broad order of implementing any GIS. Desktop GIS development is often not complex and so it is unlikely that a project would deviate much from these steps in the order given.

This paper describes only briefly the task of system evaluation. This applies to the hardware system, the software system and the GIS system. Each of these elements should be evaluated against a predetermined criteria that should be developed by the project leader. Criteria for system evaluation may be found in the current literature and will not be elaborated on here. The remainder of this paper will now describe each implementation step in more detail. Since most of the elements required for a desktop GIS may be purchased off the shelf, the assumption that the project will do the minimum amount of custom development will be made for the following sections.

4.1 Information Collection and Planning

One of the first things that anyone contemplating the development of a GIS project must do is to familiarize themselves with the technology and the benefits. This includes assessing the project requirements to see if GIS is the solution. In most requirements where there is a spatial data component, it is hard to make a case where GIS would not be useful. Most often the costs of a desktop GIS are such a small investment that the cost benefit outweighs any disadvantages.

The project leader, if he is not familiar with the technology must review the literature and any text books available on the subject. He should attend several GIS conferences, exhibits and read the recent trade magazines to come up to speed with the latest technology and applications. Another thing that he should do is to take several generic GIS training courses, such as the ones given by academic institutions or the GIS Division of Geomatics Canada. These generic courses will give a non-biased view of the technology that would not be available from a course given by a GIS vendor.

Some potential users requiring larger GIS configuration would go to lengths to study the technology during the planning stage of the development cycle. One example involves a study lasting years resulting in a specification spanning volumes of documentation. A desktop GIS buyer would have no need for this kind of thoroughness because the cost of these studies would far exceed the cost of the desktop GIS itself. However, the spirit of acquiring appropriate knowledge about the GIS technology before jumping into it remains the same.

Fortunately, potential desktop GIS users have more freedom in trying out various alternatives.

Finally, once the project leader is satisfied with his level of knowledge, he should then prepare a project plan. This plan must include costs, schedules, benefits and resource requirements. Once approved this plan should be adhered to as closely as possible. It should be noted that the development of this plan must not be taken lightly and that it is a key element to the success of the project.

4.2 System Implementation

The next stage of the project is to procure the elements required to implement the desktop GIS project. These elements are not that much different from other computer systems. The major elements of system implementation are: hardware, software, data and training procurement plus any custom application development that may be required. Each of these elements will now be explained in more detail.

4.2.1 Desktop GIS Hardware Procurement

The required hardware elements of a desktop GIS are the processing unit, the display unit, the data storage unit, the input devices and the output devices. The following table summarizes the principle hardware components, the device description and the primary function of the device.

Component	Description	Function
Processing Unit	IBM compatible PC	software execution
Display	CRT	User viewing
Storage Devices	Hard disk	software & data storage
	CD-ROM	software & data input
	Tape unit	backup
Input Devices	Digitizer	manual map data input
	Scanner	automatic raster (image) data input
Output Devices	Laser Printer	text & line and image graphics output
	Dot Matrix Printer	text & line and image graphics output
	Pen Plotter	line graphics output
	Ink jet printer	text & line and image graphics output

In addition to the selection of the type of equipment required, the project leader must also make decisions regarding the quality of the product, the amount of memory required, the reliability, the maintainability and the cost of consumables.

4.2.2 Desktop GIS Software Procurement

The software required for desktop GISs is available from commercial suppliers. There are generally more combinations and more factors involved in hardware selection than software, mainly because the software for desktop GIS is very modular. In particular, the main software components required are: system, application, development and miscellaneous. A description of each of these software elements is included in the following table.

Component	Description	Function
System Software	Operating System	Hardware and software control
	User Interface	Human interaction and system control
	Network	Communication with other systems
Application Software	GIS	Spatial data input, manipulation and output
	Database	Spatial data storage
	Personal productivity	Word processing, Spreadsheets
Development Software	Programming Tools	Custom application development
Miscellaneous	Device drivers	Peripheral device control

As with the purchase of hardware, the project leader must make decisions on the selection of software based not only on functionality, but also on the vendor, the software reliability, help line availability and support.

4.2.3 Desktop GIS Data Procurement

Perhaps one of the most neglected and misunderstood elements of any GIS system development are the data requirements. Often data procurement and manipulation will account for over half of the total system costs. As GIS technology matures, the costs of data and the costs of data input are decreasing. Many data providers are now able to provide spatial data in digital form. In addition, there are many data conversion companies who can now convert hardcopy material to digital form in a cost effective manner.

The typical major data components of a desktop GIS are summarized in the following table.

Component	Description	Function
Base data	Topographic data	Accurate spatial data to which all other data is referenced.
Thematic data	(Application specific - i.e.: climate, census, forestry, economic)	Spatial information geocoded to the base reference data.
Attribute data	Textual information linked to the base and thematic spatial	Data queries, analysis, modeling and reporting.

	data.	
Image data	Satellite or airborne acquired images	georeferenced to the base data for visual inspection and quality control.

When the project leader is acquiring data for the project, the data should be assessed for factors such as quality, cost, coverage, availability, information content, accessibility and product format. There are many sources of spatial data and there are several catalogues of data holdings.

4.2.4 Training

One of the often overlooked elements of a successful GIS implementation is the training. As mentioned, the project leader should receive general GIS training from a non-commercial organization. This should provide the project leader with an unbiased overview of the methodology and implementation of GIS. However, once the decision has been made on hardware, software and data, then vendor specific training must be taken.

It is important also to evaluate the training available from the vendor when selecting the hardware, software and data. Some criteria for the evaluation of training packages include: cost, schedule, content, workbook/text and availability. Most vendors have an array of courses available for selection.

4.2.5 Application Development

In most cases the products that are on the market today have sufficient capability to perform most of the functions required by the system in an easy to use manner. However, there are cases where some customization is required. These may be for functions that are not available, the function is clumsy to use or a special database schema is required for the application.

There are basically three approaches provided by a software vendor to extend the functionality of its software. One way is to provide a macro language, which is a procedural language that incorporates the normal commands that are used to operate the GIS. Another method is to provide a suite of callable object subroutine libraries that could be used to invoke the operations of a GIS. This method, unlike the first one, requires the use of a programming language compatible to the callable subroutines. A third method is to incorporate the GIS commands (normal or macro) in a programming language. The hybrid programming codes generated must first be processed by a pre-compiler supplied by the vendor to convert the GIS commands to subroutine calls.

In most cases the project leader of a desktop GIS project is an application specialist such as a forester, environmentalist or geologist. Most are not GIS specialists or computer programmers. In order to effect the modifications it is often most expedient to contract for custom program development to a competent company. If the system is being developed as a pilot project for a potentially larger system, then it is essential that a GIS consultant be contacted. This consultant may be able to provide a long term vision for the project.

5. Summary

It is clear that the computerization of geo-processing tasks will continue into the foreseeable future. With the announcement of Windows-95, the computer revolution is continuing to grow in momentum. The performance gap between PCs and Unix workstations is basically non-existent and users will need to make their system decisions based on price, reliability, upgradeability and so on. With the advent of a widely used 32-bit operating system for PCs, very sophisticated GIS applications can be developed.

The desktop GIS project manager will have potentially more decisions to make in the future, but these decisions should be easier to make and the technology should provide a more cost effective and robust solution. This ever improving technology will advance the way people use computers and will ease the development of novel desktop GIS applications.

6. Bibliography

Plunkett, Gordon and Lee, Y.C.; Factors in the Development of a Desktop GIS; Proceedings of The Canadian Conference on Geomatics, June 1995, Ottawa.

Gunston, Mike; Geographic Information Systems: A Buyers Guide; ISBN 0 11 330606 7; CCTA, London, 1993.