SPATIAL DATA MANAGEMENT: TOPIC OVERVIEW

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Summary

Unlike other papers in this theme that deal with Geographic Information Systems (GIS), this paper does not discuss the scientific or technological aspects associated with spatial data. Instead, it focuses on a variety of important management issues that need to be taken into account if spatial data are to be efficiently and effectively employed. While it is now a comparatively easy task to purchase GIS software and obtain data for a particular application, it is much more difficult to design, build and manage a major long-term GIS project either within an organisation or, just as commonly now, within a state, provincial or national jurisdiction. In such cases, sound project management principles and practices must be adhered to if projects are to be successfully delivered on time, within budget and to the specifications provided. While it is generally accepted that in the 1970s and 1980s only approximately 50% of all GIS projects were successfully completed, those days have passed and it is now expected that all GIS proposals will succeed. Therefore, this overview chapter focuses upon management issues that are now considered critical to the establishment of successful GIS, these being: GIS design and implementation; GIS-related standards; spatial data quality; legal issues; and the role of GIS in society. Each of these topics contains a host of topics that modern GIS managers need to be aware of and to correctly deal with when they arise.

1. Introduction

The spatial data management issues discussed in this paper are of a type that would not normally be encountered in other scientific fields, such as remote sensing or global positioning systems. The reason for this distinction is that GIS do not simply involve the purchase of a software package and data, coupled with rapid manipulation and analysis of a dataset to achieve the desired outcome. Instead, GIS implementation tasks

are often undertaken on a large-scale and need to be considered in the same management terms as other major information system design and development projects. In fact, GIS may take several years to complete and considerable human and financial resources to fully implement in order to meet the expectations made of them. Furthermore, they often involve re-engineering of organisational practices and policies as well as retraining and redeployment of personnel. Along the way, there will be many issues to consider such as the proper design, development and maintenance of the system; adherence to standards; assessing and achieving the quality expected of both the data inputs and information outputs of the system; legal issues that may arise such as copyright, privacy and liability; and finally both the positive and negative impacts that a GIS can have upon the society which it serves. Accordingly, this paper summarises the considerations that must be taken into account in order for spatial data to be effectively managed by organisations in the long-term. For details on related issues, see *Advanced Geographic Information Systems.*

2. GIS Project Planning and Implementation

In the early years of GIS in the 1970s and 80s, it could be said that project personnel were generally driven more by the urgent need to digitise large numbers of maps and to get the technology working, than they were by sound management practices. However, the lack of proper GIS project management invariably led to system failures which are now acknowledged to be as high as 50%. In other words, while most systems satisfactorily started life in their organisations and produced some early products, within one or two years over half of them would no longer be operational. From the author's experience, this meant they were often simply 'switched off'. There were a host of reasons for this such as a lack of continued funding, the lack of personnel who were prepared to spend time out from their usual careers to embrace GIS, and a lack of faith in GIS by the intended user community who could not obtain the products they needed. Of course, nowadays a GIS manager would lose his/her job if the system failed to live up to its specifications and requirements, and as such there is no doubt that the secret to the high rate of success of current GIS is that sound project planning and implementation practices are being employed.

At first glance, GIS implementation would seem to be the same as for any other information technology implementation project (and this is true to a large degree), but additional questions arise such how are the map and attribute data obtained and how can we ensure that the maps and data will be accurate, up-to-date and easy to obtain? These questions are not usually asked by users of other software products such as word processing packages or spreadsheets which users purchase, install and learn to use with relative ease. Instead, the demands placed upon GIS by users are far more open-ended, and the analyses and products that will be created from them are rarely known to the software designers and vendors who sell them. However, when GIS are successfully implemented in organisations they enable non-expert users to be more productive and responsive in their everyday tasks without necessarily adding more complexity or excessive costs to their tasks. In effect, successful GIS implementation establishes within an institution a system of data, software and hardware, people and procedures which become an integral part of the business activities of the organisation, regardless of whether it lies in the private or public sector.

Accordingly, GIS implementation consists of the following generic phases:

- gaining management support;
- strategic planning;
- implementation planning;
- system design; and
- system management.

To begin with there must be a need for GIS within an organisation to either overcome current productivity problems or to be able to do things that currently cannot be done. However, while these needs might be recognised by lower and middle management personnel there is no doubt that senior management must also be convinced of the need for GIS. For instance, in one case the author was assisting a water utility to design and implement a GIS and the greatest supporter of the proposed GIS was the chief executive officer. His reason for wanting a GIS was clear—in a mailout of almost 20,000 accounts to customers, the organisation was inundated with telephone calls from irate consumers who were angry that their bills contained wrong information. The reason was that the old paper map base which had been used in calculating the rural water supply accounts was seriously out of date, and the general manager was extremely embarrassed to find that over 20% of accounts were in error. Furthermore, it was costing him additional money to correct these errors and to re-issue correct customer accounts, so there was no doubt in the manager's mind that not only would GIS (which he knew something about already) reduce the cost of bad record keeping, but also greatly improve the reputations of his organisation and its personnel.

With management support in hand, the next step is to determine exactly what requirements are to be made of the GIS. Often the author has been asked by agencies wishing to establish GIS 'What is the best GIS to buy?", but in fact this is the wrong question to ask since it ignores the need to understand exactly what the GIS must be able to do. Instead, good strategic planning is required to analyse how staff in the organisation carry out their daily tasks, and what role spatial data plays in their decision making. When that is known, the next matters to be considered are how the spatial information products are required to be presented, to which user groups and at what frequencies. For, each of these products a list of input data sets and GIS functions needed to produce them can be made. These lists will subsequently be vital for deciding priorities in future data collection efforts, as well as identifying which GIS functions are essential to produce the highest priority products. So, in essence, identification of the requirements of a GIS is a top-down task which will eventually lead to specifying the requirements that the GIS must be able to meet.

In most GIS implementation projects it is unlikely to be simply a matter of purchasing a software product off-the-shelf. Instead, system specifications developed during the requirements analysis will form the basis of the information provided to external organisations who are requested to tender to supply and develop the system. The cost of this task can vary from a few tens of thousands of dollars to many millions of dollars, but regardless of cost the tender procedure generally remains the same. Some tender documents will only request the supply of software and hardware, while others will include the cost of data acquisition, database design, application development, training

and on-going maintenance contracts to keep databases up-to-date.

The calling for tenders to supply a GIS-based solution to meet an organisation's needs follows a pattern that is detailed elsewhere in this section, however should be stated here that it is important to be fair and impartial, and to follow due process at all stages. Usually, a short list of suppliers is made on the basis of their responses and these will be subsequently called upon to undergo comparative testing or benchmarking to determine which proposed solution best suits the organisation's needs. Benchmarking can take many forms but it should never be abused, as happened once to the author's knowledge when five shortlisted tenderers were each asked to digitise 10,000 land parcels and to provide them with basic attributes as supplied from the hardcopy information held by the organisation acquiring the GIS. In fact, the organisation had a total of 50,000 land parcels in its jurisdiction and thought it would effectively acquire a parcel database at no cost by getting the shortlisted suppliers to digitise the whole 50,000 parcels at their own cost. This fact was discovered and word quickly moved throughout the local GIS community of the unethical nature of what the acquiring organisation was trying to do. Instead, benchmark tasks must be equal for all suppliers and should be sufficient to enable them to demonstrate that their proposed GIS solution can actually do what they promise of it.

Sometimes tenderers will have a much greater role in the project and it is not uncommon for them to be also be required to undertake the system design and implementation process, especially if the necessary expertise does reside within the client organisation. In some cases, particularly where an organisation is unfamiliar with GIS, the system design could take many months to finalise as the needs of different groups within the organisations are carefully considered. Certainly, there will be some groups who are fully committed to GIS and wish to use it as quickly as possible, but often there will be others who are not so convinced of its effectiveness for their tasks. This is quite normal and each group will have different needs and expectations. In any case, once the initial software, hardware and data are obtained and formed into a usable GIS the most important 'advertisement' for the GIS will be the creation of the initial maps and reports using the new system. This need for early outputs cannot be overstated as a means of helping to demonstrate the usefulness of GIS, and also to reassure senior managers that the decision to implement the GIS was a wise and rational decision.

So there are many aspects to successful GIS planning and implementation. The paper *GIS Project Planning and Implementation* discusses in detail many more important considerations that need to be made in this important subject.

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Biographical Sketch

Gary J. Hunter came to academia in 1988 after 17 years in industry, and his experience includes engineering construction, cadastral and topographic mapping projects in Australia, Indonesia and Papua New Guinea. In 1990 he was the first lecturer appointed in Geographic Information Systems at the University of Melbourne, and is now an Associate Professor and Reader in the Department of Geomatics. In 1994 he gained his PhD from the University of Melbourne on the subject of managing uncertainty in spatial databases. He is a regional/section editor of "Transactions in GIS" and the "URISA Journal", and also serves on the editorial boards of the "International Journal of Geographical Information Science" and "GeoInformatica". In 1996 he served as President of the Australasian Urban and Regional Information Systems Association (AURISA), and was appointed a Life Member of AURISA in 1999.