Introduction of GIS - A Strategic Decision

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ABSTRACT

The introduction of a Geographic Information System requires various aspects of consideration. Although in many cases technical criteria may be fulfilled, GIS projects fail because their objectives had not been clearly defined or were non-existent. GIS is generally a decision making tool. Various forms of information are coupled together for the purpose of providing a wide range of efficient analyses.
To make a GIS introduction a success, the goals of the organisation must be analysed. From these results, the objectives of all concerned departmental levels are derived. This process leads to the requirements of the system to be introduced. Furthermore the business and work processes must be analysed as they relate to the GIS application. This process requires a broad acceptance by all end users and top management. This acceptance is the most important precondition for a successful project. This paper will discuss the combination of strategic and technical aspects for the successful introduction of a Geographic Information System.

KURZFASSUNG

Die Einführung eines Geografischen Informationssystems hat nach unterschiedlichen Gesichtspunkten zu erfolgen. Obwohl vielfach technische Kriterien erfüllt werden, scheitern GIS Projekte, da ihre Ziele nicht klar definiert wurden oder gar nicht existieren. GIS ist ein Werkzeug zur Entscheidungsfindung. Unterschiedliche Arten von Informationen werden für weitreichende und umfassende Analysen zusammengefaßt.
Um eine GIS Einführung erfolgreich durchzuführen, müssen die Ziele der Organisation analysiert werden. Aus diesen werden die Ziele der untergeordneten Bereiche abgeleitet, woraus auf die Anforderungen an das GIS geschlossen wird. Darüber hinaus müssen Geschäfts- und Arbeitsprozesse mit ihrem räumlichen Bezug in die Evaluation mit einbezogen werden. Dies erfordert eine Akzeptanz auf breiter Ebene vom Endanwender bis zum Top-Management. Diese Akzeptanz ist die wichtigste Voraussetzung für den Erfolg. Im folgenden wird die Kombination strategischer und technischer Aspekte für eine erfolgreiche GIS-Einführung besprochen.

1. INTRODUCTION

Geographic Information Systems (GIS) have been commercially availably since the early eighties. They originated as systems primarily used for the documentation and cartographic representation of spatially related information especially related to surveying, cadastral and utility applications. The decision to introduce a GIS in an organisation was founded by the demand for the automation of manual workflows. The initiative was taken by EDP departments which were capable of handling large software systems.

Once a GIS was introduced to application departments, the initiative was transferred to people which possessed a wide knowledge in the usage of GIS. This was supported by great improvements in hardware and software technology where the availability of relational data base management systems has played an immense role.

Now in the information technology age, the possibilities of GIS are immensely expanding due to the accessibility of various diversified data sources found in many distributed locations. This has resulted in transforming a GIS from a documentation tool into a decision making tool. The management of medium and larger size organisations are able to use GIS for monitoring and advancing their strategic and organisational objectives.

Still many GIS projects fail. Very often the involved people do not really understand why. In most cases it was mistakably believed , that it was the fault of the software manufacturer for not providing the necessary tools. The truth is they fail because of many reasons. These reasons are not necessarily on the side of the software vendor. This paper discusses these reasons and shows ways to overcome problems.

2. WHY DO GIS PROJECTS OFTEN FAIL?

For an organisation intending to introduce a GIS, there are five different layers of experience, which should be clearly distinguished:

1. The organisation's top management
2. The proposed project management level
3. Personnel involved at the GIS level
4. The system environment both at the hardware level and the system administration level
5. Proposed system implementation

The level of know-how and experience within these five categories are rather diverse from organisation to organisation according to a company's structure, history and area of responsibility.

The top management is typically unaware of the impact of introducing a new information technology. The strategic potential possibilities are often underestimated. Through lack of communication between top management and the project team it is often the case that the final objectives of a system are not clearly understood. Top management must be prepared to backup the project management team with full support, including all necessary human and financial resources. Failure to recognise this fact will certainly force lower level managers to make decisions which exceed their level of expertise or responsibility. There is also the danger of creating a certain degree of antagonism between other departments which are more or less uninterested in GIS technology.

The project management team often underestimates the time and effort as well as the necessary human resources at the project start. The potential of conflicts is considered a major problem and normally overlooked. If a conflict arises, such as a conflict concerning part of the data model, there is a lack of experience concerning the solution to the problem. Project managers are normally not trained to handle such problems. Lastly, project managers are normally not able to create an inter-departmental co-operation during the initial stages of a GIS into an organisation as a whole.

The personnel involved at the GIS level are in fact the users. The first task for the users of a new system is to learn it's capabilities. When a GIS is first introduced, it's users are often new employees to the organisation or employees transferred from other departments with little or no training in GIS. These users typically have no idea concerning such issues as data modelling, data distribution, data interaction or inter-departmental co-operation. Once a system has been introduced there are often problems related to the acceptance by one department's users due to a dependency created by another department.

At system environment level, the existing hardware and software components are often not considered from an overall point of view. Existing system administrative requirements may not be adequate and commercial databases may be neglected. Only a vague overview may be understood at this level.

The proposed system implementation shows a gap in the knowledge of the feasibilities and possibilities of a modern GIS. Often benchmarks are not undertaken but rather brochures are studied. Project teams consider only maps and graphics with respect to cartographic aspects rather than analysing future business and work processes. Very seldom the present work processes are not analysed, and missing the know-how of performing a system definition.

Due to these reasons many GIS projects fail. The costs are immense and in end all involved parties are frustrated.

One solution to overcome these problems is to create a detailed procedure for outlining the steps involved in introducing a GIS. The introduction of GIS is unique in so far as the investment is high and the duration of time between the initial prototype to production until the first usage is very long. Therefore it should be defined as a strategic project, where the management is not only involved, it should even be guided by the management. Conflict management has to be provided as a tool.

3. OBJECTIVE ORIENTED INTRODUCTION OF GIS

When starting a GIS project it is most important to define the objectives. At the top of a target pyramid, there are the strategic targets of the organisation. From these strategic targets the objectives of each department's requirements should be derived. This may take place in form of brainstorming and written requirement specifications. All results must be classified and organised. From these results the targets of end - users of applications can be derived. This will be the criteria for the requirements of the system. Figure 1 shows an example for deriving targets, subtargets and requirements.

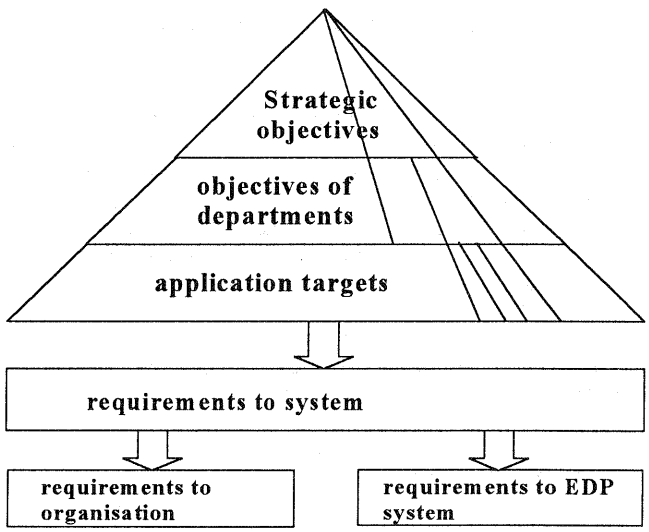

Figure 1: Deriving requirements from objectives

As an example, a strategic target may be an attractive industrial location. A subobjective might be the increase of competition and better use of diversification potential or more competent decisions. These result in the requirement to shorten the work process and make use of historic data. This suggests the system must support integrated data and a sophisticated

human interface in order to model the workflow process and it must support time in the GIS to analyse historic data. If some 5 to 20 strategic targets are identified and each strategic target identifies several subtopics, hundreds of scenarios will enter into the requirements.

The advantage of this procedure is to offer top management personnel a global perspective as to the magnitude of the problem. With this information they should be able to 'weed out' the essential requirements from the 'nice to have' functionality. By concentrating on essential requirements tends to lead a 'prototype' implementation into production much earlier by eliminating a natural human focus on details.

4. STRATEGIC ASPECTS

Strategic aspects are the most important dimension concerning a GIS implementation. Only they guarantee the success. They help to overcome principle weaknesses in the present organisation (Born, 1994). A high benefit can be reached since the objectives of the organisation are understood and the necessary restructuring can be performed in a better and elegant way. The costs of investments and current costs are reduced and conflicts between management and the departments are minimised. In addition the motivation of the employees will be increased.

Once a GIS has been introduced, it is important to benchmark a prototype to be sure all strategic targets are functional. This is generally performed by analysing existing workflow patterns compared with those resulting from the usage of the system. A preliminary cost/benefit analysis should be arranged.

5. WORK PROCESSES

The use of work processes within GIS have not yet become a matter of course today, although in commercial areas there exist quasi-standards. In GIS, systems are generally compatible for data exchange. This is due to the reason that in GIS most developments are individual and the technical processes are more complicated than with commercial processes. The notion of adapting their work processes to standardised procedures is somehow strange to technicians. To define requirements under the consideration of changing an organisational structure, existing work processes are analysed by using the methods of Structured Analysis (SA) or Structured Analysis and Design Techniques (SADT) (Raasch, 1991). On an interview by interview basis, work processes are investigated as they relate to the data exchange between administrative and technical departments. The work process is subdivided into various components consisting of terminators, storages and data flow as shown in figure 2. Following this, the optimisation towards the final process occurs, trying to minimise the number of methods within the organisation and avoiding redundant processes. This leads to a considerable acceleration of data flow and reduces the number of stops with the parties involved. The availability of GIS functionality and along with the notion of distributed data, the decision competence of the experts will be increased. The existing structure of the organisation can be reduced (lean management). The work processes are performed in GIS using modern human interfaces. The experts work with their familiar application and technical terms. The usage of GIS or operating system specific terminology can be hidden from the user.

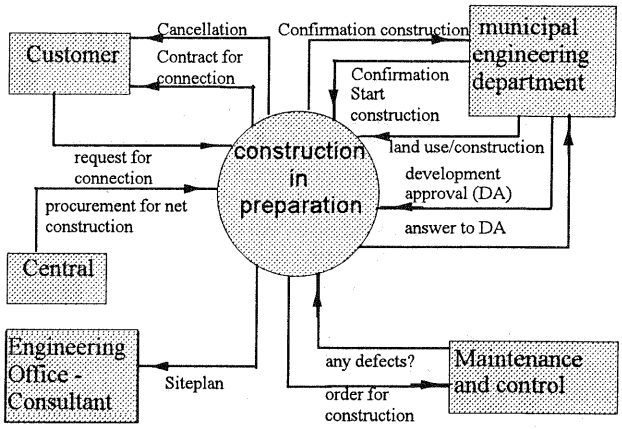

Figure 2: context diagram of a work process of an electric house connection

By performing these criteria for the selection of a GIS and considering the required applications accordingly, the presence of a GIS within the work place will be acceptable. GIS will become not only a tool in itself but also an important tool for human use and for the improvement of the work place. It can provide a highly motivated and efficient working group with attempts to optimise the economics of managing spatially related data administration.

6. TECHNICAL REQUIREMENTS

GIS requirements are rather individual to each organisation and are covered differently by the systems available in the market. This should be considered during evaluation process. By deriving requirements from objectives, one gets a clearer perspective for the GIS (Steidler, 1994). In this context it is not necessary and is also counter-productive to ask for more functionality.

At this point it makes sense to concentrate on the technical aspects which are directly related to the defined objectives. The advantage of this procedure is to be able to build up a benchmark which can meet the objectives in a reasonable amount of time and to provide a cost benefit analysis. The strengths and weaknesses of any system versus the realisation of objectives are analysed at this level. This process may or may not be an iterative one according to the vendor's understanding of the objectives. This avoids the needs of developing a 'super monolithic' system which cannot work.

6.1 Requirements for a GIS

The requirements for a GIS are structured due to their diversity (Gause, Weinberg 1993). They have to be evaluated on a product specific basis. The following list may be used as an example:

- Hardware and software environment including interfaces
- application spectrum
- user interface
- data integrity
- functionality of GIS
- integration within an existing environment
- extendibility

It is a fact that the individual requirements of the organisation are decisive for the judgement of any particular choice of the system.

The requirements of the user can be described with:

- easy use of the software
- adequate user interface
- usage in relation to various applications
- optimised work process considering the components human, work process, EDP

These points are driven largely by the human interface. An easy understandable graphical user interface (GUI) with simple dialogues and masks make usage simple. Regulations for input and output and functionality for error detection during parameter input increase not only the comfort but also help the user to increase reliability. The GUI only presents items which are relevant for current task. Typically a sophisticated GUI guides the user through a work flow in a controlled manner such that these is nearly no possibility of error. Vendor provided GUIs should be viewed as such that they represent a proposed GUI with additional tools to provide customised GUIs.

A GIS consists of so many diverse applications, that no vendor can provide a complete 'CAD' style turnkey approach. Each special application requires an extended GUI. Therefore tools to extend the system are imperative.

GIS as an optimal tool for management requires a large number of analysis functions and the overall inclusion of different type of data. The data exchange between different systems becomes more and more important. The following points should to be considered in this context:

- analysis of spatial, attribute and time data
- integration of digital terrain models (2 or 2 ½ D)
- integration of remotely sensed data
- integration of digital photogrammetric data
- inclusion of GPS
- meta databases for overview and exchange of existing data
- common data models for storage and the presentation of topography and schematics

6.2 Killer criteria

The criteria of truth for reaching the objectives of a GIS application is the user. Therefore the requirements for methods to develop new software strategies have to be elaborated by reaching the targets of the users.

Today, available GIS applications (starter kits) normally are not process oriented. There are almost no planning and maintenance modules available in the market. The applications are dominated by simple database dialogues for creation, modification, and deletion of data sets and simple routines for generating graphical elements (areas, lines, points, symbols etc.). Compared with commercial applications this would indicate that instead of a program for billing or notices of non-payment only the bill- and customer database is available in combination with database tools.

To develop an application, which is acceptable to the end user, so-called killer criteria have to be examined. These are mandatory system requirements which must be fulfilled as a precondition for the preselection process of selecting a system (e.g. Gauss-Krüger coordinates, seamless data integration, Client-server aspects etc.).

The next step consists of the adjustment of the so-called frame conditions. This relates to the compatibility with existing EDP, 'operating systems', supported data bases, interfaces and data integrity.

The last step is the definition of the application spectrum and the functionality of the GIS. An essential point of view is the availability of existing applications (data and representation models as well as human guidance).

7. Conclusion

In order to make the introduction of GIS successful, we recommend a detailed organised definition of targets. The top management should be heavily involved in the evaluation process and the communication with the project team should be very close. This leads not only to an overall accepted project, but also a desire to reach strategic goals. Business and work processes become shorter and more optimised. The organisational structures become lean, work places and working times become more attractive. The experts competence and qualification will be increased.

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