GIS PROJECT MANAGEMENT

MSc Thesis

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ABSTRACT

Recent studies concerning GIS show that it is the fastest growing segment (both hard & software) of the graphical computer market. 70% of private organizations expect to use GIS as a strategic tool within their company.

Like a product, GIS in an organization has a life cycle. According to the model of Nolan this life cycle starts with awareness and ends when full integration with other information systems is achieved. Until recently project management for GIS projects was mainly about projects which were considered to be experimental. The requirements for such projects differ from the requirements for projects which are strategic for a company. Strategic GIS projects require a project manager with thorough understanding of issues such as: planning, knowledge of the objectives of the project, project environment and politics.
There is little experience with such GIS projects. However the question " How to manage a GIS project effectively" has to be answered for strategically positioned GIS projects to be succesfull.

It is important for project managers to understand the relationship between the position of GIS in an organisation (Nolan Model) in relationship to the importance of GIS for the organisation (Mc Farlan). The way a GIS project should be handled depends, to a large extend, on these two positionings.
A combination of IT methodologies such as Structured Analysis and Design, project management methodologies such as PRINCE and Hewlett-Packards Customer Project Life Cycle 2 combined with best practices are proposed in order to provide a framework, for project managers, to handle GIS projects which are considered strategic for the organisation. This framework, based on prior experience and through evaluation of a complex GIS project has been shown, in some respects, to work.

There is still some uncertainty since there is little experience in the market with strategic GIS projects so there are not a lot of "best practices" to learn from and to further evaluate the proposed approach available.

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DISCLAIMER

The results presented in this thesis are based on my own research in the Department of Regional Economics of the Free University of Amsterdam. All assistance received from other individuals and organizations has been acknowledged and full reference is made to all published and unpublished sources used.

This thesis has not been submitted previously for a degree at any Institution.

Lieren, April 1997

J.G.A. Bestebreurtje

INTRODUCTION

In the last decade computer systems which can handle large amounts of “Geographic Information” have become sufficiently powerful and inexpensive to be used on a wide scale. Currently even personal computers are well suited to be used in GIS environments. The field of Geographical or Spatial data is very wide and GIS systems can be used for many different purposes.

Some of the more important fields of application are:

- Land & Property Systems;
- Environmental Management;
- Socioeconomic Analyzis;
- Telecommunications;
- Health.

More and more data are becoming available in a digital format. Investments in the field of data communication are huge and enable the transfer of large amounts of data all over the world.

Internet's and Intra net's are increasing the availability of information for large parts of society. And these developments change the way organizations think and act.

Well designed GIS systems will enable quick and easy access to these large volumes of data and enable organization to use them to gather information either for their own benefit or for the public benefit in order to:

- Provide services;
- Increase competitiveness
- Provide information.

According to Littlejohn (1996), the GIS market is growing at 18-30% per year.

Many organizations nowadays recognize that geographic information can serve as an important resource. A successfully implemented GIS can also enable the "non" GIS population to be more effective without increasing the complexity of their work.

GIS however is a complex information technology which requires a lot of planning in order to have a successful implementation. There is a lack of experience in large GIS project design and implementation and many questions have to be considered when performing a GIS project

some of these are:

- What are the mission, vision and objectives of the project?
- What has to be achieved by means of this project;
- How do I build such a GIS system?
- What are the experiences (best practices) in this field?

This thesis is about the project management aspects of GIS and the way to handle this complexity from a project managers point of view. This is accomplished by providing some theoretical background, a practical approach towards a GIS project and a case study of a complex GIS environment.

Objectives of the thesis

The objectives of the thesis are:

- To examine the life cycle of GIS projects;
- To explain the importance of the model of McFarlan and the position of GIS in this model;
- To look at some methodologies which are useful in GIS projects in relation to the GIS life cycle;

- To clarify if there is a difference between project management in general and project management in GIS projects;
- To describe the practical implications for approaching and handling a GIS project;
- To examine an actual case and compare this with the approach put forward in this thesis.

Problem Statement

The problem which this thesis addresses is:

How to manage a GIS project effectively?

At several places in the thesis the following question will be addressed: *"Is there a difference between a "state of the art" IS project and a GIS project"* in order to clarify if GIS project management differs from IT-project management in general.

Scope of this thesis

This thesis deals primarily with the "how" question of GIS project management. What are the generic processes and tools which are available? Which methodologies are useful? What are the consequences of the GIS project life cycle and what are the roles and responsibilities of a GIS project manager.

The "what" questions, dealing with specific processes, tools, architectures, the advantages or disadvantages of certain software packages are not part of this thesis.

Also this thesis will not provide a methodology for all GIS projects. It will present only one way to handle a GIS project and share best practices. As DeMarco and Lister (1987) : "Methodologies provide unification and prevent common mistakes but training, tools and the exchange of "best practices" are just as important".

Document Overview

This document overview clarifies the structure of this Master Thesis and the outlines of the chapters that are included.

The *Abstract* contains the main elements, my findings and arguments. The *Introduction* provides information on the changes that are currently happening in the GIS environment and that have influence on the way GIS project management is handled. Furthermore the objectives, scope and the problem statement are part of the *Introduction*.

Chapter 1-4 are the core of this document. They each cover an important element necessary for GIS project management. Two main aspects are covered in every chapter:

- Principles: The theory provided on the element;
- Findings:The reality related to this element. These findings are partly from literature and partly a distillation of my own experience.

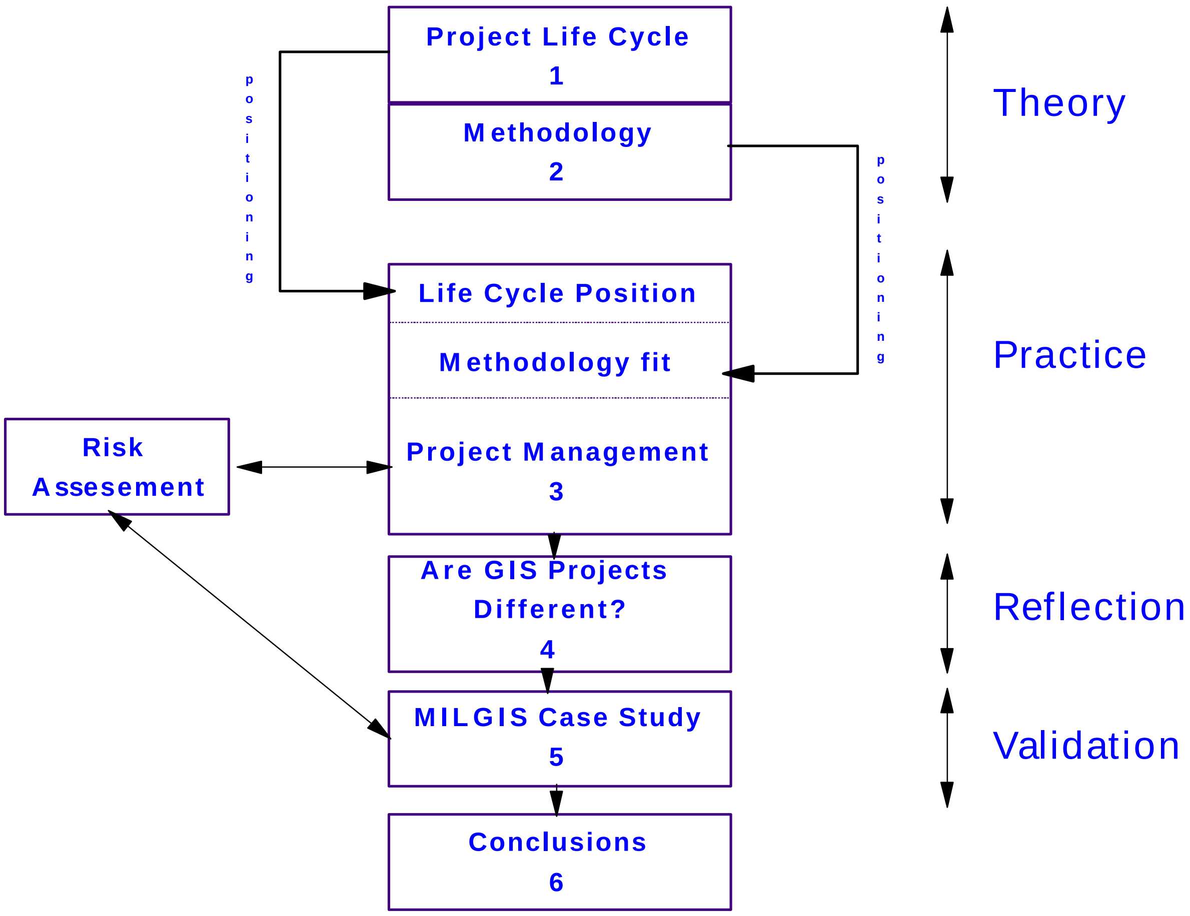
At the beginning of each chapter is a small introduction which clarifies the relationship of the particular chapter in the light of the overall problem, the sequence of the arguments and the specific contributions I have made.

Chapter 5 is a case study of an actual project called MILGIS. It consist of a secondary analysis of documents and project plans on the MILGIS project and interviews conducted with several people involved. The findings are compared with the proposed GIS project management approach developed in chapter 3. Reasons why the MILGIS project deviated from the proposed project approach are noticed and discussed.

In *chapter 6* conclusions are drawn and the developments made from the findings in this thesis are described.

The structure of the Thesis is also be represented graphically (figure 1):

Figure 1: Structure of Thesis



In the Thesis the assumption is made that the GIS project to be managed is either strategic or mission critical. As the graphic representation shows the theoretical chapters are necessary to understand the position in the life-cycle of the project and also to determine which methodology is the most appropriate.

1 PROJECT LIFE CYCLE

1.1. Introduction

GIS projects fail because they are not conducted in the right manner. Running out of planned budget, not being ready on time, not providing the expected functionality are the symptoms of failure. KPMG has a lot of experience with complex IT projects and in one of there recent publications they make the following statement on this subject:

"In the past few years the nature of IT project changed from establishing efficiency improvement to support and renewal of processes, products and culture" (Roelofs et al, 1996).

The management of a GIS project has to be aware of changing project requirements and take account of two principle factors:

- The importance of understanding the GIS life cycle(this chapter);
- The methodology which is appropriate (the next chapter).

1.1.1 Product life cycle

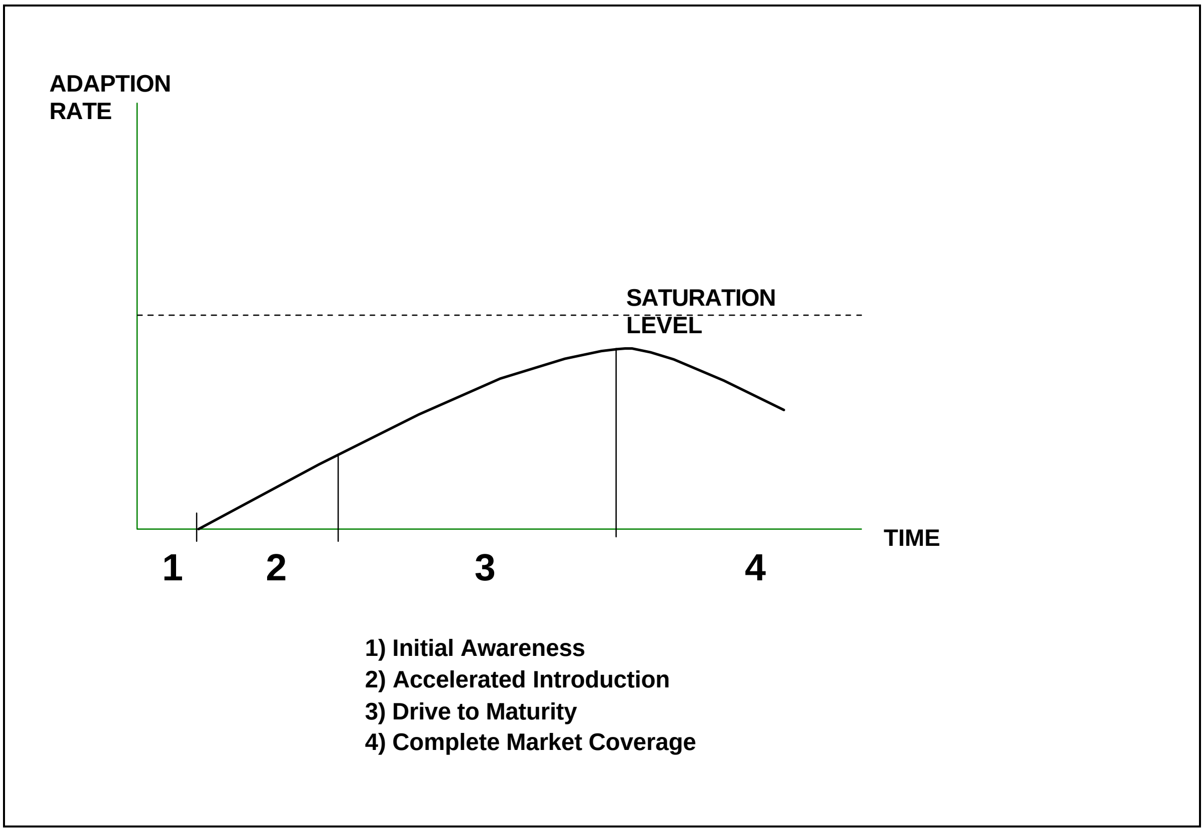
"There is a time for every season under heaven, a time to be born .... a time to die"

The life cycle of an information project is always the same. Initial awareness is the start of every life cycle, maturity the end. The difficult part is to find out which position GIS has at a particular point in time in a particular organization.

Though there is much literature on the life cycle principle there is only very limited information on the influence of the life cycle position of GIS in an organization and the way a GIS project consequently should be handled. Based on the limited experience of the author in the GIS field and his broader experience with project management within Hewlett-Packard the relationship between the life cycle position and the way to handle the GIS project is discussed in this chapter.

One model of a life cycle of a product is that of Nolan (Davis and Olsen, 1987) (Figure 2)

Figure 2: Nolan's Model of the Life Cycle



The life of a product starts after being developed by initial awareness. Customers become aware of the existence of the product mostly because of marketing activities. After this awareness there is a period of accelerated growth and the products reaches it's maturity phase. The maximum penetration in the market will be reached and finally there will be replacements or more modern products become available and a process of deterioration will start.

For a company, it is of importance to be aware of the life cycle of their products. Research and development should be in line with the life cycle enabling a company to introduce new or improved products before the maximum market coverage is reached. The total life cycle differs considerably between products. A Boeing 747 has a life cycle of several decades whereas a personal (486) computer's life cycle is less then one year. For this reason the time to develop a new plane is considerably longer than to the time to develop a new PC.

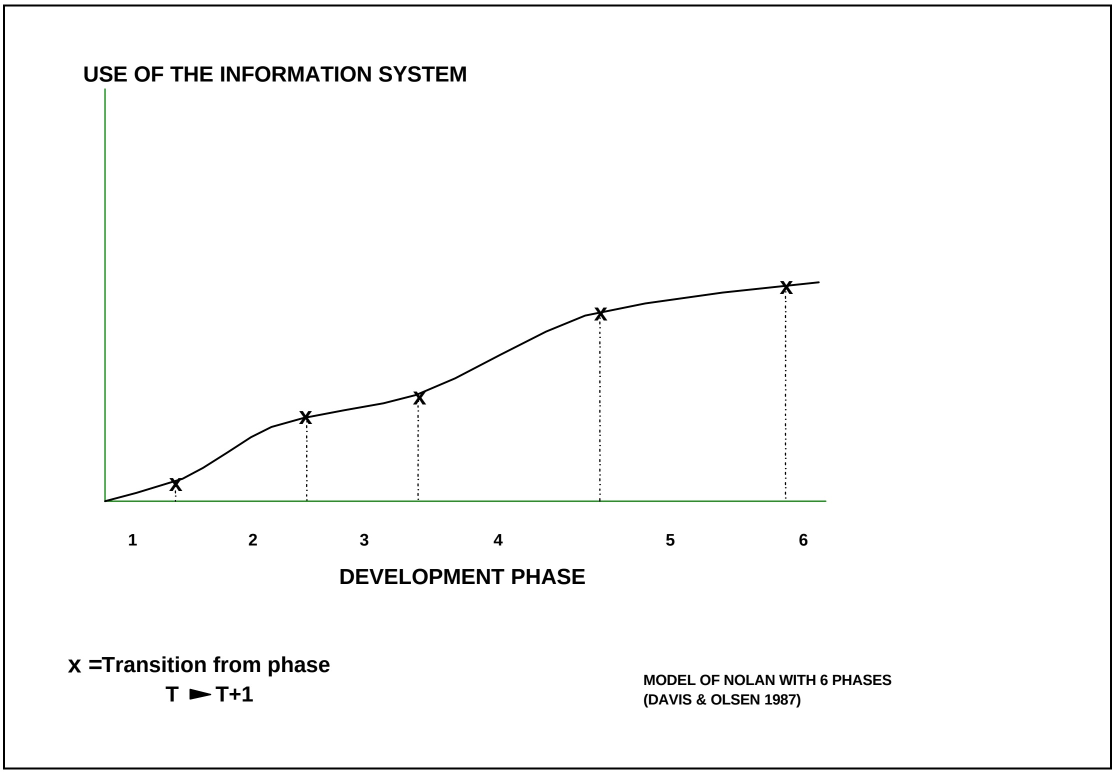
To put this into a different perspective; a delay of 6 months due to wrong engineering of a plane is probably acceptable. For a PC producer this will be the differences between success and failure as the competion has had enough time to overtake it's position.

1.1.2 Life Cycle of an IT system/IT project.

IT systems have a life cycle similar to products. For this reason the development of any IT systems is limited in time. It is, of course, important to know what this model looks like since this describes the period of time available to develop and build a system.

The model of Nolan has been developed by Davis and Ohlsen (1987) into a six phase model (Figure 3):

Figure 3: Model of Nolan for Projects



1	Start	A small group of people are using thesystem, limited and decentralized control,minimum planning.
2	Diffusion	More experimenting, more acceptance, number of users increases.
3	Management	Organizational steps are taken to ensure possibilities for intensified use and cost control.
4	Integration	The information system is integrated in the organization.
5	Data Orientation	Integration with other information systems in the organization.
6	Maturity	System is fully integrated and successfully fulfills expected tasks.

This 6 phase model is applicable to GIS as well. It is a good way to determine the position of GIS in an organization. Depending on the position in the model the demands during a GIS project will differ. This issue will be examined more fully when looking at the strategic position of a GIS project later in this chapter. It is important to understand that it is impossible to skip a phase in project planning since neither the organization nor the people in the organization are able to do this. The experiences of every previous phase are needed to step into the next phase.

For example in the beginning of the 1980’s the first word processors were introduced. The word processor in it’s initial stage had only very few users and little organization and doing away with these first word processors would not have caused a great disturbance. The word processor was in it start or initial phase. A company which decided that word processors was the way to go and which got rid of all typewriters would have problems such as:

{ No procedures in place (word processors are different from typewriters);

{ High training costs of secretaries;

{ Extremely high costs of equipment, not commonly available;

{ No internal acceptance.

1.1.3 Strategic position of a Geographic Information System in the Organization.

A recent Dutch study " Gis, noodzaak of luxe? " (Grothe et al. 1994) looking at the the position of GIS in 2500 private organizations in 1993 showed the following results:

Organization	Use of GIS
{ Utility companies;	67%
{ Trade and retail companies;	47%
{ Transport and communication;	58%
{ Financial services;	60%
{ Business services.	44%
{ Utility companies;	67%

The position of GIS systems in these organizations is as follows:

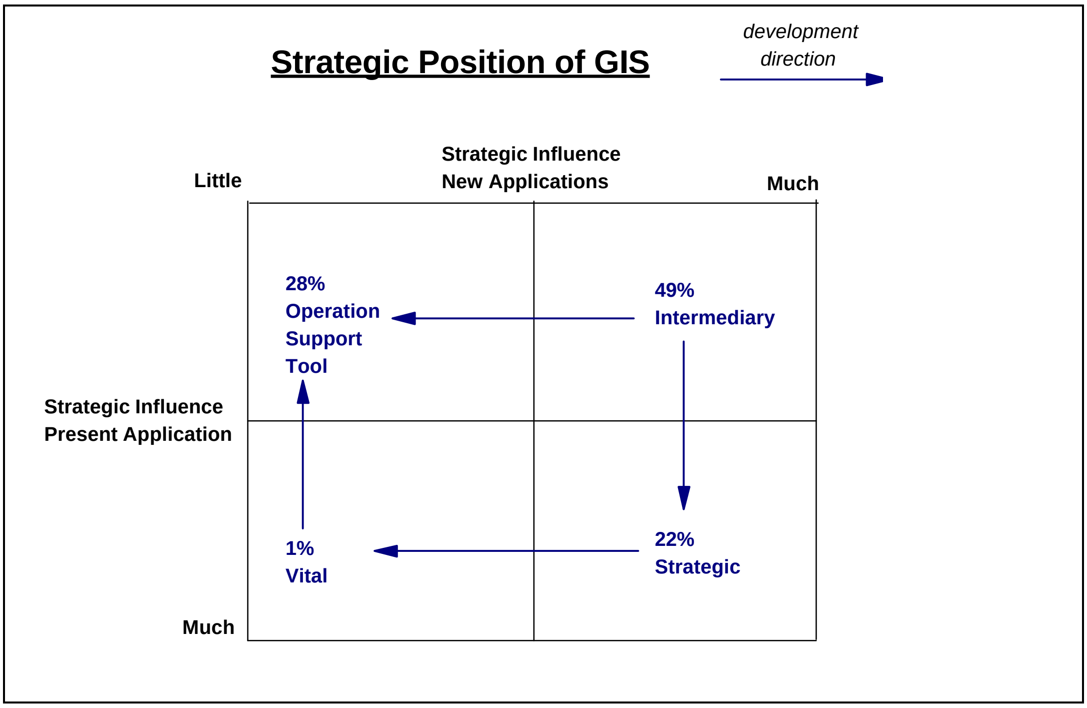
Use of GIS			
52%	11%	16%	21%
Startup	Diffusion	Management	Integration

The results show that about half of all GIS systems in the surveyedcompanies are in a startup phase. 11% are used more frequently by a larger group of users. In 16% of cases the GIS has become so important that measures are being taken in the organizational and financial field to control investments. Finally 21% of all GIS systems are fully integrated into the organization. The last two phases Data-orientation and Maturity out of the Nolan model were no part of this survey nor was a distinction made between the types of organisations and the use of GIS in the different phases. Grothe et al (1994) explains this in the following way: The 4 phase growth model was modified into a 6 phase model due to the fact that, through rapid technology changes the stadium of maturity will never be reached. It is even hard to reach the phase of integration. After a technological renewal a new lifecycle starts. The survey looks at GIS in a general sence and defines GIS as “an automated information system that can handle spatial data, including thematic mapping, automated mapping and facility management type systems”. The way organisations use GIS in different phases was no part of the survey.

In general the importance of the GIS to the organisation is less if the GIS is in a startup phase compared to the integration phase. Management will in pay more attention and give more support to systems which are in a management or integration stage because their relative importance for the company is much greater.

An other way to look at GIS in an organization is according to the model of McFarlan and McKenney (1983) which describes the strategic position of applications. Grothe et al. (1993) examined the position of the GIS according to this model (Figure 4).

Figure 4: Strategic Position of GIS, Mc Farlan and McKenney Model



New GIS applications are first tested and are considered to be in the intermediary or experimental fase. From this point on two things can happen; either the application is considered to be strategic and might even move on to become a vital application for the organization. The other possibility is that the application becomes an operation support tool without strategic or vital value.

The same applies of course to GIS applications which are in use. If such an application is either strategic or vital the influence of the application is considerable. The amount of attention from higher levels of management for strategic or vital applications is larger than the amount of attention a operation support tool will get.

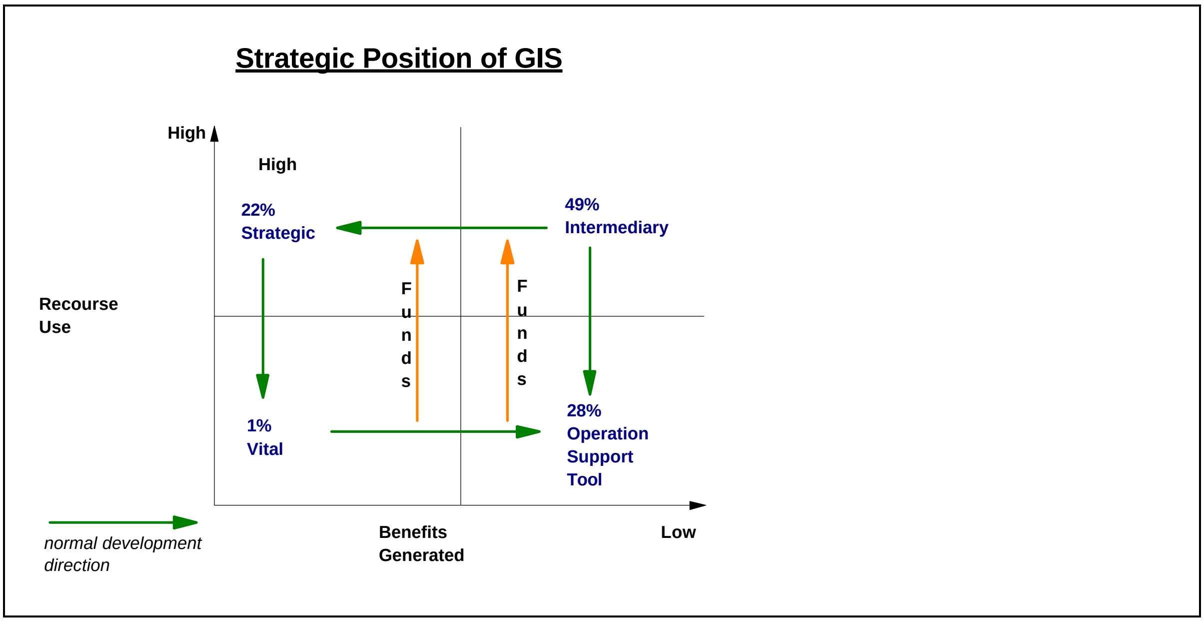
It's important to realize that the position in the above model determines the importance of the GIS for the organization. Companies are willing put a lot of effort (resources & money) into applications (projects) which have a strategic or vital position. Consequently there are always strict time-constrains in such projects. A project realizing an intermediary or experimental application will not have the same kind of resources and constraints.

Intermediary applications can become strategic when they are successful or will never be used or will become an operation support tool, which is bound to disappear in case they do not have the potential to move into the strategic stage. A basic description of the stages is:

Stage	**Description**
Support	GIS is usable for support on a operational level, there is no strategic influence of GIS.
Strategic	GIS is essential for strategic purposes at present. This influence will either diminish as GIS becomes a *Support* tool or will increase if it becomes *Vital*.
Intermediary	GIS is a *Support* tool at present but there is the expectation that it might become *Strategic*.
Vital	GIS is essential for the organization at presence and in the near future.

An other way to look at the model is as shown in Figure 5 follows:

Figure 5: Strategic Position of GIS and the effect of funding



It's important to look at the flow of the funds in this model. Most funds to develop new applications are granted either to replace systems which have become operation support tools. There are also funds available to add to vital applications. It's not common to invest a lot in operation support tools, this money is often used to invest in intermediary tools which either replace or add to the environment. There is also a tendency to invest a lot in strategic applications which might become vital applications in time.

Though it goes beyond the scope of this chapter it is important to notice that the demands on the IT system being developed vary in every quadrant. Neglecting this fact will lead to project failure since every quadrant has it's own demands.

Vital systems are often also called mission critical and have very strict demands concerning support in case of problems. Sometimes there is even demand for a standby system which can become operational immediately after a system failure. This aspect has to be taken into account during the design. The same demand is very unlikely if the system is intermediary or experimental. A recent KPMG study (Roelofs et al, 1996) relates 4 types of IT projects to the Nolan curve:

Type of Project	Position in the Nolan Curve
1 - IT as a tool	Start/Diffusion
2 - IT as a management instrument	Management
3 - IT as an improvement instrument	Integration
4 - IT as a strategic weapon	Data Orientation/Maturity

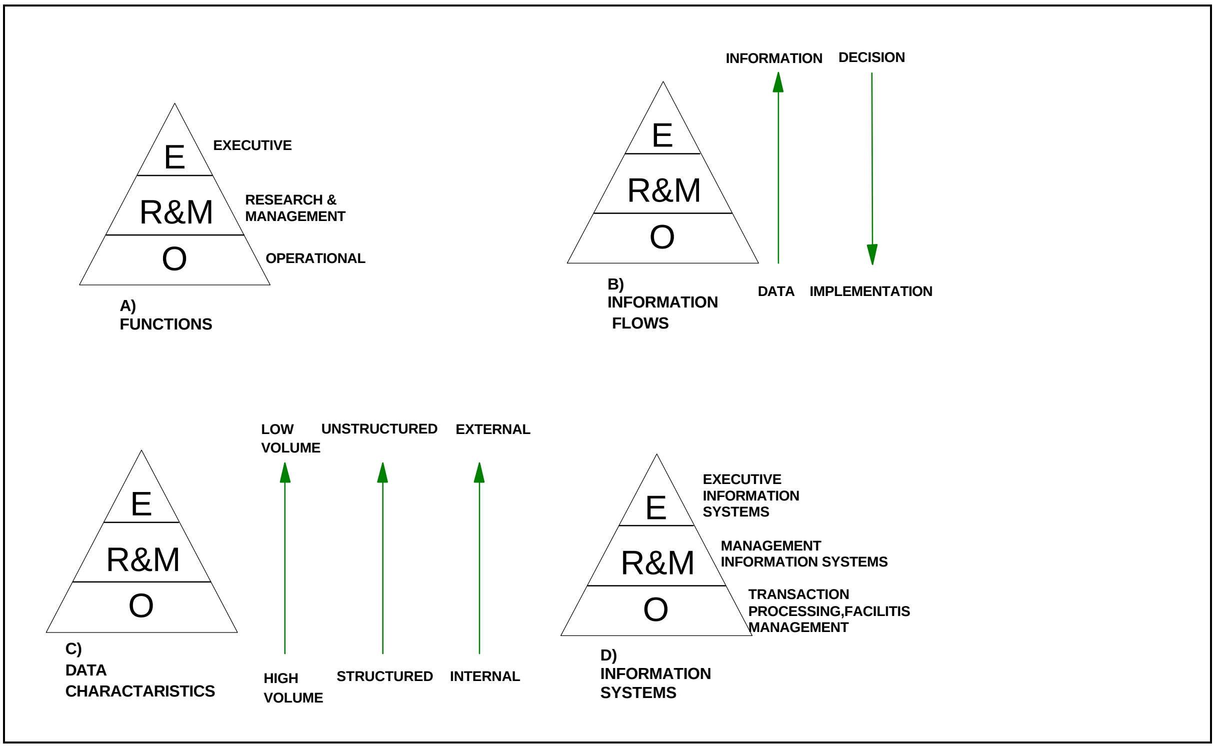
A type 4 project is far more complex than a type 1 project and requires a different way of project management. A type 1 project could be the installation and configuration of a Mapping system non automated processes. A type 4 project would link to the strategic goals of the organization and require a high level of involvement of senior management. Type 4 projects are complex and have, due to their complexity a high failure risk. Furthermore they are usually very costly. One result of the survey "GIS, noodzaak of luxe?" (Grothe et al.,1994) was that GIS will have a strategic function in an increasing number of companies. GIS will become embedded in the MIS (Management Information System) of companies..

In this thesis the author concentrates on these strategic (type 4) projects these are the kind of GIS projects which are demanded by the customers. As the study of Grothe et al (1994) shows 49% of GIS applications are in the intermediary quadrant the logical development direction is into the strategic quadrant. In the past years many intermediar GIS projects have been accomplished the experience with the, far more complex demands, strategic GIS projects is far more limited.

1.1.4 Information Needs

An other way to look at information systems by looking at information needs in relation to the position where they will be implemented in the organization. To do this "triangle diagrams" which represent the different levels in the organization are used (Figure 6). These diagrams do not represent organizational structures they focus on the information need which varies depending on the functions.

Figure 6: Information Needs in Organizations



(Source: Reeve and Cornelius, 1993, p 38)

Figure a. shows the different levels in an organization, Executive, Research & Management, Operational.

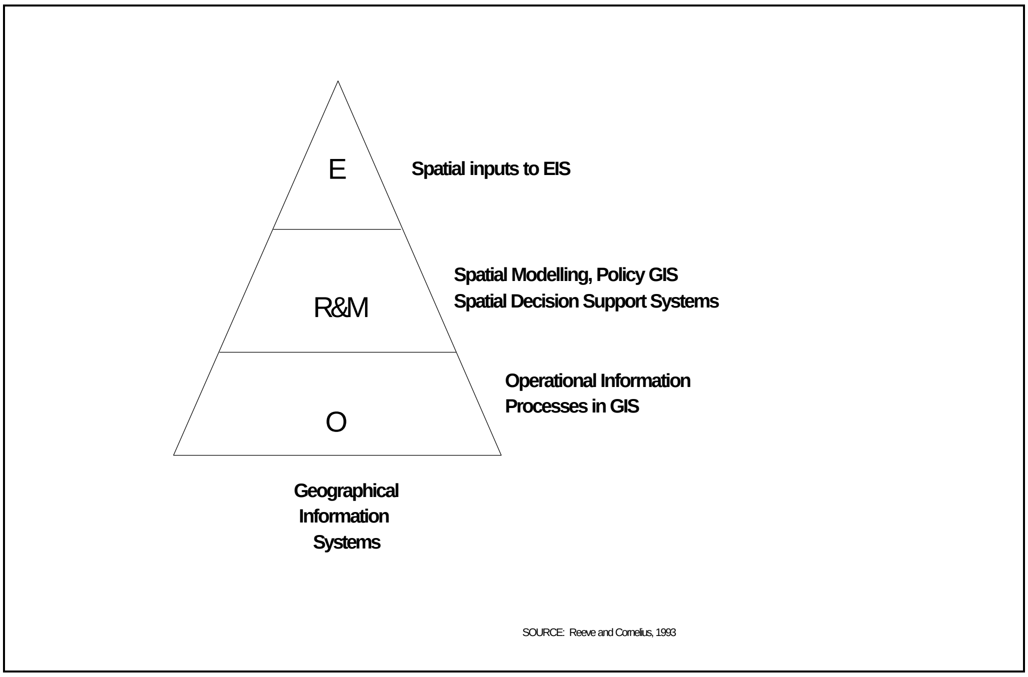
Figure b. shows that on an operational level there is a need for data and implementation whereas at the executive level there is a need for decision and information.

In <u>figure c.</u> the characteristics of the data involved are low volume, unstructured and external at the executive level and the opposite at the operational level.

Finally <u>figure d.</u> looks at the kind of information systems needed at the different levels ranging from executive information systems for the top executives to transaction processing at the operational level.

The information triangle translated to a GIS environment is represented in Figure 7:

Figure 7: Information Triangle for GIS



Depending on the position in the triangle the demands on the GIS will be different. However it is important to realize that many information systems cover large parts of the triangle and have to fulfill the needs of all levels involved.

In order to develop an appropriate information system a thorough investigation must be undertaken based on the mission of the organization, on analysis of the information needs at every level and on the translation of all of this into an information strategy and an information architecture.

1.2. Summary

Understanding the theoretical principles of the life cycle of an (G)IS in an organization is of importance when enrolling in a GIS project. The position of GIS on the 6 phases model of Nolan determines largely the available funds, demands on the project and the management attention for the project. A Dutch study (Grothe et al, 1994) shows that within private organizations 70% of the respondents use or expect to use GIS as an strategic tool.

This implies that GIS projects linked to the business goals of the organization will receive a lot of attention. Every organization ought to have fundamental business objectives which lead to a vision and mission. These can be translated into a Business/Function strategy. The IS and IT strategies have to be in line with the Business/Function strategy and, in today's business climate, information technology must deliver tangible results that support the overall business strategy and goals.

For a GIS project manager it is important to understand the business strategy in relation to the GIS project which is conducted and he must be able to answer the next important question: *How does my project support the organizations vision and how does it help to achieve it's business goals?*

Once the position of GIS in the organization is clear it is important to handle the project in a structured way. A project manager has to "build" his project organization keeping this in mind. In order to have a successful project it must be:

- On schedule;
- Within budget;
- Of good quality;
- Complete;
- Accepted by the customer.

Choosing an appropriate methodology to do these things is critical in accomplishing this difficult task.. In the next chapter methodologies for GIS projects are discussed.

2 METHODOLOGIES

2.1. Introduction

Clients experience project failure due to:

- Inadequate definition of requirements;
- Changing requirements;
- Unrealistic time scale;
- Underestimating project costs;
- Incorrect choice of supplier.

(Source: Input, 1994)

Although project managers are usually intelligent people different project managers make the same mistakes over and over again. IT projects are getting more complex due to business management and technological developments. A standard framework or methodology describing the way to perform the project management tasks diminishes at least the chance of “common” mistakes.

GIS is in the context of particular interest because:

- It is a new technology and there is relatively little experience of implementing it;
- It is not well understood;
- It has some particular characteristics which affects the choice of methodology.

In the literature on GIS there is only limited reference to the use of methodologies in GIS projects. As described in chapter 1, GIS is moving from the experimental phase in the life cycle to the strategic position. The demands on GIS projects and GIS project managers are changing accordingly and a structured project approach is becoming more important.

In this chapter (and the next chapters) the author focuses on GIS projects which are strategic of vital and are complex in the sense that several departments are involved.
To determine which methodology to use for such GIS projects is not easy. It could even be a question of how to adapt the "best available" methodology.
Based on literature studies and Rapid Application Development experiences within Hewlett Packard the author discusses the use of methodologies for GIS projects. Based on the characteristics of GIS projects which are strategic a recommendation which methodology to use is made. Finally these recommendations are tested by reference to a specific extensive GIS project in which the author was involved.

2.2. General

A methodology is a standard framework describing the way a certain task, in this case project management, can be handled. A project management methodology can be used as a foundation for doing projects and it describes all the steps which have to be taken. in a project. Also the way things can be handled, methods are described. Methods are either descriptive or normative.

- Descriptive = describing reality
- Normative = explaining how reality should look

Whether a descriptive or a normative method is appropriate depends on the situation, the kind of problem, the kind of users involved and the development environment.
For this reason it makes a lot of sense to proceed on the basis of a work strategy which at least describes the objectives and provides an argument about the choice of methods since: *"Strategies are general approaches for achieving an objective; methods are the detailed means for doing it"*. (Davis and Olsen, 1987)

Along with methods come techniques and tools. Techniques determine for which specific problems which solutions can be used and which tools are available. Schematically the sequence is shown in Figure 8:

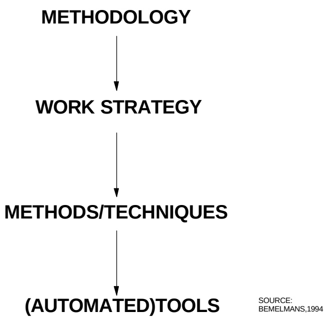


Figure 8: Methodology Sequence

Building a GIS is a complex task. It involves both technical issues such as databases, appropriate hard & software and non-technical issues such as involvement and acceptance. A project manager has to take all issues into account. The idea that there is a methodology, a solution or for that matter a single GIS package on the market which fits all GIS projects is a grave mistake as is the idea that every project needs a customized package and experiences from previous projects would not be valuable.

Huxhold and Levinghson (1995) consider that the best ways for a GIS project to fail once the vision has been established is:

- By comparing various commercial products and decide which one is the “best”;
- To assume that most commercial products are so similar that a comparison of capabilities is not necessary and select one based upon price, popularity or some other factor.

In order to avoid such failure there is a need for a structured analyses of the specific organizational, technical and environmental issues involved and a assessment of products and systems in the light of this. Methodologies are available to help with this difficult task.

2.3. Information System Development Methodologies

There is a wide variety of methodologies available. Reeve and Cornelius (1993) discuss the ones described in figure 9:

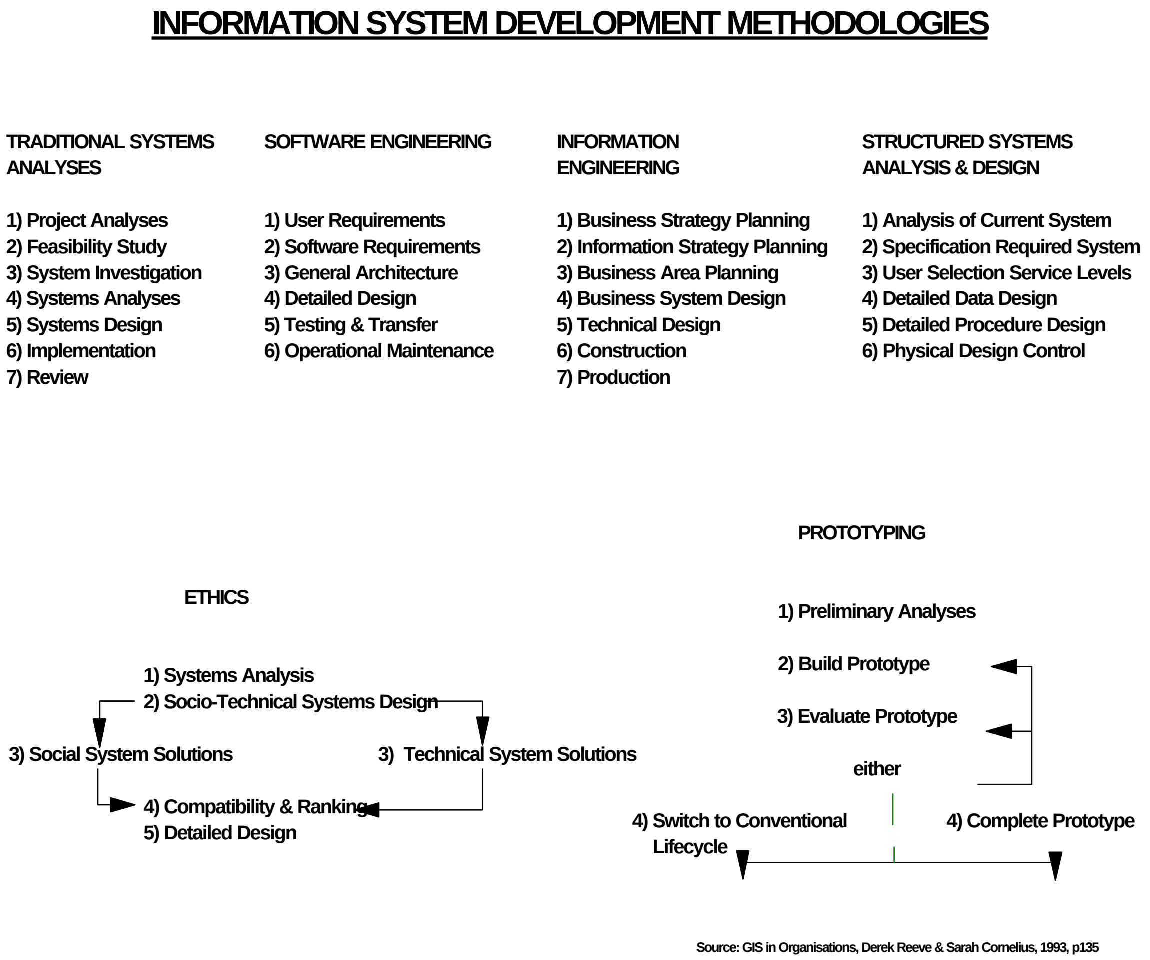


Figure 9: Methodologies

These are only a few of the methods which are available. Which one is the best to use is difficult to answer. It is a question of the kind of project,of the preferences of the organization in which the project is taking place and, of course, of personal preferences.

It is however important to understand the relation between the designer and the method as shown in figure10.

THE QUALITY OF AN INFORMATION SYSTEM

RELATION BETWEEN DESIGNER AND METHOD

		QUALITY OF THE METHOD	
		LOW	HIGH
QUALITY OF THE DESIGNER	LOW	LOUSY *I.S.*	BAD *I.S.*
	HIGH	GOOD *I.S.*	EXCELLENT *I.S.*

SOURCE:BEMMELMANS, 1994

Figure 10: Quality of an Information System

The conclusion from figure is simple; it's more important to have a good designer than to have a good method. Methods don't create information systems, designers do! A good designer takes care that the involved parties understand what is being designed thus making it possible for the involved parties to understand if this design is according to their wishes and fullfills the technological, economical and organisatorial requirements. The methodology supporting the designer, according to Bemmelmans (1994) should support the designer in doing this and the metlod should both be effective en efficient.

If possible both designer and method should be good. Nevertheless methodologies are important for projects and before choosing a method it is important to look at the way of thinking behind it since this will have a great impact on the outcome of the methodology.

Some major paradigm's are:

{ *Objectives versus inter subjective reality*; do all people see reality in the same way or are the requirements of a user different from a designer or a systems manager;

{ *Total versus partial*; do we build a total solution or do we build modules;

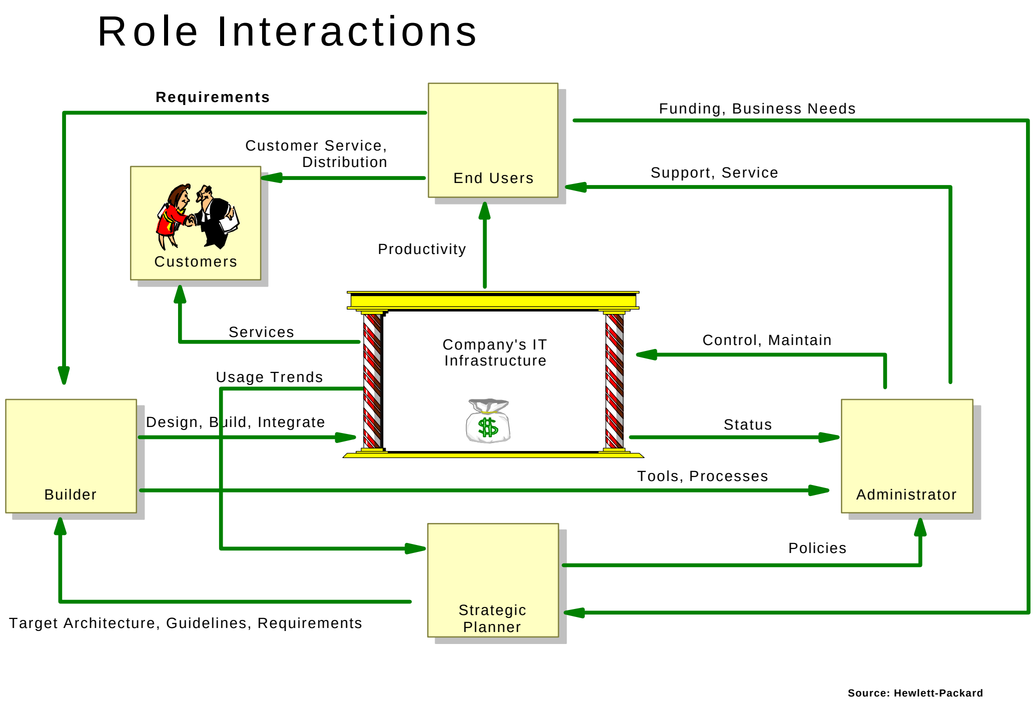
{ *Deduction versus induction*, do we take the present situation as reference or do we anticipate on a new organization;

{ *Departmental versus functions*, do we design per department or do we build on a functional level;

{ *Top down / bottom up*, do we design the system from the general idea into detail level or visa versa.

The methodology we choose to use for a GIS project should also consider user involvement because the users are the true customers of the system. Communication and understanding the different interests is the key to success because of the dangers of misunderstanding the requirements of the principal, the end-user, the builders and others involved. These interests will most likely not be in line with each other. For a successful project however all involved must understand each other’s issues and at least understand, and preferably agree to, the approach taken. Figure 11 shows some of the complexity of role interactions but is highly simplified.

Figure 11: Role Interactions



Gererally ,the end-user is interested in a easy to use application which will enable him to do his job more easily. However if not properly informed he will be afraid of loosing his job because of the project and if this fear isn't taken away he will not become a supporter.

The customers are interested in the quality of the service which they will get because of the application. They do not care if the user finds it hard or difficult to use.

The builder is interested in guidelines, requirements and the target architecture and he will not be very pleased if suddenly the requirements change which might happen if the end-users finds out that it is not a usable system.

To understand all these interactions is still rather easy. However when politics come into place, and they do in any project of substantial scale, totally different interactions are important and these are much more difficult to manage. Methodologies assist in managing the technical issues of projects; politics and role-interactions are managed through experience and understanding.

2.4. The Roaring Nineties

"When a student told professor Einstein, These are the same questions as on last years test, the professor responded: Oh yes, but the answers are different this year".

Many organizations are confronted with a rapidly changing business environments and are trying to find appropriate strategies to cope with this.

Strategies such as:

- Cost cutting;
- Protectionism;
- Financial restructuring.

often do not provide solutions as they are not unique and can easily be duplicated by the competition. The only way to survive in the long run is to constantly add value to ones product weather this is a car or a map or the provision of information.

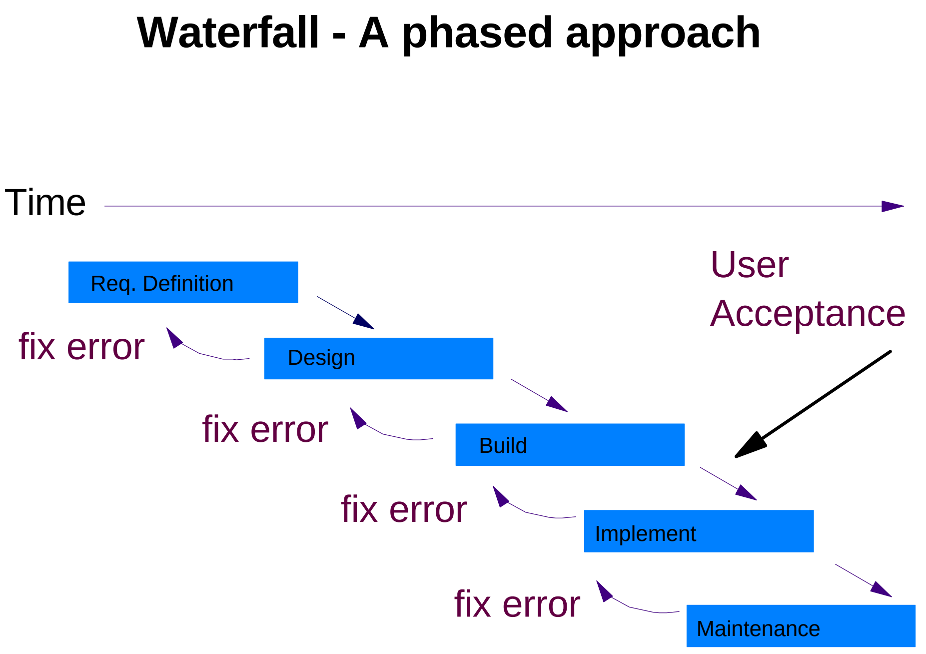
In practice this means faster time to market, increase quality, constant innovation and reacting to the customer demands quickly.

As Tom Peters (1987) said: *"No company is safe....There is no such thing as a 'solid' or even substantial, lead over one's competitors. Too much is changing for anyone to be complacent. Moreover the 'champ to chump' cycles are growing ever shorter."*

Because of changes in Business Management and new technologies which become available the role of Information Technology has changed drastically in the last decade. Development of new information systems has become much more complex. Developments like Internet create opportunities (but also threats) which were not imaginable only a few years ago. Most methodologies and methods however were developed in the late 1960's and early 1970's and nearly all of those incorporate the "waterfall" approach (Figure 12).

This approach is highly dependent on the ability to create very good and detailed requirement definitions and specification.

Figure 12: Waterfall Model



To use succesfully a methodology based on the “waterfall” approach the following assumptions must be valid:

- Pre specification is possible;
- Change is expensive;
- Good communications;
- Static model is adequate;
- User’s understanding is complete;
- User’s know (ahead of time) what they want.

It is typical for these kinds of methodologies that the moment of user acceptance is late in the development cycle. It is not possible to change the solution at this stage without a lot of effort and expense. The easiest opportunity to change is in the requirements definition phase. Try to imagine the impact of such a methodology in a GIS environment. This would mean that the GIS users should have a complete understanding of the entire system. GIS is evolving very rapidly and new functionality is added to GIS systems every few months. Furthermore only in the last 10 years GIS has been available on affordable hardware platforms so there is not much knowledge about completed complex GIS projects. Also what was advanced a year ago is considered to be basic the next because of the tremendous development speed of GIS.

"In most projects, the first system built is barely usable... There is no alternative but to start again, smarting but smarter.. The discard and redesign may be done in one lump, or it may be done piece by piece.. it will be done... The management question therefore, is not whether to build a pilot system and plan to throw it away. You will do that. The only question is whether to plan in advance to build a throwaway, or to promise to deliver the throwaway to customers."

(Brooks,1995)

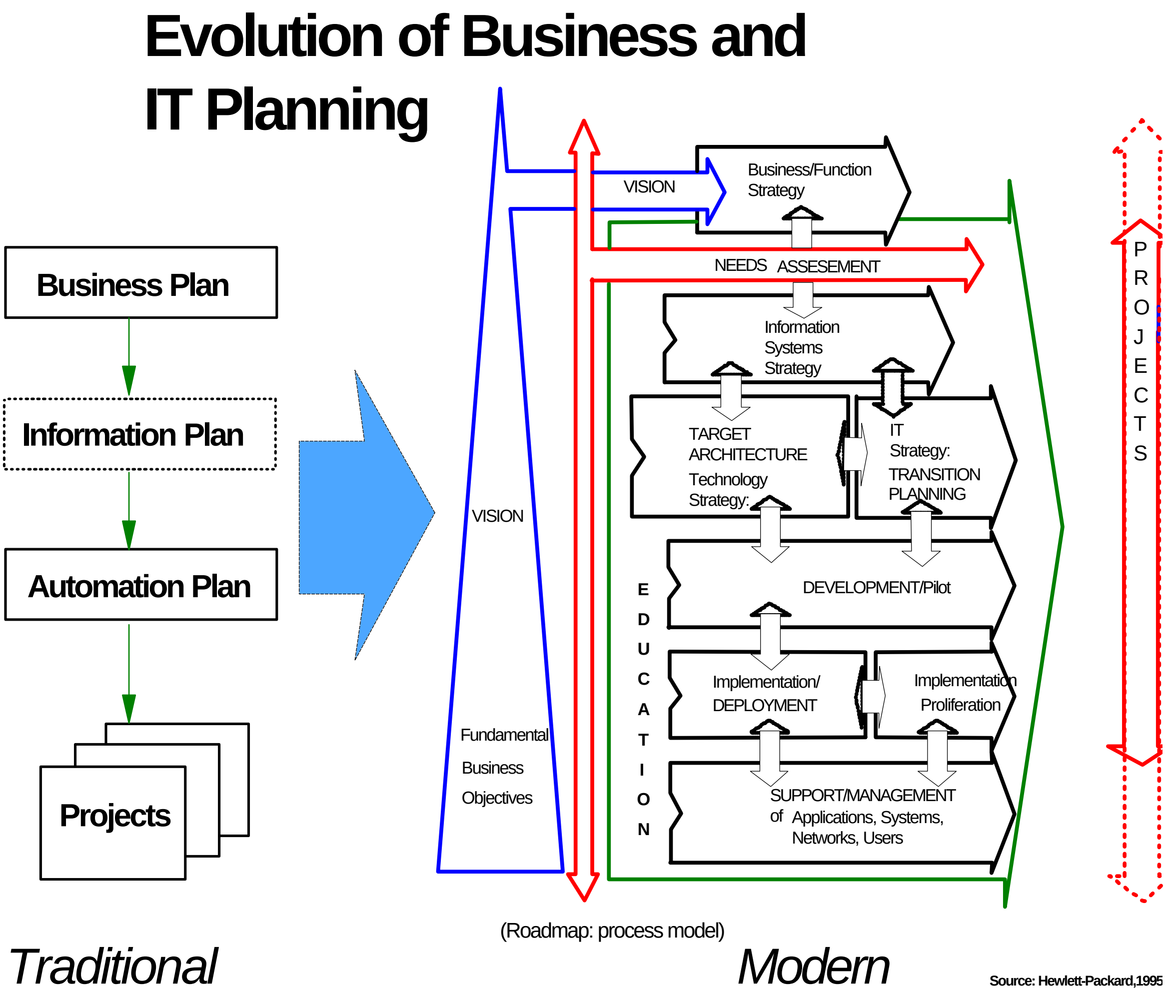
Nowadays it seems that change, death and taxes are the only certainty in life and we know that during nearly every project the original requirements change and the ability to adhere to this will decide the success or failure of the project.

Traditional business planning as done by most companies takes the following steps:

- Business plan;
- Information plan;
- Automation plan;
- Project Plans.

The business plan normally does not take into account the possibilities or pitfalls in the information and automation plans, there is no feedback whatsoever. As a consequence more and more organization are trying to establish a business plan using "business to IT alignment". This is a process that ensures that all company strategies (business strategy, IS-strategy) are in line with each other. (Figure 13)

Figure 13: Evolution of Business and IT Planning



In the past projects were defined after all the other plans were established. The present business demands are for a more flexible way of handling projects.

At the highest level there are the mission and vision of the organization which provide the fundamental business objectives. The business strategy which is in line with mission, vision and objectives, interacts with the IS and IT strategy. This means that all strategies support and strengthen each other. In this way the information systems are directly linked to the organizations strategy and are the most effective. It’s obvious that GIS-projects have to fit to this model as well. For this reason a GIS project manager should be aware of these business fundamentals.

In the Arthur Young Practical Guide for Information Engineering (1987) seven objectives are listed when developing organization wide information systems:

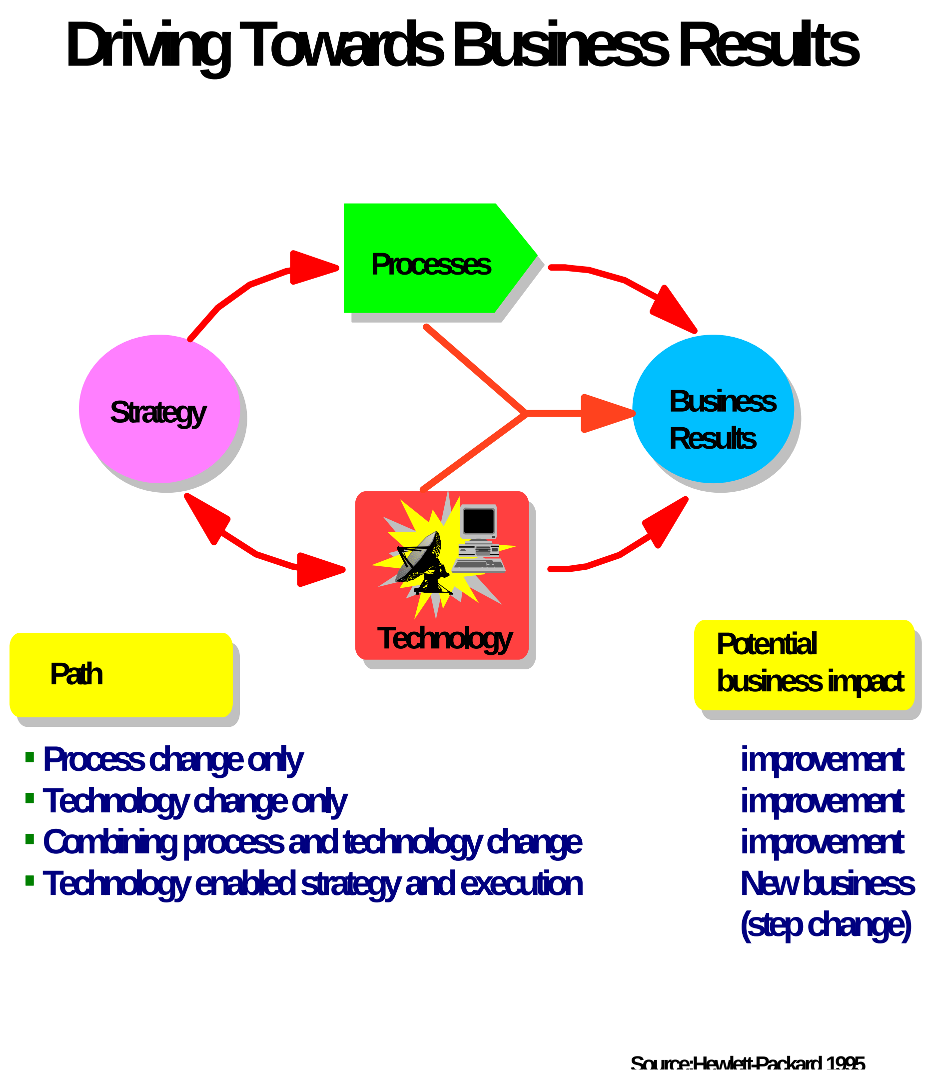
1. Responsive and accurate support to the information needs of senior managers by developing information systems that are of strategic importance to the organization;
2. Focus of the IS team on relating information system activities and products to the organization goals and critical success factors they support;
3. Providing senior management with an increased understanding of, and a greater ability, to control the organization's information systems;
4. Assistance to the organization in gaining and maintaining a competitive advance in the marketplace by identifying strategic use of information technology;
5. Decreasing the time required to bring new applications into productive use, and reducing the maintenance problems associated with keeping them cost effective and productive;
6. Involving users more effectively in information systems development through the increased use of techniques such as joint application development and proto typing ;
7. Improving the quality of information systems software by increasing the rigor of methods used to create it, and by basing the systems design on data and activity models of the underlying business.

Reeve and Cornelius (1993) write:

- Information Systems are the servants of business needs (not the other way around);
- Information Technology is the servant of information requirement (not the other way around).

Though both statements are true it does make sense to align the strategies in order to gain advantage. As shown in figure 14 there are several ways to ensure alignment.

Figure 14: Business to IT alignment



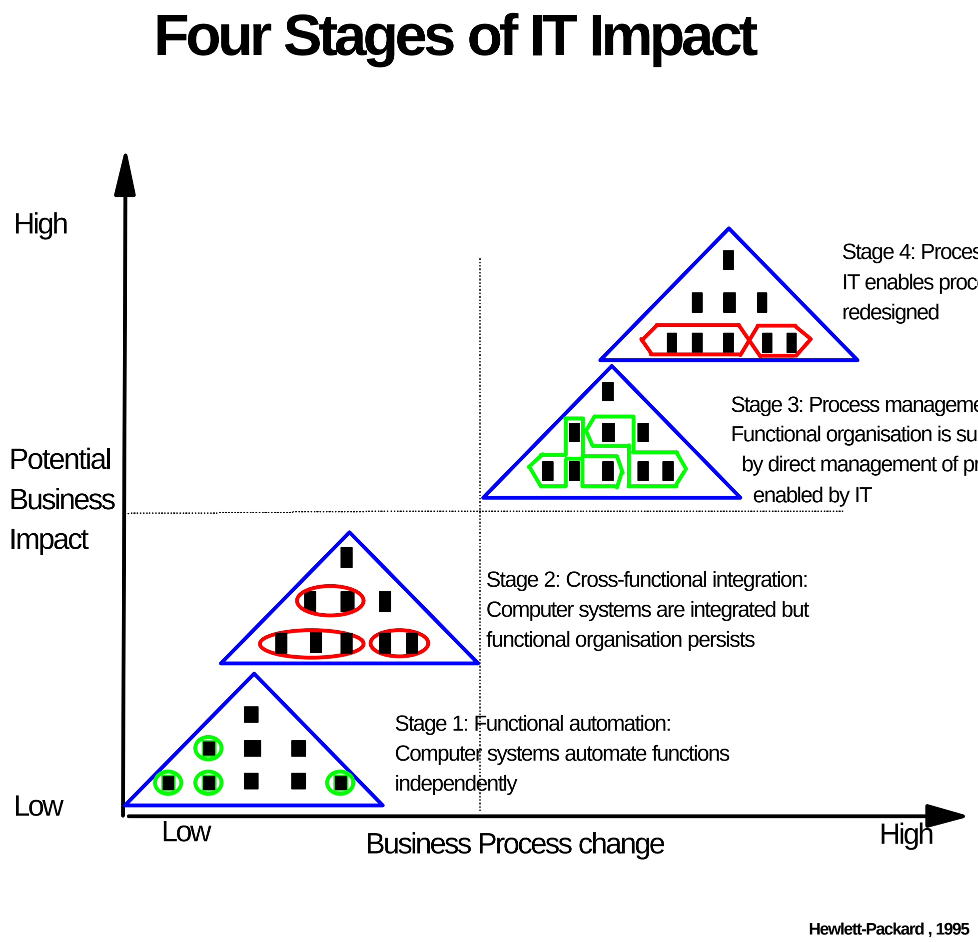
Through process change, technology change or a combination of both it is possible to improve the business result. A real breakthrough can only be reached adopting a technology enabled strategy. For example if a new company strategy is to “provide the customer with information on the status of their order and order volume” this can be done by changing the reporting process of the order administration. Adding a new order-tracking system could provide customers with a on-line information system with the actual order status of the moment. In this case the process changes and the technology enables the change, thus improving the total process.

The urge to fundamental analyses and radical redesign of business processes to drastically improve an organizations performance to meet today’s competitive requirements, in terms of costs, quality, service and speed, is common in many organizations. This process, which is sometimes also called Business Process Re-engineering, is using the process and technology change to achieve breakthrough results.

The way IT is being used has an influence on the business impact of the IT systems. Where organizations in the past used IT in a purely functional or cross functional way the demands of the nineties make it necessary for many organizations either to use IT in a process management way or ultimately redesign their entire processes.

The importance of this should not be underestimated; if the expectation of the principal of a project and that of the organization are not in line there is bound to be a problem. An IT project has an impact on the organization. Depending on the kind of project, the impact can be different. (Figure 15)

Figure 15: Four Stages of IT Impact



GIS projects can be in different stages of this model. Complex GIS projects not only require information from different departments within the organization but also demand a certain organizational structure around the information. If a total GIS systems uses 3 different departments as an information source it is necessary to make appointments about, for instance, the moment to update, the way the GIS database can be used and the ownership of the data.

Only providing data is often not enough, organizational appointments have to be made.

If a GIS is used to reach a breakthrough, for instance using a GIS and GPS to provide information to a fleet of trucks for optimal routing and availability of cargo, this will also require strict appointment with the purchase and sales departments and the truckers themselves.

2.5. Choosing the appropriate development methodology for a GIS project.

Choosing the appropriate development methodology depends on the situation. The “one fits all” methodology unfortunately does not exist.

Currently, combinations of information engineering and proto typing are used. The basic thought behind information engineering is that data is the most stable factor when developing an information system. This method specially is useful in a project with the following characteristics:

- High uncertainty of specifications;
- Need of decision support systems;
- Low expertise in this field of current users;
- High level of uncertainty concerning the exact specifications of GIS.

On the other hand if a current system has to be replaced the best choice of a method is probably SSADM (Structured Analysis and Design) which was produced by CCTA a UK government agency (Reeve and Cornelius, 1993). SSADM presumes that there is an existing manual or computersystem and analyses first the existing system and, on that basis, specifications for the new system are made.

In general, traditional System Analysis takes a lot of time which makes this methodology less and less popular. A project analysis and feasibility study easily takes 0.5 - 1 years of time. Considering the fact that product life cycles are diminishing all the time this is often much too long.

The next table shows traditional versus Rapid Application Development times. Traditional in this case means that, for instance the prototype is a limited program that simulates the required functionality of a very simple application (a mainframe approach). A client-server pilot is a sophisticated version of the production system that is functional from the beginning but is limited in number of users, speed and functions.

DEVELOPMENT TIME: TRADITIONAL VERSUS RAPID APPLICATION		
Phase	***Traditional***	***Client-server***
feasibility	prototype 1-6 months	pilot system 1-3 weeks
final user specifications	1-6 months	continuous
system design	3 months - 1 year	included in the pilot system
coding	6 months - 3 years	production system 9 - 20 weeks
testing and revision	3 months - 1 year for most changes	continuous, 1 week for most changes
total time	**1 - 6 years**	**10 - 20 weeks**

(Adapted from Donevan, 1994)

In order to use of techniques to best effect most systems currently are designed as client-server systems. Whereas the life cycle of a mainframe is > 10 years the life cycle of a PC (with the same power as the mainframe of less then 10 years ago!) which is being used as a client in a server client configuration may be less then 1 year.

The life cycle is getting shorter and shorter due to the development of more advanced, and resource consuming, software. If, in a project, we foresee development times of several years we can be sure that all hardware will be outdated by the time the project is finished. Furthermore it is important to undertake development is such a way that it is possible to use technological innovations in the field of our project. Also it is very likely that innovations will enable to do things which nobody was aware of when the project started. If the chosen methodology enables this, it is of great help. Van den Berg (1996) of the province of Utrecht says in a interview concerning GIS: “You know what you want, if you see what is possible. However a GIS environment will be used to the utmost if users, up front, explain what they expect in the field of information, analysis and presentation. This is a dilemma”.

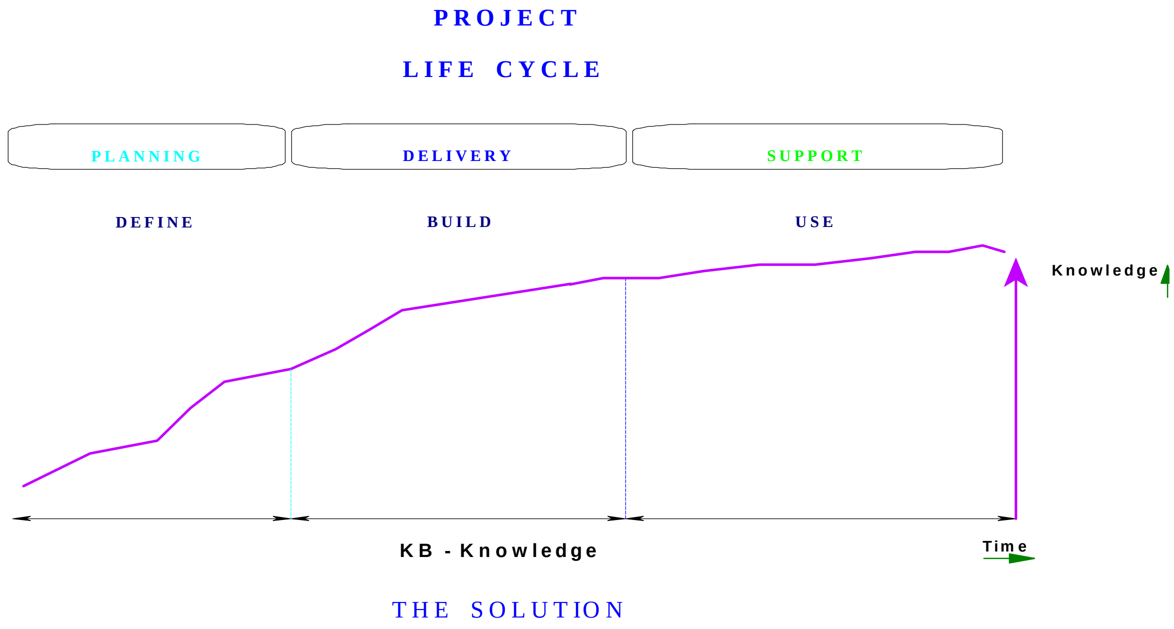
How to handle such a dilemma? On of the ways is using Rapid Application Development and Joint Application Development Methodologies.

2.5.1 Rapid Application Development/Joint Application Development

Probably the most difficult task in a project is to define what has to be built. In order to do this the client has to tell what the GIS system should look like.

But in practice: ***'They don't know! '*** because also for them it is the first system of this kind so they lack the knowledge which comes from experience. *"There is no question; the geographic information represents a critical element of the information technology structure. But we find ourselves struggling with what that means and how it can be implemented"* (Odenwalder, quoted by Wilson, 1996). Of course there is usually a rough idea about the kind of solution they are looking for but to specify exactly what it should look like is often impossible. Nevertheless there has to be consensus on this issue since it provides the criteria on which the project will be accepted or not. The basic problem is the knowledge base of the client at the beginning of the project as represented in Figure 16:

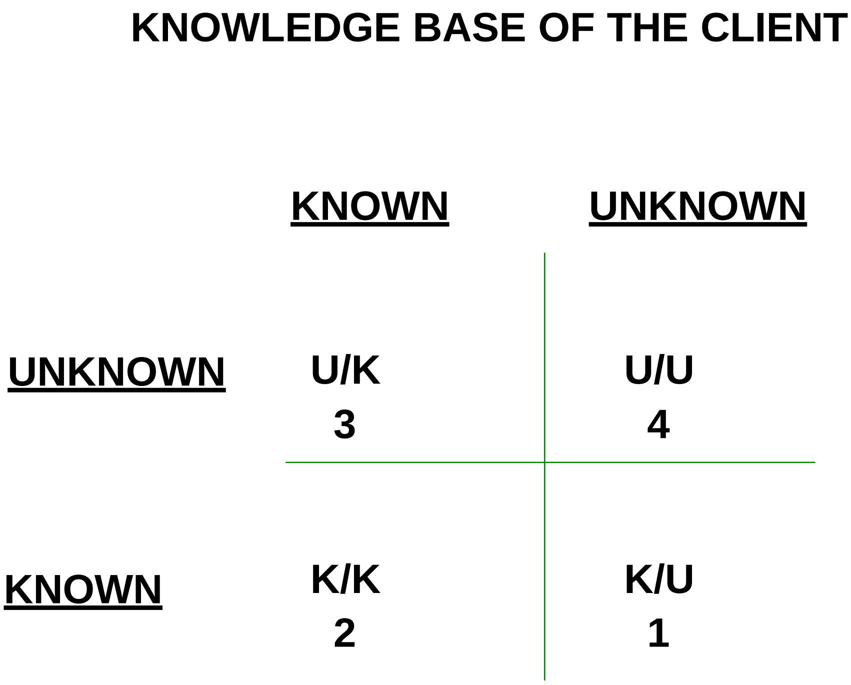
Figure 16: Project Life Cycle



The moment the client needs to know most, during specification, the amount of knowledge is very limited. The result is often a set of unworkable specifications with which the principal tries to describe every situation. Project managers have learnt through many disappointments that such projects generally fail. The knowledge base of the clients can be considered in terms of white spots and black spots of knowledge.

Figure 17 shows the 4 knowledge quadrants:

Figure 17: Knowledge base of the client



As shown there are 4 situations:

1. Known/Unknown, there is an awareness that some things about the GIS are not known at the moment and have to be found out during the project;
2. Known/Known, these are the things which are certain; it is a GIS for 3 departments with 40 users;

3. Unknown/Known, the things which have to be assumed as the client knows he/she does not know; number of objects is not known but will not be above 2 million objects;
4. Unknown/Unknown, the things which the client doesn’t know he/she doesn't know; e.g. due to a reorganization the clients department will stop existing.

In this context it is not so difficult to understand why creating functional and technical specifications is a difficult task.

For these reasons Rapid Application Development (RAD) and Joint Application Development (JAD) has become widely applied in the last few years. RAD and JAD make it possible to work in a itterative way thus gaining knowledge of the Unknowns in Figure 17 during the proces.

Human beings almost never perform a complex task correctly the first time. However, people are extremely good at making a mediocre beginning and then making small refinements and improvements. RAD and JAD make use of this principle. RAD is one of the Software Development Life Cycle Methodologies (Martin, 1995) that produces quality applications in a short time.

RAD is characterized by:

- Iterative development approach;
- Heavy emphasis on enterprise and data modeling;
- Use of automated tools for rapid proto typing and code generation;
- Active end-user involvement throughout life cycle;
- Relies on reusable code, forms modules.

(Baum, 1992)

The heart of RAD is rapid prototyping ; creating a working model from the requirements to verify business functions and operational characteristics. As users are heavily involved in this process they give constant input, have a lot of involvement and consequently accept the end results.

RAD starts with Joint Application Development. *"The basis idea of JAD is to select key end-users and conduct workshops that progress through a structured set for planning and designing a system"* (Martin, 1995).

During the JAD sessions a system is planned and designed. Based on this design a prototype is build. This prototype can have the following functions:

1. Learn during building;
2. Proof of concept;
3. Introduction and testing of new concepts;
4. Understanding the true complexity.

Prototypes can either be thrown away or evolve. The constant feedback and feedback loops provide an optimal possibility to reach the maximum end-result by constant interaction with and acceptance from the client.

2.6. Summary

There is little experience with complex GIS projects which are strategic of nature. Rapidly changing business environments require organizations to find appropriate strategies. Implementing GIS can be one of these strategies. Traditional methodologies like the Waterfall approach require a detailed user understanding of what the end result should look like.

GIS projects have usually a few key characteristics:

- High uncertainty of exact specifications;
- Limited experience of users;
- Moving into “new” fields of automation.

For this reason a iterative approach like Rapid Application Development is suitable as a methodology for GIS projects. In chapter 3 the way actually to implement such a methodology in a GIS project is described.

3 PROJECT MANAGEMENT FOR GIS

3.1. Introduction

The previous chapters describe the life cycle of GIS projects and the methodologies which are useful. But how to apply this knowledge when doing an actual project?

Based on the life cycle and methodology principles outlined above in this chapter an approach towards an actual project is proposed. The assumption is made that the GIS project is of a strategic nature and involves several departments of an organization.

Finding the appropriate guidelines is not easy. Not many GIS projects of this magnitude of complexity have been conducted and even fewer have been documented. The approach in this chapter is based primarily upon the PRINCE handbook (Bradley, 1993) for project management which is primarily meant for Government projects. PRINCE is an abbreviation of **PR**ojects **IN C**ontroled **E**nvironments and is the standard project management method for Government (in the UK) IT departments approved by the CCTA. Basically PRINCE is the definition of the products to be produced by a project. When using the Structured Systems Analysis Design Methodology (SSADM) PRINCE is the project management methodology to be used. SSADM however is, as argued in chapter 2, not always applicable to GIS projects. Methodologies like RAD/JAD have to be used. By extension PRINCE is not always applicable. The argument here is that a specificific management approach for strategic GIS needs to be developed. This involved combining PRINCE with "The Customer Project Life Cycle"(Hewlett-Packard, 1995) which is the mandatory project management approach of Hewlett-Packard and taking account of the issues described in "Managing Geographic Information Systems Projects (Huxhold et al, 1995), and Management van Complexe IT projecten (Roelofs et al, 1996) of KPMG. Additionally the authors own experiences is used to genereate a set of guidelines to handle GIS projects. Issues like Project Initiation, Deliverables, Monitoring and Risk management are discussed.

3.2. General

In this chapter a practical approach towards GIS project management is described. The importance of a Project Initiation Document, Quality Control Procedures and Monitoring of the project is clarified.

What is a project: A unique set of activities with a defined time frame, with a well defined goal, with acceptance criteria, with known risks which are all established at the beginning of the project.

Huxhold et al. (1995) mentions some interesting facts about IT projects by referring to a 1989 study by Croswell who found that relatively few GIS installations in the USA and Canada are fully successful.

Some other statistics show the same:

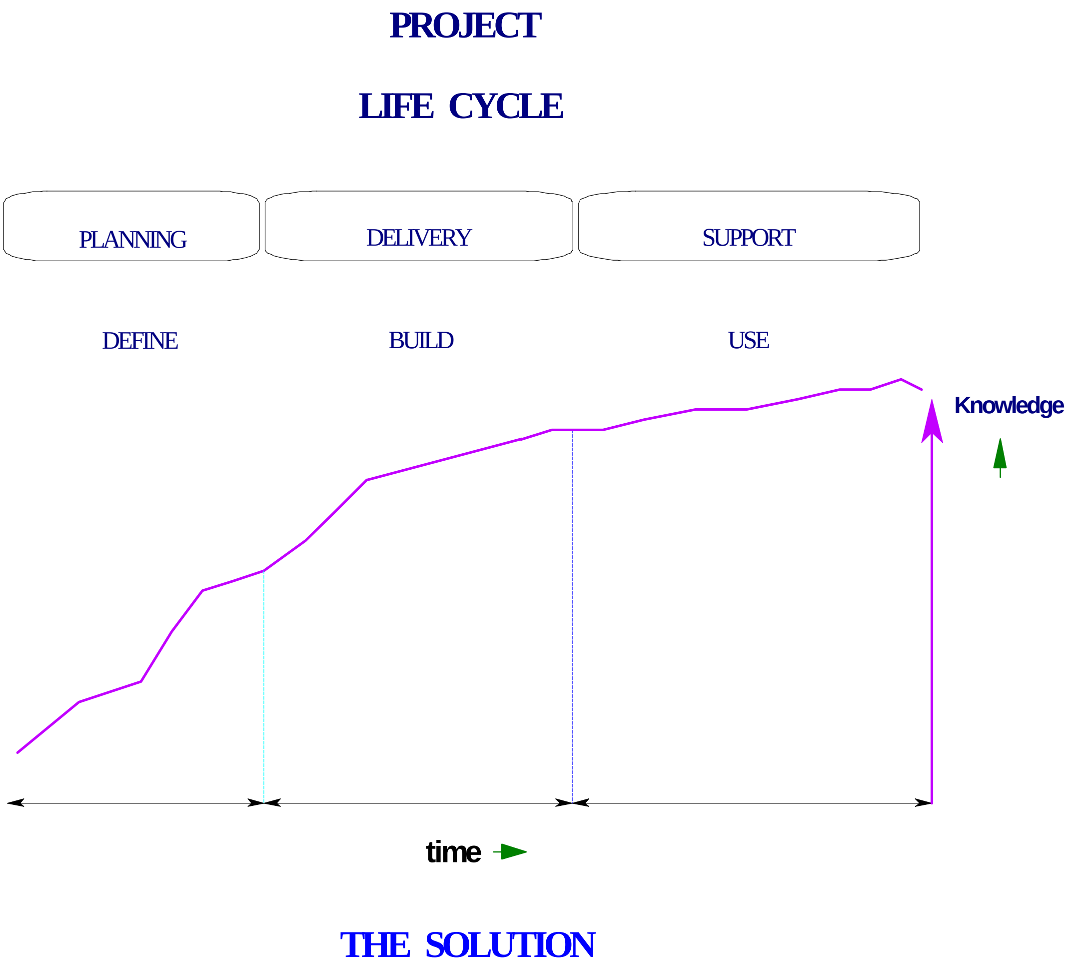
- 25% of all major IT projects are not completed (Jones, 1981);
- 15% of major IT projects deliver products which are never used (De Marco and Lister, 1987).

The reasons for this, which they all mention, are mostly not technological but institutional (sociological). Starting a project is easy, ending it successfully isn't. Project management is ***not*** an easy job and the difficulty of most projects is underestimated.

One could compare a project with somebody's dream of what the future might look like. Somebody else has to make the dream come true and as everybody knows there are not only beautiful dreams but also nightmares!

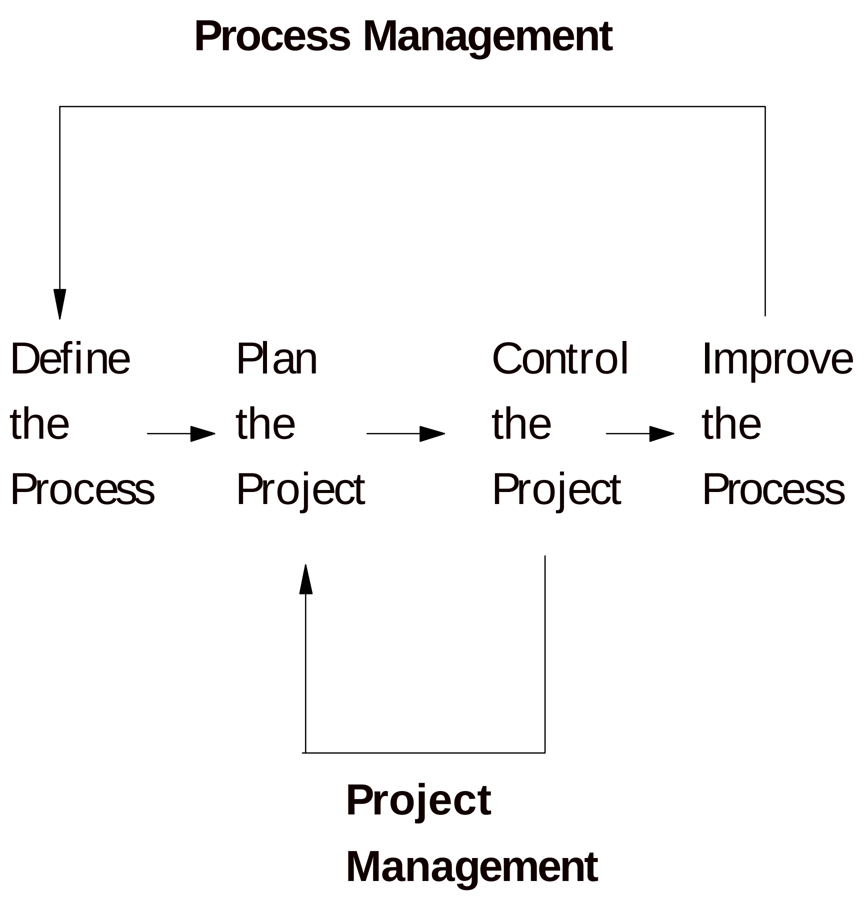
When a GIS project manager is being told that “this is an easy project to do” he always has to think of the knowledge base:

Figure 18: The Project Life Cycle



As Figure 18 shows at the very beginning of the project, when the specifications have to be defined the knowledge base is the smallest. How about the knowledge base of the customer? His/her knowledge base is not much different because all the work still has to be done and the sum of the work often looks less complex than the parts. Yet specifying the parts in an appropriate manner is of paramount importance.Many customers ask for project management but also would like to have some process managegement as well. It is important to know the difference between a process and a project. A process (Figure 19) has the following sequence:

Figure 19: Process Management & Project Management



Many projects don't start with a clearly defined requirement specification. Often there is a need to look at the process as well. If the process is not working properly there might be a need to improve it. Without doing this the project might be endangered. This is especially the case if the project also requires organizational changes (different job, different responsibilities). In practice many project managers also manage processes that will enable the project to succeed. Nowadays not many projects start with a full set of functional specifications and it is increasingly important to be aware of the underlying processes.

3.3. The project stages

Many inexperienced project managers make the mistake of starting a project by taking a piece of paper or a product like MS-PROJECT and filling in the blanks. This is **not** project management!

Looking at a project the following stages can always be recognized:

1. Planning;
2. Delivery;
3. Support.

The main focus of this thesis is on planning and delivery though support will be discussed briefly later on.

The urge to jump the delivery phase is only human but needs to be avoided if the project is to be successful. Specially the planning stage where the objectives of the project are clearly stated and are agreed upon is of paramount importance.

How does a project start? Some examples are:

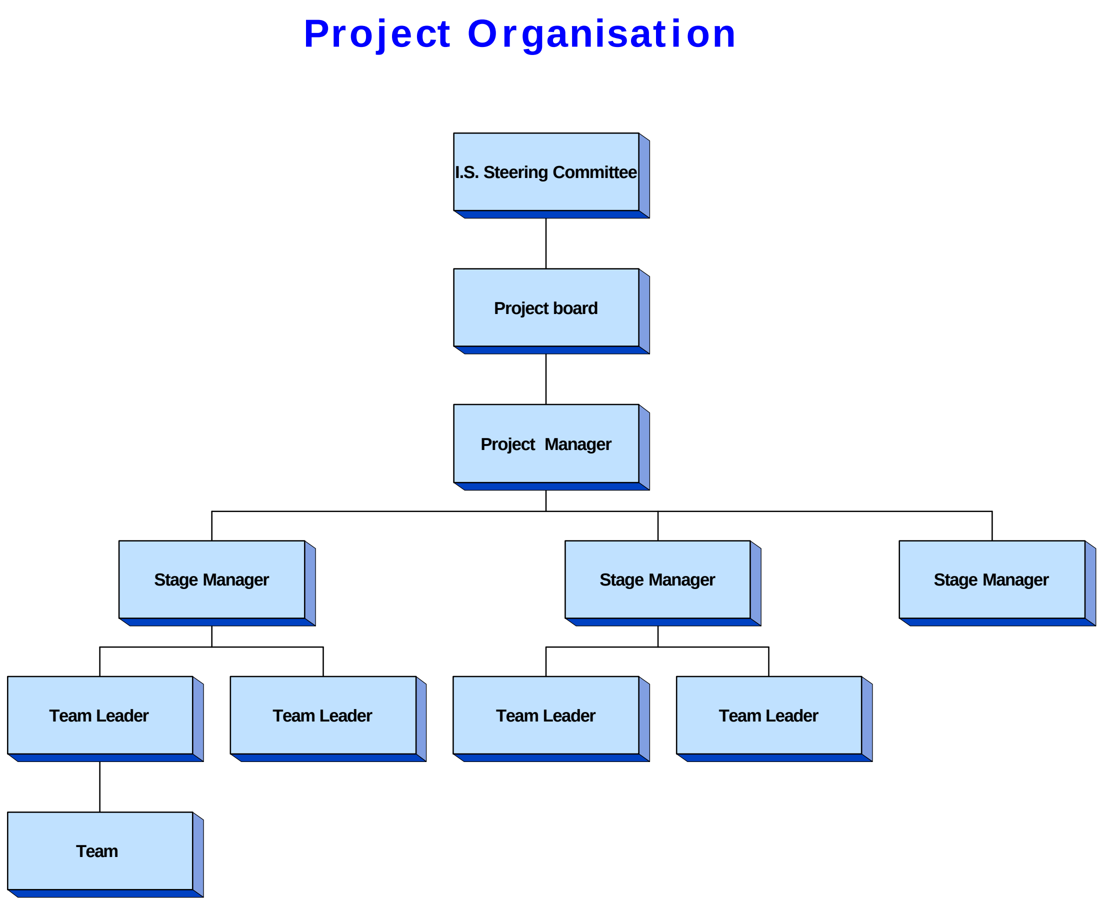
- Champion; somebody in the organization who is very enthusiastic about the possibilities of GIS will start a decision making process;
- Management; on the basis of their strategic planning process, contacts with other organizations management recognizes the need for a GIS;
- Customer demand; customers of the organization ask questions which can only be handled if a GIS is used;
- External consultant; an external party which has been invited to give advice proposes a GIS to solve certain problems/questions in the organization.

3.4 Project Initiation

In the GIS Project Management Handbook British Columbia Ministry of Forest (date unknown) a Project Sponsor is mentioned: “This person is the promoter of the project. His role is to “represent” the project to management, and secure priority and recourses for the project. He also acts as the supervisor for the project manager.” It is obvious that such a person is needed in projects but in large complicated projects it is better to have a project board.

According to the PRINCE-handbook (Bradley, 1993) the ideal project organization looks as follows (Figure 20):

Figure 20: The Project Organization



If the project is highly visible, risky and of strategic or mission critical importance to the organization, it is very important to establish an IS steering committee. This committee is responsible for the overall objective's of the organizations business and keeping the project in line.

Subjects such as : Hardware strategy (PC's, Mini's or Mainframe);
Software strategy (Windows, NT or UNIX);
Application strategy (Arc/Info or System 9);
Staff strategy (hire or freelance).

will be covered by the IS-steering committee.

They however are not involved in the day to day business of the project. For this purpose the project board is established. This board should consist of people at the management level as they have to make decisions on recourses, budget etc.

The project board should have the following managers:

1. Executive, he/she is the link with the steering committee and has the role of project sponsor;
2. Senior User, representing the users of the system ensuring support for the project at the users level;
3. Senior Technician, representing the parts of the organization which will take care of the technical implementations.

The project manager reports to the project board.

3.4.1 Responsibilities of the Project manager

To get a good idea about the responsibility of a project manager take a look at the job advertisements in some magazines:

{Translate customer demands into realizable and manageable product specifications;

{Give advice in the field of product improvement;

{Meet with other involved departments and suppliers;

{Guard budget and time lines;

{Make detailed project plans; Lead one or more projects;

{Give verbal and written reports to the management;

{Look at details without forgetting the big picture;

{Meet predefined project objectives;

It is the responsibility of the project manager to define the roles and ensure the availability of internal and external recourses so the proposed solution can be delivered.

There are 2-kinds of project managers:

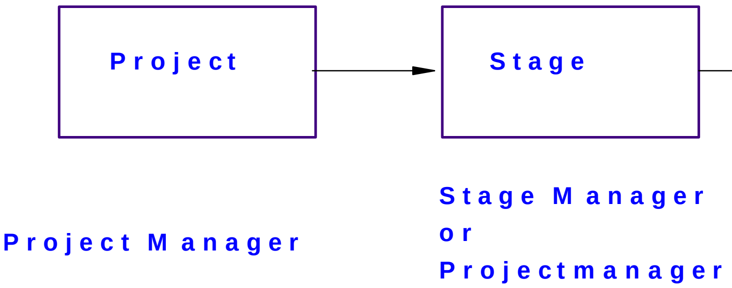
- { Internal; somebody appointed from the own organization;
- { External, somebody hired from the outside on a temporal assignment.

Sometimes a combination with an internal and external project manager is chosen.

One problem Internal project managers fase is the risk of becoming a "if you have a spare minute" project manager who still has their own previous job to fulfill as well. Don't be fooled, managing a project is almost never a part-time job. A second common mistake internal project managers make, which is not uncommon to external project managers as well, is to forget demanding senior management involvement in the project.

In a good project organization is a big part of the work. In order to define the required organization one has to look at the work which has to be accomplished. It is very tempting at this point to go into details but there is no need for this yet. The work which has to be done in the project must be split into major phases, activities, sub activities and tasks. Depending on the level of complexity it might be worthwhile to appoint one or more stage managers which are responsible for parts of the project. A stage manager is technically responsible to deliver the products of one or more stages. Often the project manager also has the role of stage manager.(Figure 21)

Figure 21: Project->Stage->Steps



So on a macro level the project is divided into stages which are divided into steps. Steps are carried out by teams (which, depending on the complexity of the work, might be only one man or a team with a team leader). It is likely also that internal recourses are needed. In the Project Initiation Document, which is mentioned later on in this chapter, there should be a list of needed recourses mentioning the required skills and, appropriate, the names of specific individuals if they are essential for the success of the project.

It is important to seek agreement on the organizational structure which is being used for the project since it is a representation of the resources needed in the project.

Being a project manager is **not** a part-time job unless it is an unimportant project.

There is a tendency to underestimate the importance of good project management which in general is regarded as being a overhead and very costly. A good project manager will however ensure that a project is completed according to plan, within budget, within time and will create an acceptance level for the project in the organization.

Always remember: ***Success has many fathers, failure just has a stepmother.*** Get the appropriate management involved! For this reason the very first thing a project manager has to do is to establish a Project Initiation Document.

3.5 The Project Initiation Document (PID)

A “Project Initiation Document (PID)” describes the environment in which the project will take place, the mission and objectives of the project, the business case and the risk analysis. Also the responsibilities of the project manager and the quality insurance plan are described thus forming an insurance that the necessary prerequisites to make the project successful are met.

A PID should at least contain the following items:

- Background of the project;
- Mission & Objectives;
- Scope;
- Constrains;
- Organization of the project;
- Project Plan's;
- Deliverables, milestones and acceptance criteria.
- Risk Analysis

This is also a good time to remember that many people will participate in the project and they all will produce documents. A project manager has to think of a method to ensure document and version control by using unique reference and version numbers. Though there are many methods and examples to think of it is always smart to adapt the method used in the company one is performing the project for since this method is commonly used and understood.

Don't underestimate the importance of this issue. Try to imagine a group of people with different versions of the same document all providing output but leaving the project manager the task to combining it all and find out what their comments means.

3.5.1 PID:The background of the project

The background of the project provides a frame of reference and explains the present situation with something about the history of the organization or department where the project is taking place.

The background description together with the mission and objectives ensures that there is a shared vision among all involved.

This shared vision also helps to put all things which are being demanded from the organization and the project staff into the right perspective.

3.5.2 PID:Mission, Objective and Strategy

In order to understand the goals of the project often a very thorough understanding of what is demanded in the project is needed. This might require a lot of investigation. Nevertheless without this understanding it is not clear what needs to be achieved. A project manager needs to be clear about they way they have to go and what is the goal. In Alice in Wonderland the Chesire Cat tells Alice that it does not matter which way she is going if she doesn't know where she wants to go. It is obvious that a project manager ought to know where he is going to and for that reason there needs to be a common understanding on the:

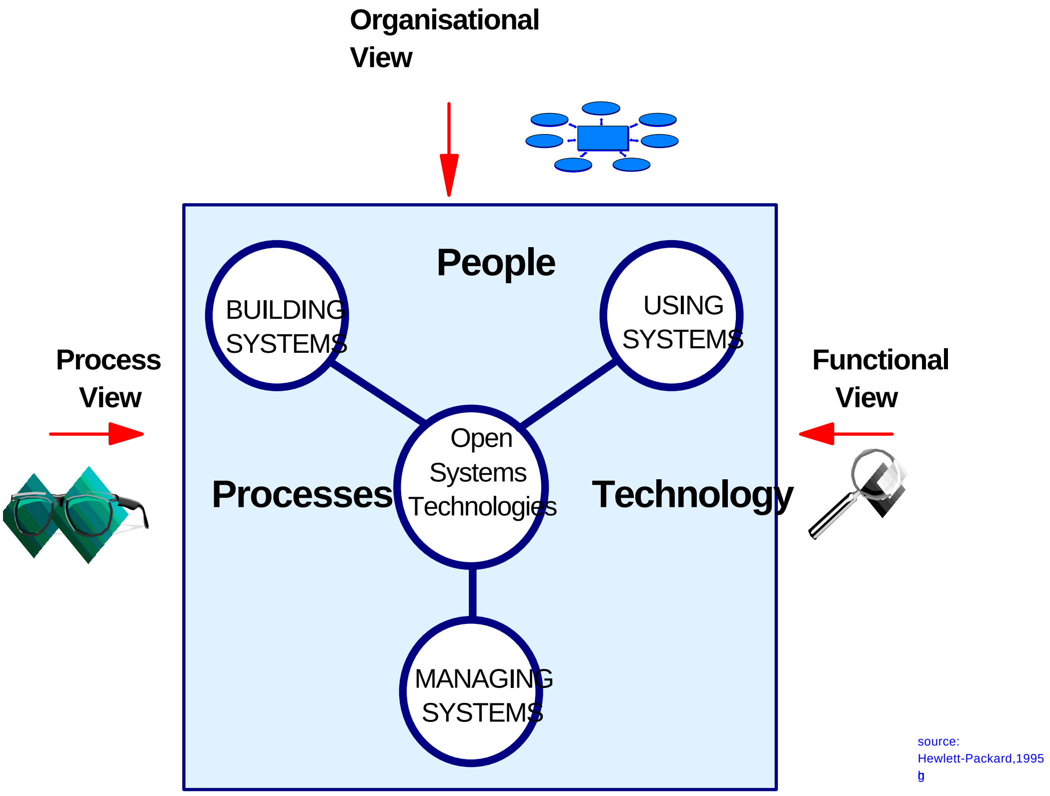
- Mission - Why are we doing this project?
- Objective - What will be done?
- Strategy - How we reach the objective?

Also once these have become clear they must be checked with the project board and the IS steering committee. At this point of the investigation it also has to be clear what the life cycle position of GIS is within the organization. Is it an experimental system or is the system of strategic value. Strategic GIS projects have different expectation levels from senior management and require more involvement of these senior levels. These aspects should be reflected in the PID as well.

3.5.3 PID: Scope

The challenge of a project manager is to manage complexity. Figure 22 shows the viewpoints which are possible.

Figure 22: Viewpoints



There are many ways to look at a project and depending on whether or not the viewpoint is organizational, process- or functionally oriented the requirements and demands will be different. In order to manage such a process the project manager has to know and get agreement upon the scope of the project.

Requests for proposals are often a perfect example of nonrealistic scopes with requirements such as: Build a GIS with sufficient performance for 10 users with a user-friendly user interface. Beware; this will prove to be an impossible task to accomplish until; GIS, sufficient performance, user and user friendly are clearly defined.

For one customer a beautiful system might be a combination of Arc/View and Arc/Info whereas somebody else might consider a pink painted PC as being a beautiful system. Make sure it is clear what it is the customer is asking for and agree upon this. Also know what are the unknowns of the project and de-scope them. Don't make the mistake of being responsible in a project for undefined issues unless you did a thorough risk assessment. (See the chapter on Risks).

3.5.4 PID: Constraints

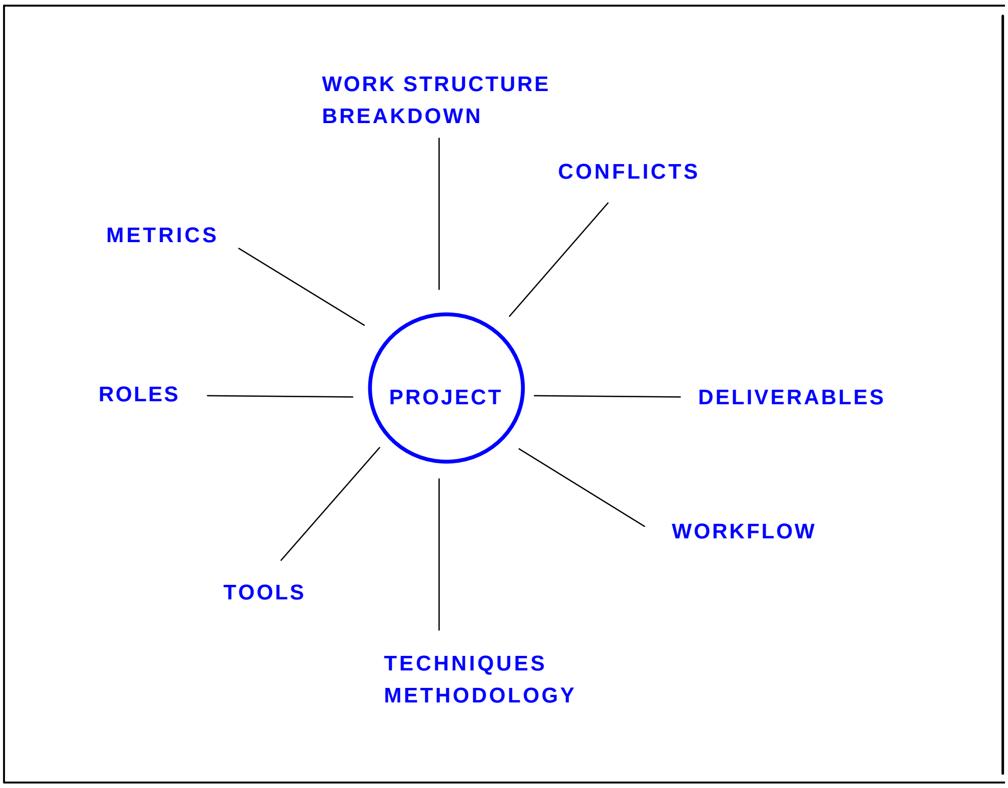
It is important to clarify which are the constrains in a project. For instance if the project is on the basis of fixed price the full financial responsibility is in the hands of the project manager. However formal change request will lead to additional costs.

If there is a fixed end date for the project and an overdue penalty is part of the project plan this can only be accepted if the resources needed from the organization are available at the stated moments in the project plan. The same applies also if for instance the computer room has to be reorganized and this is not ready when planned.

3.5.5 PID: Organization of the project

In order to define the required project organization it is important to look at all the aspects which have to be taken into account and the work which has to be accomplished. There are many things to take care of! Figure 23 shows the Work structure Breakdown.

Figure 23:Work Structure Breakdown



Work structure Breakdown	- A detailed description of the work to be done.
Conflicts	- Conflicts which have to be resolved.
Deliverables	- What has to be delivered during the project.
Work flow	- Dependencies between activities.
Techniques	- Standard approaches for the problem.
Tools	- Supporting technologies like MS-Project, Word Processor etc.
Roles	- Resources and skills needed.
Metrics	- Quality measuring techniques

3.5.6 PID: The Project Plan's

In the PID there is a project plan. This however is not a chance to get into details In this stage the project plan needs to be high level. It has to be made quickly (but thoroughly) and will identify:

- Major project stages;
- Major deliverables/milestones;
- Type of resources needed;
- Costs;
- Time estimates;
- Key assumptions ;
- Prerequisites;
- Risks;
- Quality Control.

Though quality control is mentioned as the last point it is certainly not the least important of this list as we will see later on.

To acquire the above information and put it into a plan is not an easy task. The phrase "drowning in data without getting any information" might easily become true.

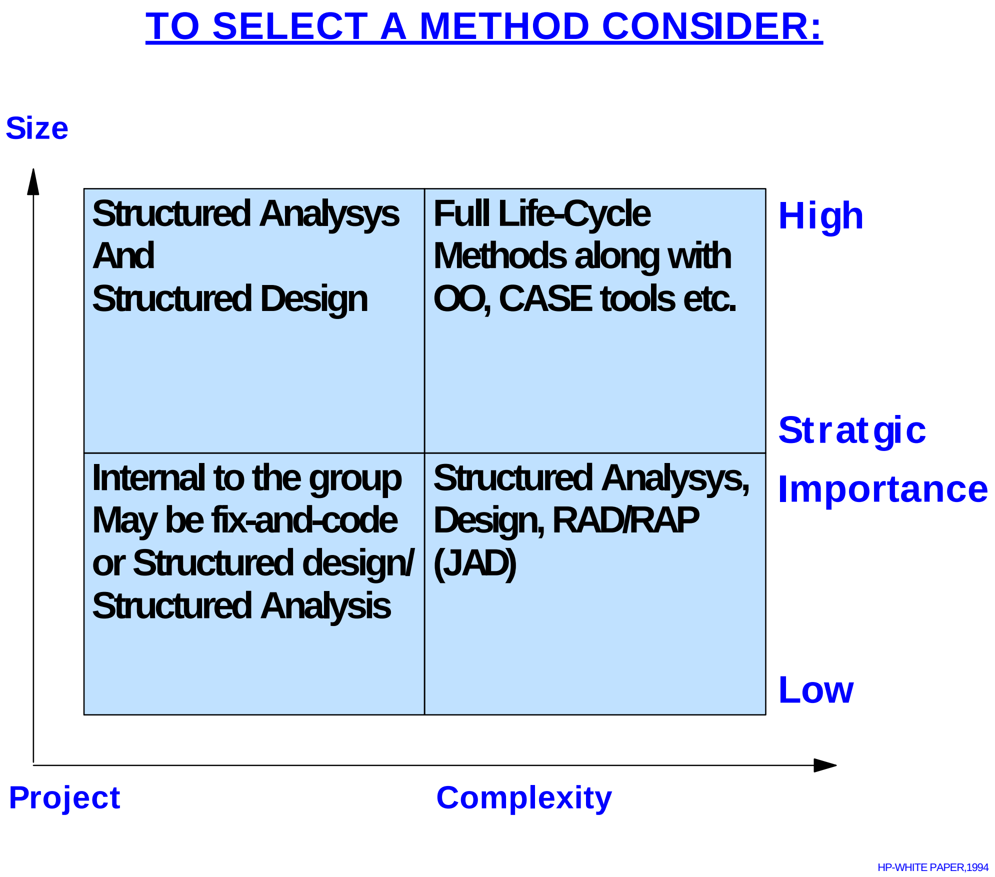
When asked, the organization will provide tremendous amount of data, reports, idea's etc. but often it is not hard to understand that there are many way's to approach the problem.

A few years ago the way to find out what to do was by a traditional approach like the Waterfall method which was described at an earlier stage.

It is not unlikely that GIS projects require different and more modern methods.

It is sensible to choose a methodology which is in line with the problem to solve.

Figure 24: Methodology Selection



As the graph (Figure 24) shows, and as was mentioned in chapter 1, JAD or Joint Application Development is a good approach when implementing a new emerging technology such as GIS.

Remember, implementing is much more than just configuring new tools but it also can have major organizational impacts. Business Process Re engineering (try to find an business magazine in which this is not mentioned) was invented because of this. JAD as a methodology is suitable if:

- The customer does not exactly know what to expect of GIS;
- The situation which has to be resolved by using the GIS isn't clear;
- It is not known what things to expect during implementation.

"The basic idea behind JAD is to select key end-users and conduct workshops that progress through a structured set of steps for planning and designing a system" (James Martin, 1995).

During the JAD workshop, consensus is reached on the business requirements (scope). Furthermore there is a large amount of involvement during the workshop which will ensure greater acceptance levels afterwards. The rules of a JAD session are:

- No egos;
- Only constructive comments;
- Only one person speaks at a time;
- Facilitator (project manager) is neutral;
- Team sets the rules;
- Agenda will be followed.

At the end of the JAD workshop the deliverables/ tasks and requirements should be defined. This list has then to be agreed with the project board!

3.5.7 PID: Deliverables, Milestones and Acceptance Criteria

A description is made of every deliverable. This can be a final product but also the functional specification of a certain product. It has to be clear, and agreed upon, what will be ready at which moment in time. The outcome of a JAD workshop or a RAD prototype could also be a deliverable. The deliverable has to be described so it is clear to everybody what has to be made. Also the time line and the acceptance and possibly the quality criteria have to be written down.

A deliverable flow diagram also is an important part of the project documentation.

It is important to define and agree upon deliverables and milestones during a project. A deliverable is the proof of an accomplished effort and it is:

- Tangible;
- Visible;
- Measurable;
- Quantifiable.

Of the various reasons for defining deliverables in the PID the two most important are:

1. To agree upon milestones with the project board which can be accepted at a certain moment in time;
2. To have visible milestones in the project.

In order to make the deliverables tangible, visible, measurable and quantifiable they have to be specified and acceptance criteria have to be created and agreed upon. It is not enough to state that a GIS has to create maps Deliverable definitions are required saying something like: “The GIS has to be PC based on Arc View providing a connection to a central Arc/Info system”.

Sometimes it is not clear what a deliverable should be. In this case it is possible to use Joint Application Development Techniques(JAD). JAD is one of the methodologies which were developed by James Martin (1995). The basic idea of JAD is to select key end-users and conduct workshops that progress through a structured set of steps for planning and designing a system.

One of the results of such a workshops is a list of deliverables.

The next problem is to find out if the objectives of the deliverables are met? For this reason there must be an acceptance plan. In the acceptance plan there can, for instance, be an acceptance test which has to be performed in order to show that criteria are met. It is not a good idea to delay the content of the acceptance plan until later in the project. A phenomena called “Creeping Elegance (constantly adding functionality requirements)” can have devastating effects. During development the idea's about the project can change. Where "having a connection between two systems" was the original goal, after some time, due to performance reasons, it could to become a "high speed connection with possibilities for file compression routines included". New functionality is always possible but it is a change to the original scope of the project and it must be made clear that it will have effects in term of costs, time, recourses needed or a combination of these.

Having deliverables also makes it necessary to have a quality plan in place which tracks technical, financial and time performance. For each major deliverable there should be a plan how to track the Progress and quality. It is obvious of course that it makes sense to place quality/metrics control into the hands of somebody other than the person who is responsible for the progress of the specific deliverable. Metrics are important in controlling all aspects of a project from direct control of implementation to monitoring of milestones. This is illustrated by the following table which shows the response times of the metrics needed by the different players.

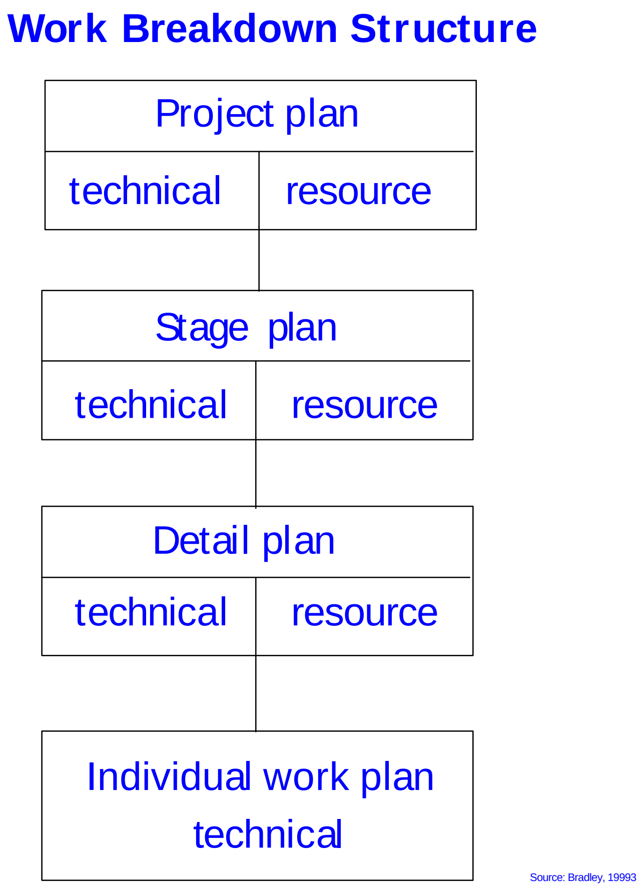
Primary User	**Engineers**	**Project Manager**	**Project Manager**	**Project Manager**
Use of Data	Understand & Change Software Work Products	Identify trends & Potential Problem Areas	Adjust Schedules	Adjust Plans, Revise Estimates
Optimum Timing	Seconds-Minutes	Hours	Weeks	Months

(Source:Practical Software Metrics for Projects and Process Improvement, Grady 1992.)

As the table shows an engineer needs immediate feedback whereas a project manager, depending on the kind of issue, needs either hourly inputs or weekly/monthly updates. If all goes well no response is needed but if there is a problem the engineer should be informed immediately so appropriate action can be taken. It is not enough to wait until the milestone date to find out what's wrong and why the milestone was not reached in due time. A project manager keeps track of the progress all the time so he can see a problem develop. Metrics are the tools which allow this process to work.!

Based upon the information acquired a Work Breakdown Structure is made. The project is broken down into sub-projects based on deliverables. For this purpose, automated tools are handy. A complete Work Breakdown Structure (Figure 25) will have the following elements:

Figure 25: Work Breakdown Structure



At the highest level is the project plan which is broken down in stages. The stages are broken down in details and if necessary there is an individual technical work plan. At all levels the technical issues and the needed resources are described. The project plan should be the consolidation of all lower levels.

In the PID it is not necessary to go into great detail with the work structure breakdown. It is sufficient if the major steps are described. If necessary detailed plans of every step can be made and added to the project file. After the deliverables, milestones, acceptance criteria and a work structure breakdown are made the plan has to be presented to the principal.

3.5.8 Present PID and Kick-off meeting

The PID has to be presented to the project board and they have to agree upon the plan. If the project board disagrees on the PID it has to be redone until agreement is reached.
This is of the utmost importance since the PID is a major management tool for controlling the project. An external kick-off meeting together with the management and representatives of the client is the next step. (NB: those who will be affected by the project should also be involved). Such a meeting stipulates the importance all parties see in the project.
Furthermore it is a chance to share the goals of the project with all involved and is an opportunity to introduce the key project members. Schedules, milestones, plans, roles and responsibilities should be shared.
A kick-off meeting should also be a time of celebration which is a chance to share the enthusiasm of the organization and project team towards this project.

3.6 Detailed Plans/Work Structure Breakdown

In the PID there is a work structure breakdown and a resource list. Depending on the complexity of the stages more detailed plans can be made describing each step. The principles are just the same as those used in the PID. The level of detail depends on several factors such as the complexity of the work, the size of the engagement and the experience of the staff involved. After getting an overview of the activities and tasks involved, two of the most important and difficult assignments of the project manager are to:

- Quantify the resources needed;

- Estimate time & costs.

There is software available on the market which enable a project manager to do this in a very structured way.

Basically there are two “charts” which are the basis for estimates:

- ♦ Gantt Chart; a representation of all tasks and their time relationships;
- ♦ PERT (Program Evaluation and Review Technique) Chart; a representation of beginning, end, duration and resources needed to accomplish tasks.

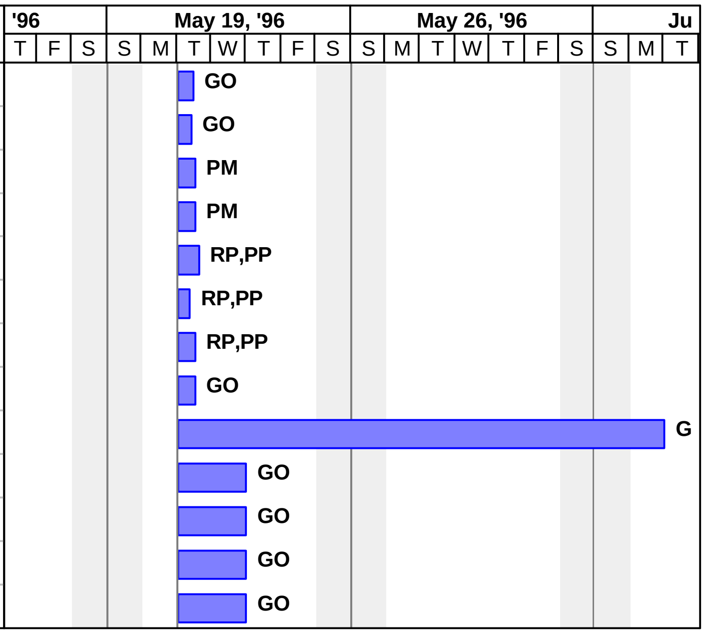
A PERT Chart shows the relationship between the tasks whereas the Gantt Chart shows the time constrains. In the following example data has been used from “The Project Management Handbook” of the British Columbia Ministry of Forest (date unknown) on a project in which there is a need for reports and maps showing the “waste” potential (the acceptable amount of waste) in a certain area. The list of activities/recourses is used as input for MS-Project, a planning tool.

The following diagrams (figure 26 & 27) show :

- ♦ Basic Input;
- ♦ List of relationships.

Figure 26 Basic Input

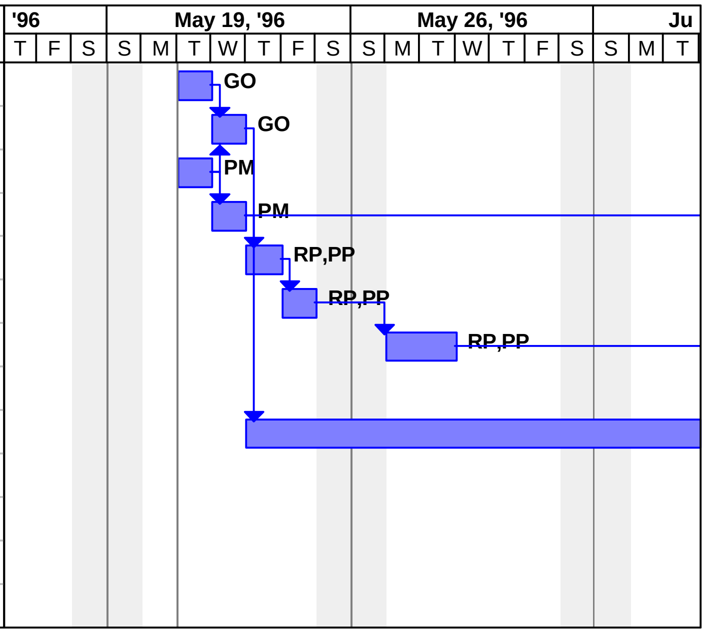
ID	Task Name	Duration
1	Download files	3h
2	Contact Pedologist	2h
3	Get terrain maps	4h
4	Get programming info	4h
5	Define Terrain database	6h
6	Design terrain attribute list	1h
7	Assign GIS levels	4h
8	Translate forrest data	4h
9	Digitize terrain maps	10d
10	Enter terrain attributes	2d
11	Produce update maps	2d
12	Digitize update map	2d
13	Mass-wasting program	2d



GO= GIS Operator, RP = Regional Pedologist, PP= Project Programmer, PM= Projectmanager..

Figure 27: List of Relationships

ID	Task Name	Duration
1	Download files	8h
2	Contact Pedologist	8h
3	Get terrain maps	8h
4	Get programming info	8h
5	Define Terrain database	8h
6	Design terrain attribute list	8h
7	Assign GIS levels	16h
8	Translate forrest data	16h
9	Digitize terrain maps	11d
10	Enter terrain attributes	3d
11	Produce update maps	3d
12	Digitize update map	3d
13	Mass-wasting program	3d

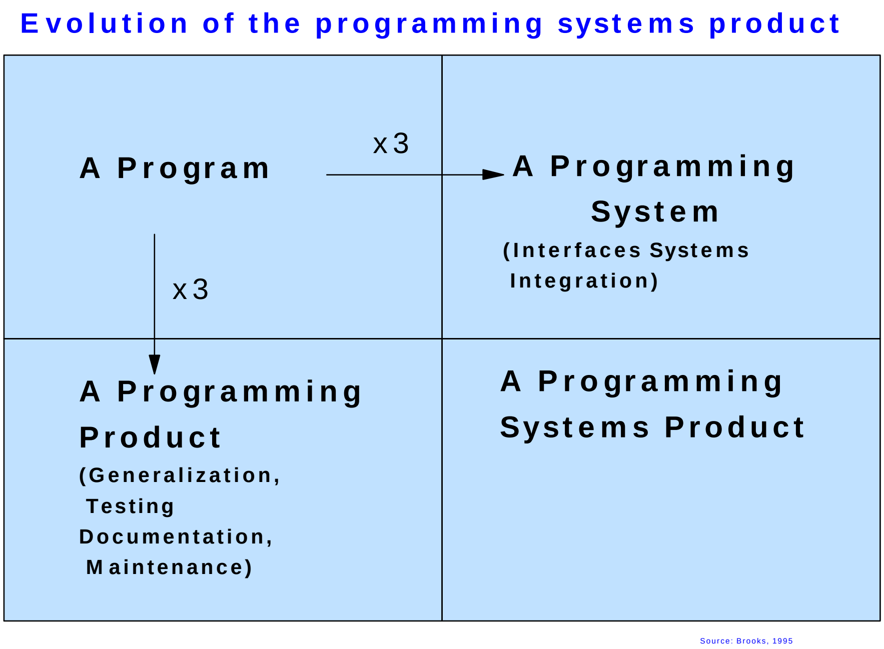


Unfortunately tools have no knowledge about the data. Even in this time of sophisticated IT systems the project manager has to provide information. This requires a lot off skill and experience. It is a major problem to estimate the time taken to complete tasks. Experience elsewhere often is of little value but everybody seems to be an expert. His or her son installed Encarta in only 15 minutes so installing a package like Arc/Info should take no more than a day. Though tempting to listen to such “experts” it is important to remember that the total in general looks more simple than the separate parts. This point is well made in “The Mythical Man-Month” (Brooks, 1995) which compares the difference in effort to create a:

1. Program, ready to run by the author on the system on which it was developed;
2. Programming product, a program that can be run, is tested, repaired and can by extended by anybody and which can be used in many operating environments and is well documented;
3. Programming system; a collection of interacting programs coordinated in function and duplicated in format;
4. Programming systems product, a programming systems which is truly useful object, tested, repaired, and documented and which can be used in many operating environments.

Most projects require programming systems products whereas most people think that they only require a program. As the following picture (Figure 28) shows a programming systems product requires at least 9x the effort building compared to a complex program.

Figure 28: Evolution of the programming systems product



Brooks does not compare the effort involved in turning A Programming Product of A Programming System into A Programming Systems Product in the figure. However he writes that this will take 9 times the effort of writing a program.

An experienced project manager uses some “rules of the thumb” if they have to give an estimation on the duration of a task which he understands but has no actual experience with: Take the time you believe it will cost, multiply this with factor 3 and in general this will reflect the actual time needed to do the task.

It is very important to discuss with the customer what his “documentation standards” are; what has to be documented and to what extent.. Making documentation is a profession as well and many projects fail either financially or totally because the documentation didn’t get enough attention. The size of this work should not be underestimated. Additionally if resources from the customer are needed it is important to agree this with the customer. Also it might be necessary to give training to personal of the customer either to get them involved in the project or to give them the necessary background to work with the system.

It is important to clarify what the project will **not** attempt to do. As John Tuman jr. the president of Management Technology Groups Inc.put it being able to say: “No we don’t intend to address this particular problem” is critical when clarifying roles and responsibilities. In the work structure breakdown every identified task should have a recourse and a cost estimate:

TASK	RESOURCE	DURATION	COSTS
Define Data Model	Senior Programmer	100 hours	120$/hours 12000
Discuss with Modelers	GIS Specialist	60 hours	150$/hour 9000
Build Data Model	Senior Programmer	250 hours	125$/hour 31000
Coordination	Project Manager	40 hours	200$/hour 8000

The required skill set of the resource needed has to be defined so there can be no misunderstanding about this. For instance a senior GIS programmer is somebody with at least 5 years experience with Arc/Info and not somebody of 60 years or older. Similar specifications are needed for needed recourses from within the organization.

After defining the input to the analysis the next step is to specify the interdependencies of the tasks. Like building a house; it is unrealistic to place the roof before the walls are ready. However it is possible to make the necessary preparations, or even start building in case of a prefab-roof, during the creation of the walls.

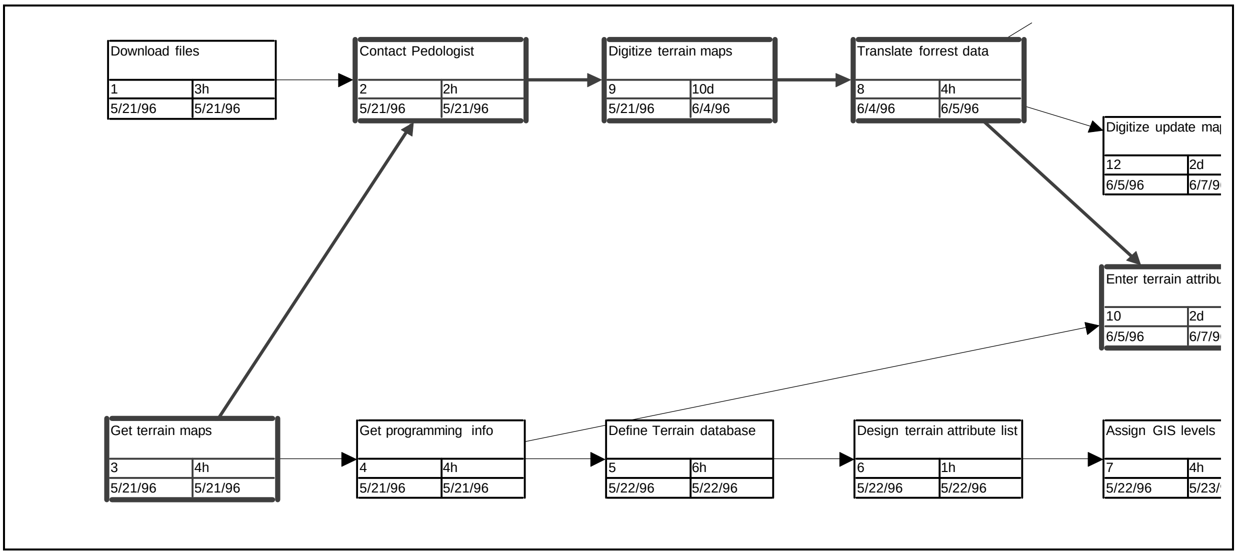
The next example shows what good planning can do:

Activity	Duration	Total
Creating the walls	12 weeks	week 1 - 12
building & placing the roof	4 weeks	week 12-16
total time needed	16 weeks	**16 weeks**

Activity	Duration	Total
Creating the walls	12 weeks	week 1-12
roof preparation	2 weeks	week 10-12
roof placement	2 weeks	week 12-14
total time needed	16 weeks	**14 weeks**

By knowing the interdependencies of the tasks it is possible to make a planning in which certain activities go in parallel thus diminishing the total time needed for the completion of the project. The best way to do this is to work backwards from the point that the project is completed. It has to become clear what are the predecessors of certain tasks, what are their duration and earliest starting and latest acceptable starting dates. By means of this input it becomes clear what the total duration of the project is and how the critical path looks.

Figure 29: Critical Path



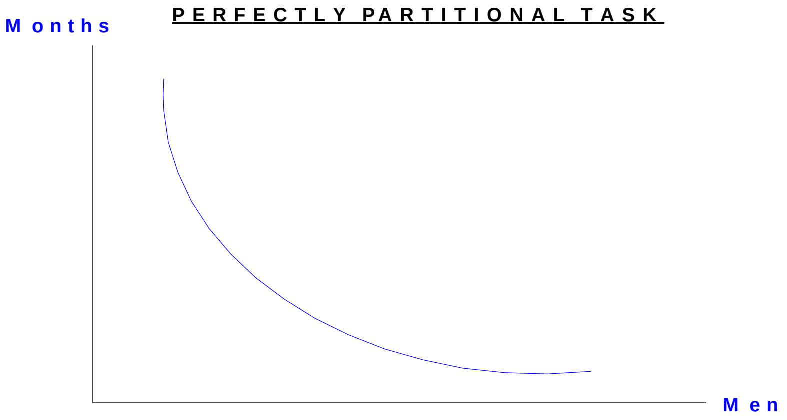
As this PERT chart (figure 29) shows activity nr 2 can only start after the completion of activity number 3. Activity 10 can start after the completion of 8, 9, 2,3,and 4.

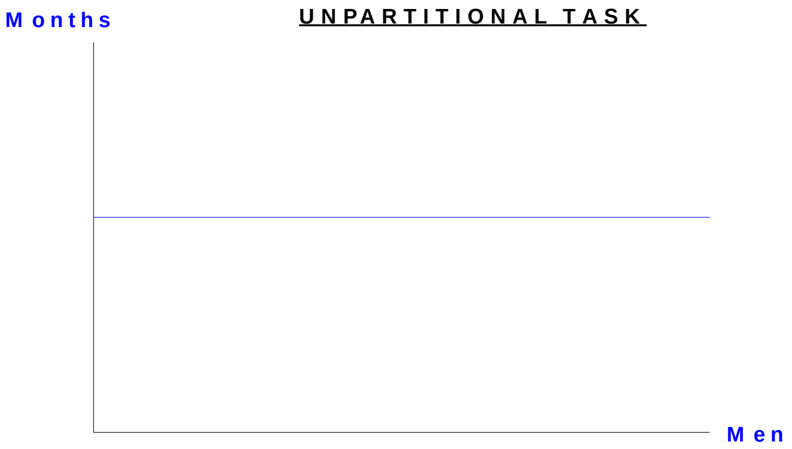
Imagine doing this on a sheet of paper specially if changes must be made in the planning!

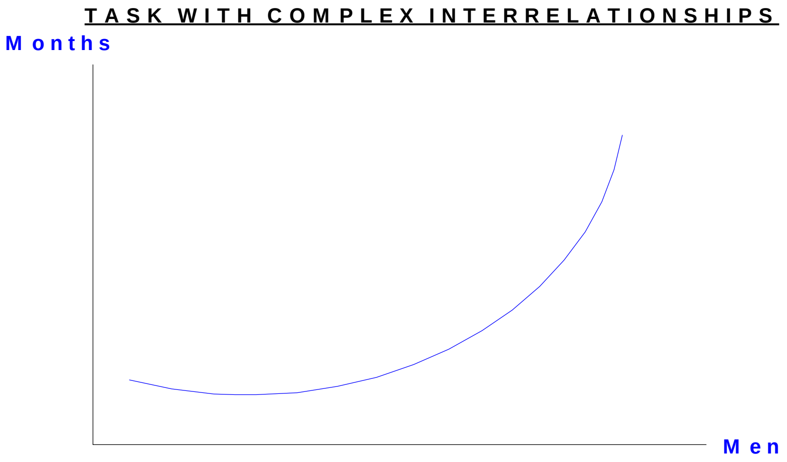
There is a tendency to believe that by adding resources it is possible to shorten the needed time for a project. This sometimes is valid but it depends greatly on the nature of the project. Getting a baby will take something like 9 months but even when putting 9 women to work it will not become 1 month! Or how about 9 dentist trying to pull 1 tooth

The next graphs (figure 30,31 and 32 show the effect of increasing resources, the effect depends on the kind of task:

Figure 30,31 & 32: Types of Task





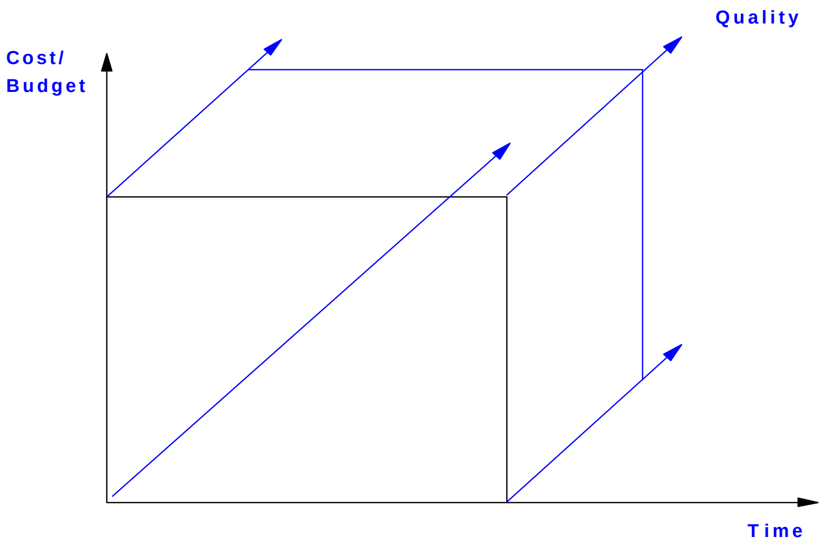


As the graphs (Brooks, 1995) show, increasing resources do not always mean that the total time needed will be shorter. In certain cases the duration of a project will increase when the number of people working on it grows (and so will the costs).

On the basis of the work structure breakdown and it's related costs, recourses and time constrains a discussion with the project board or sponsor can be held about the project and it's milestones . By doing this the customer stays involved in the project.

Whenever a discussion starts about the duration, costs etc. remember there is a firm relationship between quality, costs/budget and time(figure 33):

Figure 33 Relationship between Costs, Budget, Quality and Time



Finding the right combination of technical performance, financial performance and working within a given time schedule to provide the necessary quality easy. The customer has to be made aware of "quick and dirty" principles if he starts pushing to the limits. Also keep this picture in mind if requests for changes are made. Make sure they are de-scoped from the original project.

3.7 Monitoring

3.7.1 General

After spending 90% of the available time and 80% of the available money only 15% of the work is done. Though this seems ridiculous these things happen all the time. Without a mechanism for adequate monitoring and reporting it is very difficult to keep track of a project.

Most GIS projects are costly, complex and last over a long period of time. Furthermore there is relatively little experience in the field of GIS projects as it is a new field compared to other IS projects such as financial applications. Without a well established plan to control the progress of a GIS project problems will occur. It is not enough to have only the normal project reporting of the project team members. It is also necessary to have formal meetings progress meetings to ensure that it is given enough and regularly attention.

3.7.2 Progress Meeting

The objective of the progress meeting is to measure the actual progress against the project plan and to address eventual problems. Progress meetings should be held at regular intervals (e.g. weekly) and both the project manager and stage managers should be present.

During the meeting at least the following issues have to be covered

- Progress of each activity against the project plan;
- Review of the total engagement against schedule, costs, open issues, quality review status, known problems;
- Customer relationship

The end result of the meeting should be a progress report containing the results of the meeting, any alternative plans and (if necessary) a new schedule. Furthermore a brief overview should be sent to the project board to inform them on the progress.

3.8 Risk Management

3.8.1 General

"Project Risk is the cumulative effect of the changes of uncertain occurrences adversely affecting objectives" (Project Management Institute, 1992).

The goal of risk management is to identify project risks and develop strategies to reduce or to enable steps to avoid risks.

Risk management is a part of everyday life and it is something which is done on a every day basis. Think of driving a car through rush-hour traffic when you are late for an appointment, most people drive at a different speed and take more risks compared with the Sunday afternoon trip with the family to visit relatives. The benefits of the higher speed to reach the appointment in time are seen as making the extra risk acceptable.

Nobody will send a 5 year old child with a purse full on his bicycle to the middle of town to buy a color television set. There are to many risks involved:

- Traffic accident;
- Diversion;
- Wrong Television;
- Theft of purse or television;
- etc.

Yet if the child would be 18 years old many of the risks, which still exist , have different values and the chances they will occur are much smaller. Risk management is about identifying risks and assessing the changes and impact if they occur.

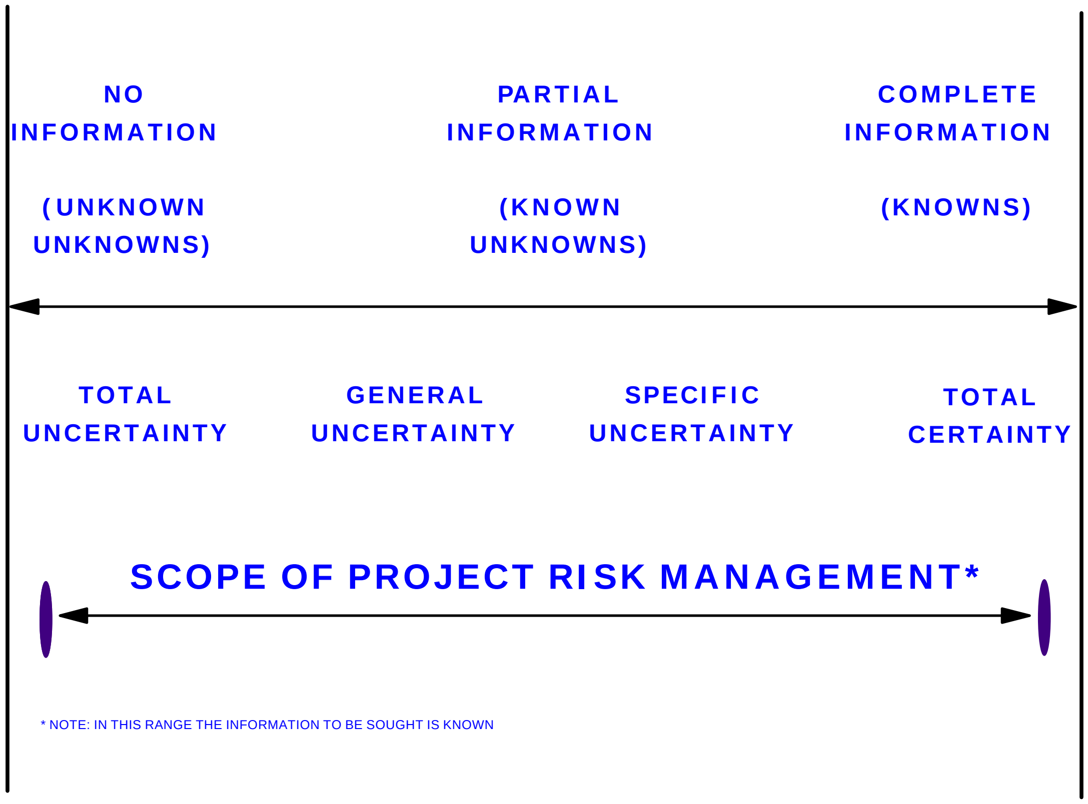
INPUT, an independent market intelligence organization studied project success factors, by means of questionnaires and interviews, in Europe and the USA. Their study revealed 4 major factors why projects fail:

1. Initial requirements are inadequately defined;
2. Poor management by vendor;
3. Inadequate risk evaluation at the start of the project;
4. Lack of user involvement during the course of the project.

(INPUT:1994)

In chapter 1 of this thesis the principle of de-scoping and the principle of the known-unknowns was mentioned. Risk management tries to quantify the risks associated with this. The Scope of Risk Management is shown in figure 34.

Figure 34 Scope of Risk Management



Realize that risk management does not eliminate the risk but anticipates it and enables managers to take decisions beforehand; *risk management isn't crisis managemen*t.

Risk can be handled in a proactive and a reactive manner.

Proactive means taking steps to avoid the risk; reactive means defining actions to take if the risks actually emerges.

Imagine building a system with the following objective:

‘Keeping a fleet of trucks on the road and making sure vehicles arrive as quickly and a safely as possible at their destination’. A powerful combination of GIS and GPS can accomplish this task.

Though there is undoubtedly a lot of pressure involved in putting such a system in place the results of a malfunction could be enormous. For this reason there should be a proactive approach: The software will be tested up front. This probably will be done by means of a live-test where the systems and the “old” planning mechanism will work simultaneously for some time looking for faults in the new software and thus diminishing the risks.

A reactive approach to this same problem would be an action plan which comes in place if there is a problem with the software. In this case probably both strategies will be necessary since testing is never 100% . In fact the approach which is taken depends much more on the impact of the risk then on the chances it will actually occur; for a piece of software used to control a nuclear power plant it is not acceptable to test only 95% of the code, for a Internet Web browser one might wonder if even 60% of the code was tested.

3.8.2 The four phase approach

Basically there are 4 phases in Risk management:

1. Identification;
2. Assessment;
3. Response;
4. Documentation.

Identification:

How does a project manager know if there is a risk?

There are some general project risk situations which are good signals:

- The project sponsor/board does not recognize that every project is an exercise in risk;
- The project is very different from the last one;
- There is a feeling of uneasiness;
- The project scope, objectives and deliverables are not clearly defined or understood;
- There are a large number of possible alternatives;
- Some, or all technical data is lacking;
- Standards for performance are unrealistic or absent;
- Costs, schedules and performance are not expressed in ranges;
- The future timing of events is vague;
- Prototype of a key element is missing;
- High R&D component;
- Similar projects are delayed or have failed;
- Wide variations of bids were received;
- No appropriate contingency planning;
- Someone starts “heading for the best” without any plan.

(Source: Project Management Institute, 1992)

In order to get a good idea of the project risks a brainstorm session is a good tool. In such a session a group of experts using the available information look at both the vulnerability and potential risks.

For vulnerability risks the confidence level of the experts can be used. Vulnerability addresses questions such as; Is it possible to access an Oracle Database with ArcView and can we build the desired program? Depending on their experience experts should be able to tell about such risks.

For potential risks a "What if" analysis is the appropriate way to do an assessment.

The following probability and impact matrix can be used:

Probability				
High	HL	HM	**HH**	
Medium	ML	**MM**	MH	
Low	**LL**	LM	**LH**	
	Low	Medium	High	**Impact**

HH

You can manage the cause -> Pro-active plan

You can't manage the cause -> Contingency plan

MM

Mostly contingency plan

LL

Don't worry

LH Do the utmost if it occurs (e.g.World war III)

A preventive action plan will: Reduce the potential of the risk.

A contingency plan will: Reduce the impact of the risk.

The problem is of course selecting the right approach. It is basically very simple, all project risks are characterized by the following three risk factors:

1 Risk event: What might happen to the project;

2 Risk probability How likely is the event to occur;

3 Amount at stake The severity of the consequences.

The formula is: Risk event = Risk Probability * Amount at Stake.

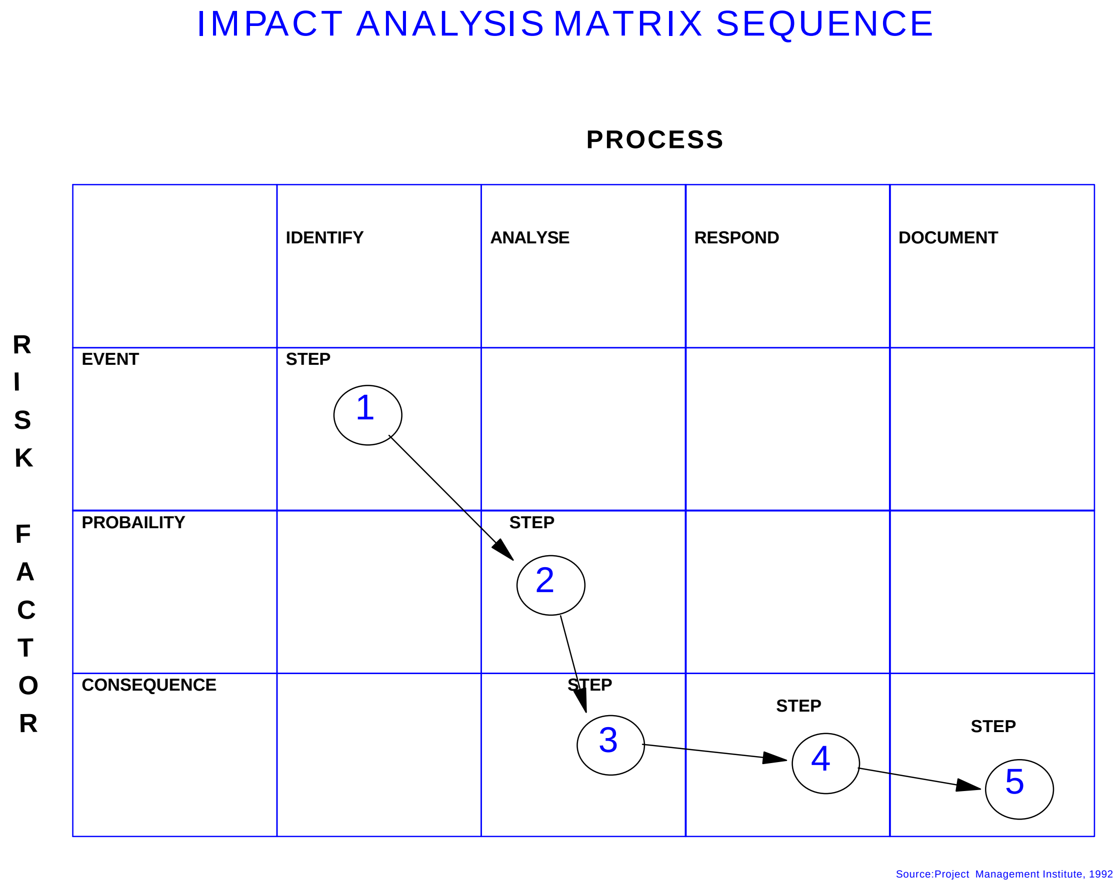
On the basis of the outcome of this formula a decision must be made whether a preventive action or a contingency plan is appropriate. During the assessment more information on all the mentioned factors is gathered.

3.8.3 Assessment

Remember: *An unidentified risk is a threat, a defined risk is an opportunity.*

Risk is natural; there is **no** way to diminish all the risks but the consequences of the risks can be accessed. A simple assessment is shown in Figure 35:

Figure 35 ImpactAnalysis



Step 1: Select events to be examined by organizing a brainstorm session;

Step 2: Analyze the probability based on the methodology described before.

Imagine the situation were final planning may start after the scope is defined and there is a final approval: If there is a probability of 80% that the scope of the GIS project is defined by next month and the chance of final approval is 70% the chance that both events will occurs is: Pr(event1)*Pr(event2)=Pr(both events)

$$0.8 * 0.7 = 0.56 = 56\%$$

So the chance that the scope will be defined and the project will be approved is only 56%.

If only scope or approval is needed to start the project planning the picture looks quite different:

Pr(no scope) * Pr(no approval) = Pr(no planning)

0.2 * 0.3 = 0.06 (6%)

Based on these kind of calculations (which in practice are often a bit more complex) it is possible to look at probability and associated costs.

Step 4: Defining a response.

Knowing the consequences of a risk makes it possible to develop a suitable response. Such a response could be e.g.: gather more info, find additional funds, find assurance company to assure certain risks.

Step 5: Conclusions & recommendations.

In the last step conclusions and recommendations are made to clarify the risks involved. This results should be taken into the project planning and communicated with the project board. Based on the outcome of this communication the decision to run or even stop the project can be made.

3.9 Change requests, expectations and deviations

3.9.1 General

That change is the only certainty in this uncertain world is a popular statement. Though this is undoubtedly true it is not acceptable for a project or for the project manager.
After the PID is made and agreed upon all changes have to happen in a controlled environment. Not so long ago organizations in charge of project management refused to accept request for change from their principals or they charged ridiculous prices to implement changes. For GIS projects the situation is very different. Remember most GIS projects, until a few years ago, could be found in the ‘experimental’ square of the McFarlan Model. Changes were not a big issue since everybody recognized that this was necessary.

As GIS projects move into the strategical or mission critical square it becomes very important to control the requested changes by the customer.

Even with techniques like “Rapid Application Design” at a certain moment in time everybody has to agree upon the functional and technical design and all changes have to be examined.

3.9.2 Change Control

The customer, for whom the GIS system is made, is of course in control of the change. After all his organization has to work with the system and get the necessary results out of it. Asking for changes is very tempting:

1. Could you add this functionality as well?
2. I’d like to have a push button over here;
3. Could you present this data as well?
4. etc.

Many of the requests at first glance seem to be easy to realize. For reasons of customer satisfaction, often without further analysis, the changes are made.

This is very dangerous, looking at the examples above the following questions are relevant:

1 How will this affect the other parts of the application?

2 Maintenance could become more complex;

3 Performance of the system might diminish;

4 etc.

If change occurs the following questions have to be addressed:

- ♦ What is the impact of the change (time/costs)?
- ♦ What are the risks involved with this change for the entire project?
- ♦ Is this an essential change?

- What additions are necessary and who is responsible for the result?

Every change should be properly documented on a change request form (see addendum) and be signed off for approval by the project board.

3.10 Exceptions

Even it the planning is suburb, everybody agrees, and the project looks like a dream-case exceptions will happen. Nobody can foresee the unforeseen but if the unexpected happens action has to be taken to resolve the problem.

Basically the steps are simple:

1. Identify the problem;
2. Describe the reasons how the problem started;
3. Access the impact on the project (time/costs/quality/etc.);
4. Make a recommendation how to solve the problem;
5. Access the impact of the recommendation on the project;
6. Describe any other options (if appropriate);
7. Access the impact of the other options on the project;
8. Inform and involve the project board;
9. Gain approval for the solution proposed;
10. Incorporate solution in the project plan.

Exceptions should be very well documented. An example exception form can be found in the addendum.

An example of an exception could be:

In a GIS project the digitizing will be done by the digitizing department of the organization. It will take 3 persons four months.

Another project however slipped dramatically and due to the penalty clauses in this project it is necessary to put all resources on this project.

Problem:

Due to unavailability of Digitizing Department digitizing will start in July instead of March.

Reason:

Other priorities set by company management.

Impact:

6 months delay in the project as other resources have to be rescheduled as well.

Financial impact is an additional costs of.............

Recommendation.:

Have an external company do the digitizing.

Impact:

Project costs will increase with............

Option:

Hire free lance digitizing staff.

Impact:

Difficult to find and often of low quality

Recommendation:

Not a good alternative.

3.11 Threats in a project

In the article "Software Engineering in GIS Development" Williams and Bury make the following two statements:

- Modern GIS systems are as complex as the problems they're intended to solve;

- The implementation of a GIS system should be engineered just like any large software system.

GIS, MIS or any other large project within a company or within government is a risky endeavor and unless carefully planned doomed to fail in one way or another.

A few of the risks involved in projects are:

- Unclear Business Objectives, the objective of a project should be clear otherwise the expectation level isn't in line with reality;
- Unclear Requirements, if it is not clear what a system is expected to do the results will be poor. A system for financial planning for one person might mean a multi-million dollar SAP system and for others a Lotus spreadsheet;
- Unrealistic Objectives, often companies expect projects to solve problems which actually require organizational or process changes;
- Poor Planning, large projects tend to be very complex both from an organizational and from a financial point of view. A planning methodology and lots of experience are required to get good and realistic planning in place;
- Unclear Deliverables, Depending on the point of view the deliverables might be looked upon in different ways causing wrong expectations.
- Lack of ownership, unless there is involvement of all parts of the organization involved they won't feel any responsibility towards the project or might even feel threatened by the project;
- Ineffective Tracking, a formal tracking method is needed to avoid situations where 95% of the time and money is spent and only 15% of the project is done;

- Creeping Elegance, though tempting it is very dangerous to change the functional specifications during the process to improve the end result. This phenomena called creeping elegance might complicate the entire project and give major future support problems.

As GIS matures the expectations of customers change and they will expect the same from a GIS project manager as from any other project manager.

There are two way to tackle this challenge:

- On intuition;
- With a structured method / methodology.

Companies quickly find out that intuition alone isn't enough so there is a preference to handle projects through a methodology.

However always remember that a methodology can never be an excuse not to think! As De Marco and Lister (1987) say: “Methodologies encourage people to start thinking in a paranoid defensive way. The last project which had 1 ton of documentation was a mess so this project has to produce 2 ton’s of documentation. Voluminous documentation is often part of the problem and not the solution”.

The answers lies in a combination of methodology, responsibility and motivation.

Basically there are only 2 questions for a project manager:

- What do I have to build?
- How do I build it?

A project manager who has a clear view and can answer these questions will succeed.

3.12 Project Closure

3.12.1 General

It is difficult to come to a formal end of a GIS project. There are several reason for this including:

- No acceptance criteria defined at the beginning of the project;
- Arguments about the objectives, scope and deliverables between project manager and organization;
- Extra functionality (changes) introduced during the project with no proper risk/cost/time assessment;
- No formal procedure for project-ending was agreed upon.

If possible every project plan should have deliverables and milestones. The project manager and the project board agree upon milestones and deliverables. If necessary the project manager negotiates with the project board which actions are necessary before a deliverable is accepted.

Quality management will be very helpful to ensure that criteria are met. At the end of the project the entire solution has to be delivered and accepted formally.

3.12.2 Acceptance testing

If the acceptance test is not agreed upon at the beginning of the project a project manager can be in trouble. For this reason a test plan has to be established and agreed upon at the beginning of the project.

Such a plan should at least contain:

- What aspects of the solution will be measured;
- What are the conditions of the test;

- When will the solution be accepted, denied or partly denied;
- Who will sign for agreement;
- What will be the procedure if the parties don't agree;

As user expectations change during the project the acceptance plan is a good development guide line. A successful acceptance test should be signed off.

3.12.3 Project Closure Meeting

Though a successful acceptance test often is sufficient to end the project a formal project closure meeting should be conducted.

During such a meeting the following actions have to be conducted:

- Confirm completion of all deliverables;
- Close all open issues;
- Make sure that the solution can move into a support mode;
- Sign a formal acceptance letter with the principal.

During this meeting the project manager, stage managers and the project board and executive steering committee have to be present.

3.13 Quality Review

In their book "People ware" De Marco and Lister (1987) make the following statement on quality: *"Quality is free but only for those who want to pay for it"*. What they mean with this statement is the following; organizations who are not prepared to spent money on quality or live by the rule:" quality, but only if there is time" will get what they what they are asking for -> no quality at all!

Nevertheless it is important to take care about quality assurance throughout the project. In " Assessment and Control of Software Risks" Jones (1994) says: " Costly and late projects invest most of the extra work and time in finding and repairing errors in specifications, in design, in implementation". The data he uses shows a strong correlation between lack of systematic quality control and schedule disasters.

For this reason a quality plan must contain at least the following:

- Quality assurance procedures and measures;
- Major deliverables to be tested and reviewed;
- Time plan;
- Review team members must be in place.

The quality criteria or measures should be documented in the technical specifications of the product. Sometimes the client has specified quality matters such as MTBF (Mean Time Between Failure) of MTBR (Mean Time Between Repair) figures as a quality measure.

The quality review team should look at the product they are reviewing and not the errors they find based upon:

1. Their understanding of what the product should be;
2. Quality criteria as stated in the product plan.

The review has to be a formal process done in a methodological way resulting in a list containing the errors the team found and agreed upon so they can be corrected in a later stage.

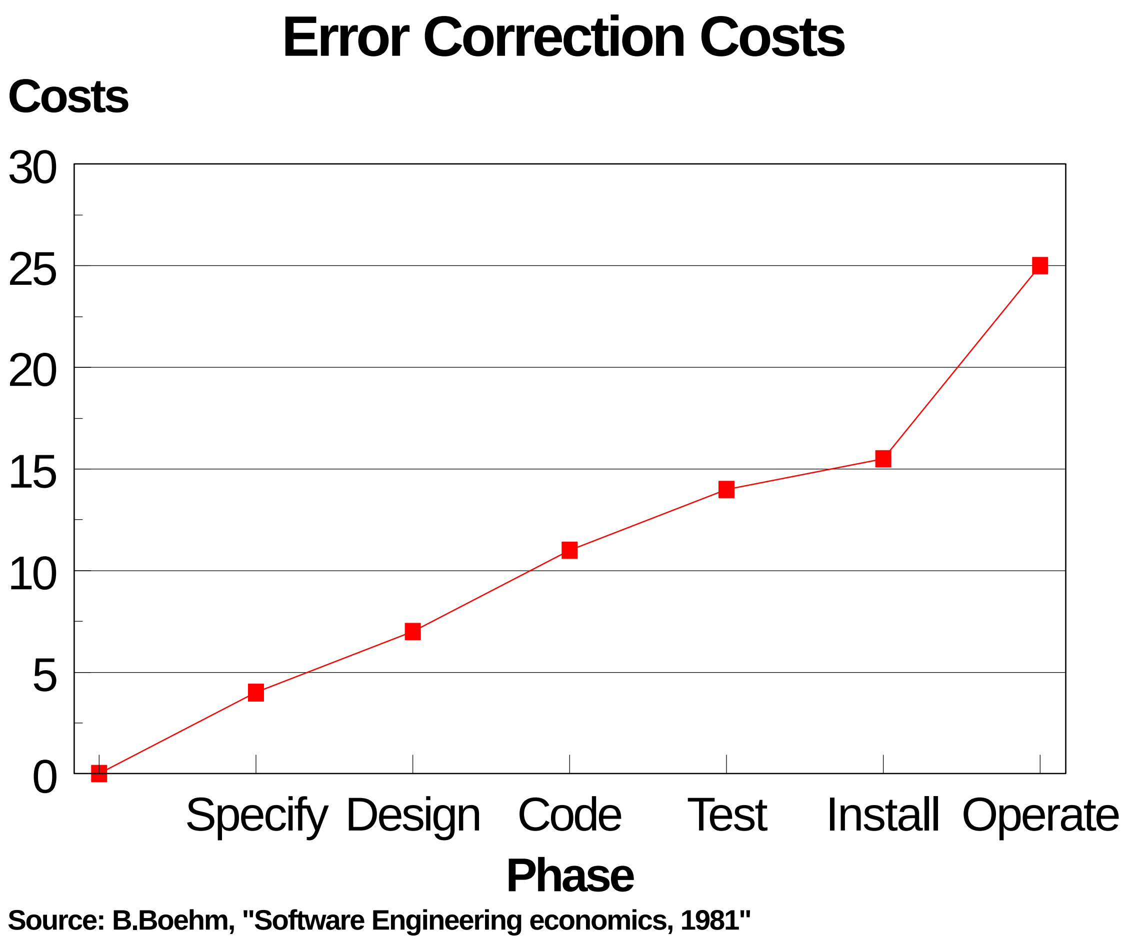
The end result of the review can be 3-fold:

- Completed; the deliverable will be formally accepted;
- Follow-up required; a time-limit and the actions to be taken must be agreed upon;
- Rescheduled, a new quality review will be done for this deliverable as it did not meet specifications and needs major rework.

In the addendum there is an example quality review form which can be used in projects. Quality reviews are no threat to a project manager. Junior project managers tend to postpone quality reviews until the end of the project and find out, often very late or even too late, what went wrong. It is worthwhile, if possible, to do a quality review as early as possible for instance over the specification or the design.

The idea behind this is that it proves to be cheaper to repair failures in a early stage of the project.(Figure 36)

Figure 36: **Error Correction Costs**



This picture shows that a failure which is noticed in the operating phase is 5 times more expensive to repair compared to a failure noticed in the specification phase. Quality reviews are a way to ensure that mistakes are noticed as soon as possible thus diminishing costs.

3.14 Training

The importance of training people is often underestimated. Training and education should be in line with the activities in the project plan. Though it seems to be very inexpensive to do, "training on the job", which in reality often means working via a trial and error approach, can never replace the benefits of formal training.Adequate training will enable those who receive the training to do their job more effectively.

Huxhold and Levinsohn (1995) provide a sample education and training program which can be of help deciding what training is required:

Sample Education and Training Program				
Who	**Topics**	**Purpose**	**Forum**	**When**
Senior management process	GIS orientation and Implementation	Benefits and implications of GIS implementation	Half-day seminar (GIS demonstration)	At start of GIS planning and implementation
Business Unit Managers	GIS orientation Implementation process GIS fundamentals/ application	Familiarization Allocation of resources	In-house seminars GIS conference attendance In-house seminar	At start of GIS planning Prior to GIS implementation During Implementation
Non technical end users training	GIS orientation Applications limitations	Familiarization Capabilities	GIS concepts course In-house seminar Vendor training during installation	At start of GIS planning Prior to Needs Analysis
Operations staff	GIS orientation Task and technology specific training	Task of technology competence for GIS operation	GIS concept course Vendor training On-the-job training installation	Prior to Needs Analysis/ Functional Specs Technology
Systems staff	GIS orientation Analyses and design GIS development tools	GIS design techniques competence Software customization	GIS concepts course Vendor training Systems course	Prior to analysis and design tasks. Prior to system installation and testing
Project team	GIS orientation GIS project design and management	GIS concepts GIS management competence	GIS courses Mentoring program facilitated by a GIS expert	Prior to project start Prior to GIS implementation

3.15 Support

The final step in the project is to make sure that the solution will be supported and procedures are in place for changes. Also the appropriate contracts for hard-, software and application support have to be in place. The support plan must address the customers stated requirements. Detailed approach plans for specific situations must be in place. Typical parts of a support plan could be:

- Warranty criteria;
- Maintenance plan;
- Hard/Software support plan;
- Reliability (Mean time between failure/Mean time to repair);
- Contingency plans;
- Software changes/improvement plan.

In the support plan also the costs of labor by contractors on the developed product for maintenance or change requests can be included. The content of the support plan, as stated, depends on the customer requirements. If the system has to be functional for 100% during weekdays between 0.800 - 17.00 hours it might be necessary to have a fall-back system. In the support plan the necessary actions, such as be the purchase of a fall-back system should, be mentioned.

3.16 Summary

In this chapter a practical approach to handle GIS projects is introduced. When the position of GIS on the life cycle is determend and a methodology is chosen the question “in what way has the project to be conducted” remains. By putting a lot of emphasis on the project initiation, the involvement of the appropriate levels of the principals senior management, by clearly defining the milestones and deliverables and by doing risk management it is possible to create a controlled GIS project environment.

A GIS project conducted in this way has a good change of being:

- On time;
- Within budget;
- On specification;
- Useful to the customer.

Yet two important questions remain:

1. Are GIS projects different from other IT projects?;
2. Will the proposed approach actually work?

In the next two chapters these questions will be discussed.

4 THE SPATIAL COMPONENT; ARE GIS PROJECTS DIFFERENT?

4.1. Introduction

This thesis explores the best ways to handle a GIS project. It is important to understand if GIS projects differ from other IT projects in order to determine the best way to handle a GIS project. In this chapter, through literature study and from own experience of the author a comparison between GIS projects and other complex IT projects is made.

GIS projects are considered "special" because of several reasons such as:

- GIS is a new technology;
- The term GIS can mean a lot of different things, it is not well defined;
- GIS is considered to be difficult.

Based on the above assumptions the questions "Are GIS projects different?" is approached and answered.

4.2. The G in GIS

"Geographic Information" is information which can be related to specific locations on the Earth. It covers an enormous range including the distribution of natural resources, the influence of pollution's, description of infrastructures such as buildings, utility and transport services, patterns of land-use and the health, wealth, employment, housing and voting habits of people.

Most human activity depends on geographic information: on knowing where things are and understanding how they relate to each other.

(Handling Geographic Information, Report of the Committee of Inquiry chaired by Lord Chorley, Departement of the Environment, 1987).

Many Information Systems in use by companies and organizations deal with information which has a spatial component. Any database containing addresses or location codes has some of these characteristics yet we don’t call such a system a Geographic Information System.

- Until only a few years ago systems capable of doing GIS tasks like spatial analysys were not available or extraordinary expensive. The recent price decreases of computer systems and the tremendous performance improvements have changed this situation dramatically in the last decade and made GIS affordable. Applications which were considered to require mainframe capacity nowadays run smoothly on a Pentium PC. Suddenly it is possible for any organization to have an information system with a spatial component; a GIS.

4.3. The IS in GIS

Information Systems can have different roles in an organization. According to Strobl (1995) they can be:

- Operational Support of processes; getting the data needed in the process. Or to put it in a more simple way; automating the day to day processes like a database of clients or in case of a GIS the catalog of a collection of maps;
- Documentation of records, documenting the available records of an organization;
- External information; providing information about activities and records of an organization for marketing or sales purposes;
- MIS; Management Information Systems; supporting management in providing information.

Most IS systems can be put in one of these 4 categories.

The position of an IS system in the organization depends on the category in which it is placed and can be either:

- Central; for the entire organization or a large part of the organization e.g. a customer DBMS;
- Departmental; only used in a specific department e.g. a marketing DBMS;
- Specialist Group; only used for a very specific purpose e.g. a CAD system;
- IT infrastructure; the basic infrastructure of the entire IT operation e.g. a network management system;
- Outsourced; considered to be a non-core operation of the organization and placed in external hands e.g. a salary payment system.

When looking at GIS on basis of these categories it is not so difficult to understand why GIS is considered to be different from “normal” IS systems.

Most IT managers haven’t got the faintest idea what a GIS system is. What they know is that it has to do with maps or drawings. For this reason GIS and CAD are often placed in the same category: difficult and only useful for the specialist but no part of the central IS environment.

This positioning of GIS is both an advantage and a disadvantage.

Why an advantage?

“Many of the first GIS projects were undertaken by departments without the involvement of a central IT/IS department. A lot of freewheeling was done by GIS enthusiasts who had knowledge and idea’s about Spatial Information but not so much knowledge about IT and IS strategies and practices. Nor did they see GIS as a part of the Corporate Information Strategy “ (Grimshaw, 1991)**.** The projects they did however turned out to be successful and enabled organizations to do things, like complex spatial analysis, which were almost impossible in the past and often of strategic importance to the organizations.

Why a disadvantage?

"More than with other sectors of automation in GIS there is a tendency to abandon the IT profession, somebody who has had a small course in programming should be able to build a system". (Corsten, 1996, Manager of Urbidata interviewed by Mom of VI Matrix magazine).

GIS implementations that are ad hoc developments primarily designed to improve the operations of the organization are potentially under utilizing the benefits of GIS. Managers need to see GIS among a range of management support tools, in a way that other information systems might be viewed (Grimshaw, 1991). After the successes in the 1980's the expectation levels of an organization on GIS are increasing. Results presented by Grothe et al (1994) and Grothe and Scholten (1996) show that GIS is moving from being experimental to being strategic or even mission-critical. In this process the demands put on a GIS project become higher and higher. IT specialists are needed (as well) to make such projects successful even though they might have been a burden in the past. Without the involvement of IT and IS specialist it is not possible to integrate GIS with the other IS systems in the organization as for this the cooperation of the IS and IT department is needed

4.4. What is so special about GIS?

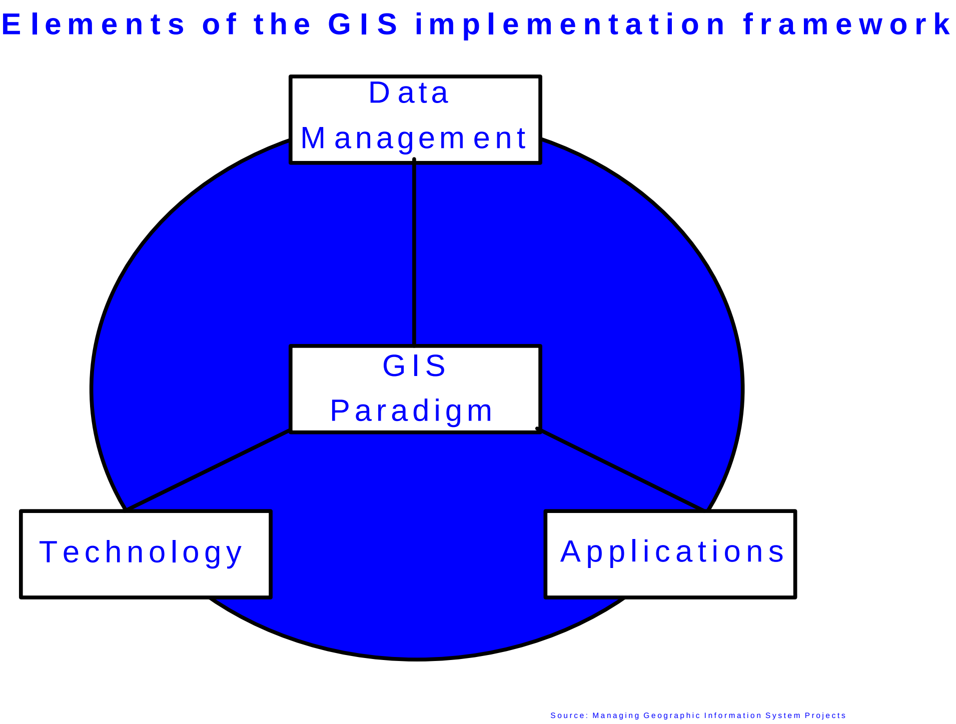
There are several descriptions of GIS.:

- "A GIS is a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real word. (Burrough, 1986)".
- "A System for capturing, checking, manipulating, analyzing and displaying data which are spatially referenced to the Earth (Departement of the Environment,1987)."

- " A Geographic Information System is a decision support system that integrates spatially referenced data in a problem-solving environment (i.e. application). (Grupe, 1990)."
- " The total of actions and tools that will lead in doing task and taking decisions in relation to spatial questions to the supply of relevant information. (translated from Scholten, 1991).

The difference between the above descriptions are considerable and shows that the field of GIS are broad and complex. Huxhold and Levinsohn (1995) show some of this complexity in what they call the GIS paradigm which is shown in Figure 37:

Figure 37: **The GIS Paradigm**



GIS projects have to do with a combination of applications, technology and data management. It is important to mention that some of these don't have to have any spatial component at all. An application could be a database with information on a object which is geo referenced in an other database. What obviously is missing in this framework is the organization, the people in the organization and their functions.

One model which includes these and which makes it more easy both to understand why GIS projects are complex and to see the speed in which things are developing can be found in the GIS-house concept of Grothe et al (1994)(Figure 38). In 1996 the same authors presented a similar study in which a new picture was shown showing a street of GIS houses (Figure 39) connected through a data-highway such as Internet.

The complexity of such a concept is far greater but this actually shows the tremendous speed with which the GIS market and the demands towards GIS projects are changing.

Figure 38: **The GIS House**

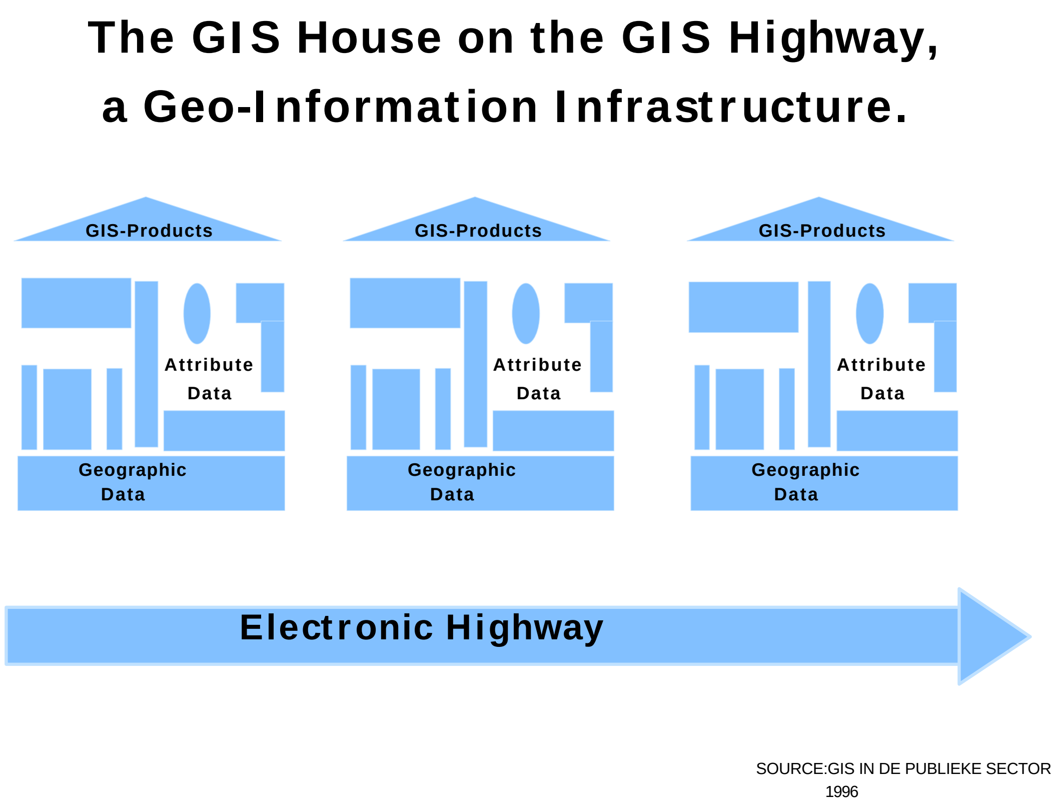
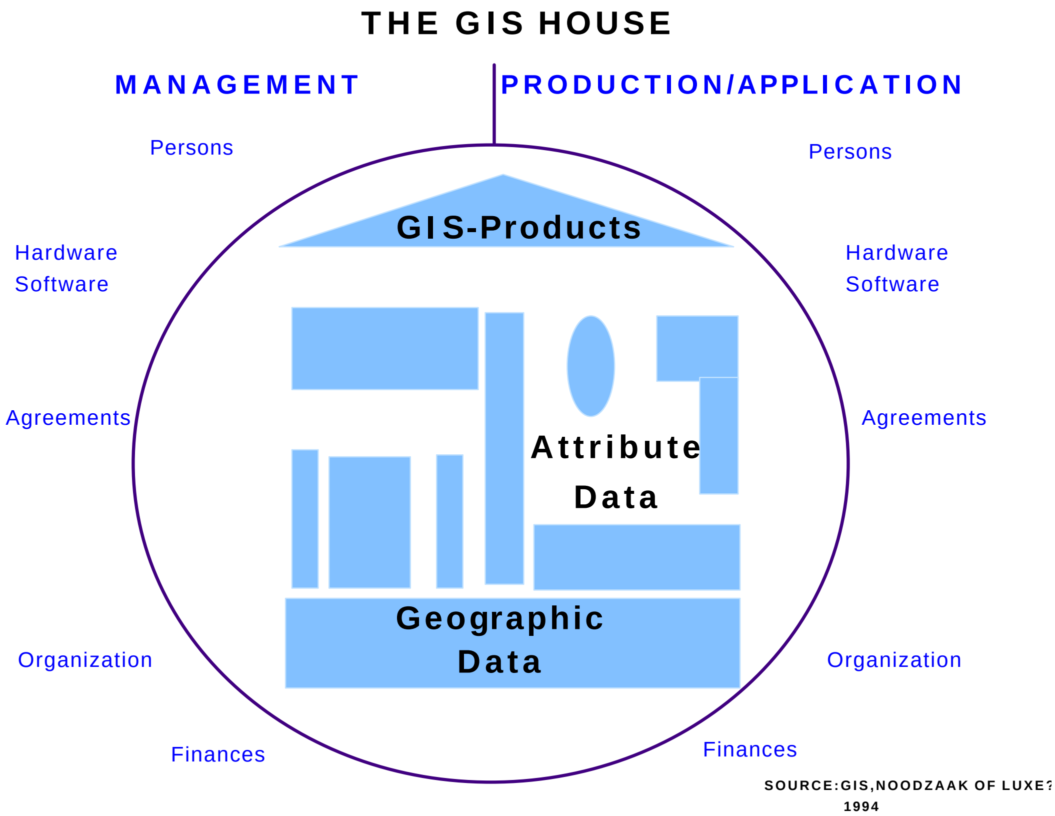


Figure 39: **The GIS House on the GIS Highway**



The GIS house gives an organizational view on the geo-information provision within an organization and consists of 4 components (Grothe and Scholten,1996):

1 Foundation	Geometric and topological information;
2 Building blocks	Important administrative c.q. thematic and temporary attribute information;
3 Roof	The added value which GIS provides for the organization;
4 Cement	The connections between 1,2 and 3 which consist out of all agreements which enable the house to be build. These are personal, financial, technical and organizational agreements.

The second layer of the GIS-house is the layer were the attribute data is. Van Oogen (1995) distinguishes between the following kinds of attribute data:

- Identifying; to make the entity unique;
- Describing; to describe the entity;
- Geometrical; to describe location, topology;
- Graphical; to describe an entity of a nonstandard type like a graph or a photography;
- Meta; to describe information about information about information like age, creator, scale, dependability factors.

Depending on the goals of the project, the data available within the organization this can be more or less complex. GIS-projects providing “Data warehouse” facilities such as the NSDI (National Spatial Data Initiative) (Schell, 1995) initiative in the USA or the National Clearing House (RAVI, 1995) initiatives in the Netherlands are about creating national or even international information infrastructures which consists of several GIS-houses where every GIS-house in it self might be a combination of other GIS-houses connected via a data highway.

This is not utopia, these developments are happening at the moment. The challenge and complexity is huge because this has never been done before for any IS.

Except that there is a lot of experience in building for instance a “Financial Application House” this has been done many times before. All the snags and pitfalls are known. With GIS houses this experience isn’t there yet. As mentioned in chapter 2 the first step in a project life cycle is planning. During the planning the project is defined. In order to define how to build the GIS house the organization has to rely on the knowledge base. Unfortunately the knowledge base for GIS houses isn’t that big as not many have been built so it is likely that there many unknowns. In the building phase but certainly during the usage of such a systems this will become obvious. Depending on the way the system was built (traditional or client-server) it will be more or less difficult to make changes needed.

However companies are expecting not only a GIS house, they need a GIS street or even a small village. This requires much more than just putting hardware, software and an application together. There also has to be a good understanding about the organizational impacts and matters like ownership of data, data quality and the establishing of Meta-information which is Information about the Information.

4.5. The acquiring of Geo Information

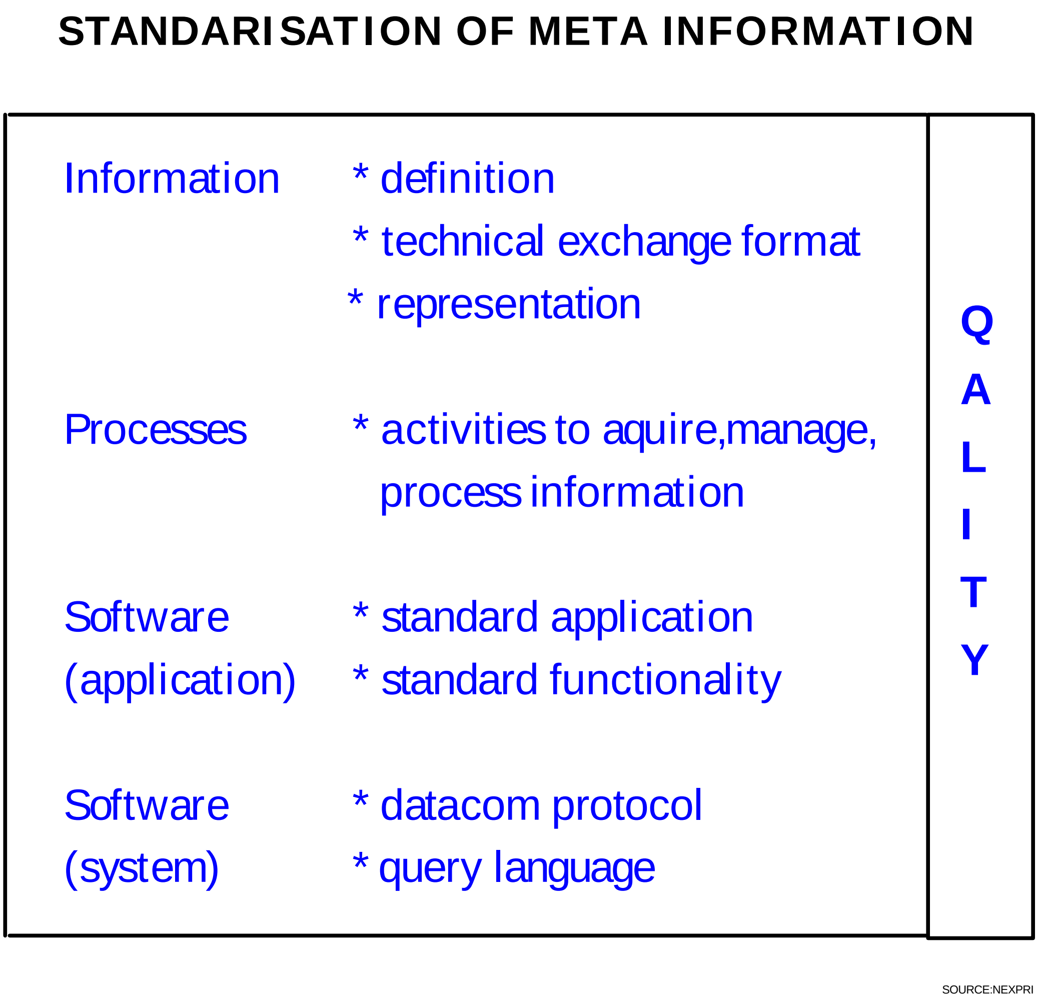
The Common Data Model from "Managing Geographic Information Systems" (Huxhold and Levinghson, 1995) has the following requirements:

- Shared geo positioning;
- Standard data definition;
- Explicit entity relationship;
- Planned data distribution;
- Standards for data communication;
- Data maintenance processes.

The difference between most other projects and GIS projects is that the required standardization mostly goes beyond the department and often even beyond the organization. Compared with the implementation of a financial system such as SAP-R3 for example a GIS implementation is more difficult since there are only few standardization rules for GIS whereas financial applications have many rules. Furthermore, financial packages are regularly only dependent on data from within their own organization. Something which does not apply to GIS where in many cases data is needed from several other organizations.

Exchange of Geo Information, which is necessary for a successful system, is only possible if a number of standards, are in place: (Figure 40)

Figure 40: **Standardization of Meta Information**



In addition, quality is a constant issue. For a successful GIS project it is important to know which data exchange will take place and hence which data exchange agreements and standards are used.. A GIS project manager who underestimates this will have a problem. Additionally, are questions concerning ownership of data (copyright) and the associated costs.

Data exchange and standardization issues are also important in other types projects but they are nearly always so in GIS. The Open Geodata Inter operability Specification (OGIS) of the Open GIS Consortium (Schell, 1995) might be a first step on a long way to standardization. However the speed with which things are developing isn’t very promising.

4.6. Are GIS projects different?

GIS projects are new in the sense that there is only limited experience with them. The field of GIS is very broad and the possibilities seem to be nearly limitless. It is not yet so clear however what is feasible to do with a GIS and what is not.

GIS projects are generally complex and often very expensive. There is a tendency among professionals (both GIS and non GIS) to focus strongly on the visual (graphical) aspects of these systems. For the GIS specialist this is fairly logical as this what he understands best. The non GIS-IT professional compares GIS with CAD as he also only understands the graphical parts of the system.

GIS projects have kept out of the mainstream of IS projects until now since they are considered to be “different and complex” but this is the fate of every new technology.

Due to the very rapid technology development and the increasing interest in GIS suddenly there are difficult multi departmental or even multi organization GIS projects which have become feasible but there is little or no experience in how to handle such projects.

As a matter fact there isn’t that much experience with other non-GIS projects with comparable magnitude and complexity as well.

A conclusion is that GIS projects are not all that different from other projects without a spatial component. However there is yet little project management experience in doing GIS projects which are strategic and developments enabling new solutions are advancing rapidly. This problem is further compounded by the tendency of GIS and non-GIS specialist to trade GIS as something “special” which prevents an exchange of general project management experiences and knowledge. GIS projects are different in the sense that spatial data enables specialized types of analysis which can be performed with them. Forthinham (1996) says: *“The defining characteristic of spatial data - the thing that makes it special- is that it is tied to locations. This means that each piece of data has a unique set of relationships with all other pieces of data”.*

4.7. Conclusion

GIS projects are complex IT projects. Their magnitude of complexity is so high that there is little project management experience available. In this sense they are different but this is not because of the spatial component but because of the complexity level.

The spatial component, which gives a unique relationship of each piece of data to every other piece of data is not found in other IT environments. In this way GIS projects are different because of the things which can be accomplished by using a GIS due to this unique data linkage.

5. MANAGING A REAL PROJECT - THE MILGIS PROJECT.

5.1 Introduction

In chapter 3 a framework was put forward for effective management of a GIS project. The importance was discussed of knowing where the project is in the GIS project-life cycle and the choice of an appropriate methodology which fits the problem to tackle. Nevertheless there still is an important question to answer: Does this work for an actual GIS project? This chapter is about an actual GIS project called the MILGIS project. It is based on the following material:

- The MILGIS project plan (Scholten,1991),
- Van GIS projecten naar structuur (Scholten, 1993),
- The Environmental Geographical Information System of the Netherlands and its Organisational Implications (EGIS, 1990),
- Visualisatie van de Milieuproblematiek (Ormeling et al 1993),
- European Groundwater Treats Analyzed with GIS (Thewessen et al 1992)

In addition discussions took place with several people who played an important role in the project.

Using the available material the information was analyzed in terms of project management structure which is proposed in this thesis. Whenever there is information missing or different from what might be expected comments are made trying to explain the deviations. In order to get a better understanding why certain steps were taken those involved were interviewed. Their remarks are included as comments.

5.2. Approach

The case study is the “MILGIS” (Environmental GIS) project of the National Institute of Public Health and Environmental Protection which started in the late 1980s.

Though the original project plan “MILGIS 1990-1993” did not have the same structure as the Project Initiation Document (PID) which is mentioned earlier in the thesis, it has many similarities. To keep a clear and understandable structure in this chapter the “MILGIS” project plan was put in the PID format. Deviations from the way a project should be approached according to this thesis and the actual way the “MILGIS” project was handled are commented.

Comments in Italic format.

5.3.Content of the MILGIS PID

The content of the PID is as follows:

- Introduction;
- Project Environment: - Background
  - Objectives
  - Scope
  - Constrains
  - Methods
- Project Organization;
- Project Plans -Work Structure Breakdown
  - Deliverables
  - Resource Overview
- Risk Analyses
- Quality Control

5.3.1.MILGIS PID - Background

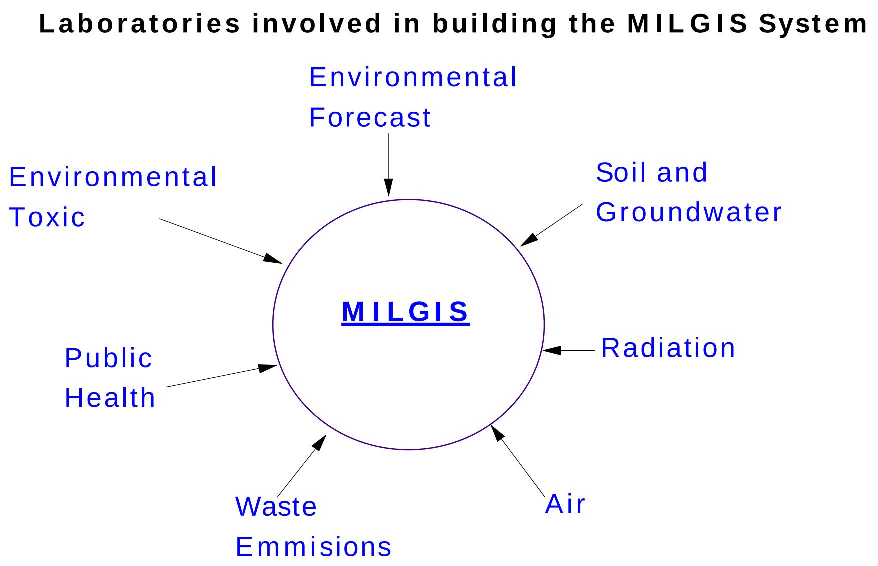
In 1984 an institute was created (through mergers) in the Netherlands called " The National Institute of Public Health and Environmental Protection" abbreviated as RIVM. This institute is part of the Ministry of Public Health, Welfare and Culture.

A third of the capacity of this institute is devoted to environmental research.

This research is done by separate laboratories which generally worked independently of each other but were faced with the challenge to produce an environmental forecast report for the Dutch government every 2 years. The first report called "Concern for Tomorrow" (Langeweg) was published in 1988.

Environmental research at the RIVM is divided into the sectors air, soil and water, radiation and waste. Research is done by specialized laboratories in each field supported by organic and inorganic analytical laboratories as shown in figure 41.

Figure 41: **RIVM Laboratories**



In order to reach a multidisciplinary integrated approach it was necessary to find a way to make the different laboratories which were responsible for air, water, soil, radiation, waste etc. work together. From the environmental point of view there were 3 strategic projects at the RIVM:

1. Environmental Forecasts; Once every 2 year the institute has to produce a "State of the Environment" investigation;
2. Environmental Quality Monitoring Networks; the RIVM was given a coordinating role in managing environmental quality and sampling networks for the Netherlands;
3. European Environmental Agency; the European Community was planning to establish an "European Environmental Agency" in which the RIVM would play an important role.

These strategic projects will produce large amounts of data and will require a lot of reporting. Managing and integrating all this data could not be accomplished with the available data management systems at the RIVM.

For this reason A GIS concept was introduced in the RIVM in the late 1980's. The project was called "MILGIS" (MIL=MILIEU=ENVIRONMENT).

There was only little GIS experience within the institute. After some internal work an external project manager was appointed who had the difficult job of establishing a GIS system which could accomplish this difficult task.

5.3.2.MILGIS PID - Mission, Objectives, Strategy

The mission of the MILGIS project is " the development of a multi-user GIS as basis for data management, data distribution, data analysys and data presentation which has to be fully integrated in the production process of the RIVM".

> *Comment: Though this mission answers the question "why are we doing this project?" it is rather complex and highly ambitious. It is of the utmost importance*

to have a very straight forward mission which can be understood by everybody involved which is agreed upon with the principal of the project. This mission can easely be misunderstood the mentioned points can be interpreted in different ways. What is fully integrated? What is meant by the bais for data management, data distribution and data presentation. What data distribution, management and presentation is meant here?

As stated in chapter 3, Mission, Vision and Objectives should provide a "Common Understanding" so it is clear to all involved what it is that has to be accomplished.

The objectives were 4-fold:

1 Sort out, maintenance and integration of large quantities of information with a spatial component;

2 Make the information mentioned under 1 available for several users;

3 Analyse this spatial information;

4 Present the information by means of maps.

Comment: In chapter 3 was stated that a good objective is measurable. This does not apply to the above objectives. E.g. point 1 could be quantified, what are large amounts of data in this case? What kind of analysys is ment under 3? However it is important to realize that this project plan was written for a partly potential hostile public. Keeping some objectives a bit vaque can be a strategy. However more clarification is necessary in a PID.

The strategy of the “MILGIS” project was to provide a central basic database accesable to all.

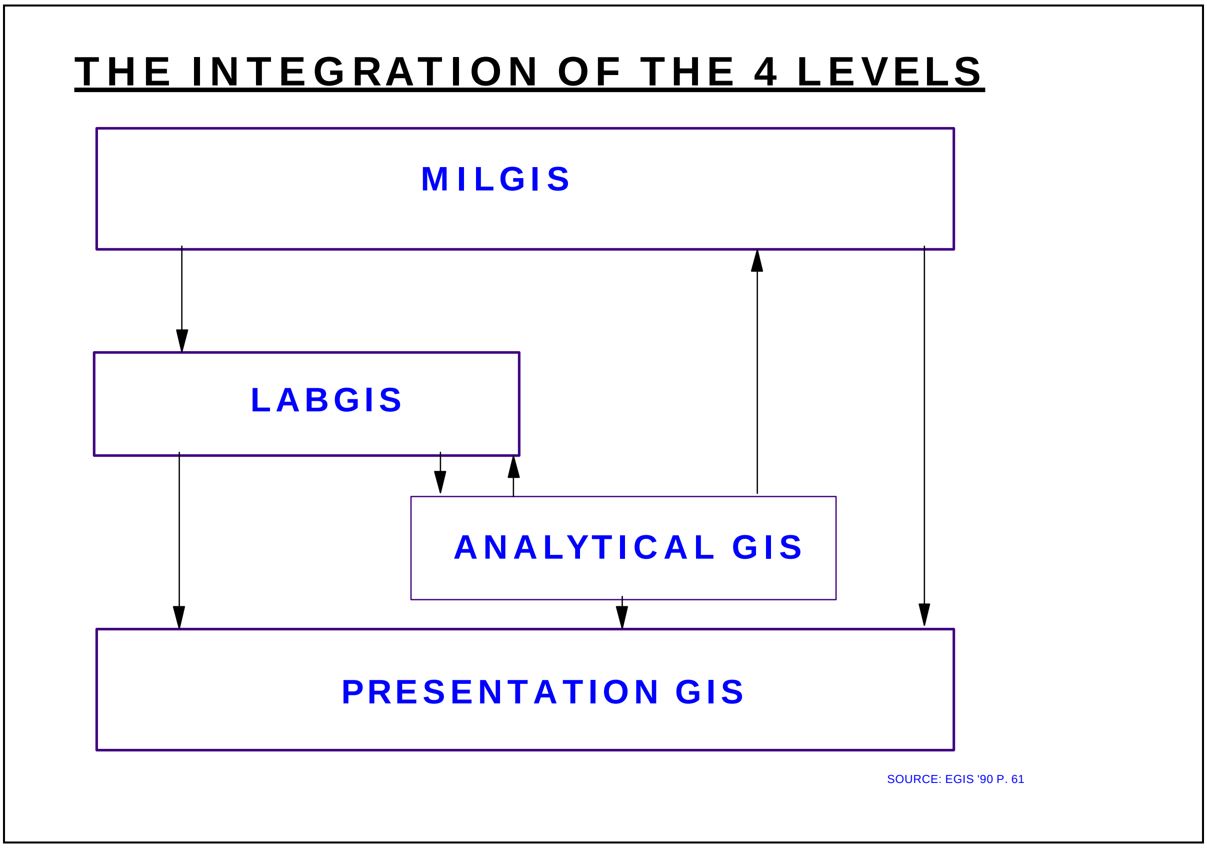
> *To this strategy the same objections apply as to the mission and objectives. It is all rather vaque and multi-interpretabel. A strategy should be clear and explain how the objectives will be reached.*

5.3.3.MILGIS PID - Scope of Work.

The scope of work is structuring data and making it easily accessible to all users. In order to do this a four level approach was chosen for the MILGIS project:

- ♦ Level 1: MILGIS, Structuring data and making it accessible to all users;
- ♦ Level 2: LABGIS, Laboratory data of primary processes used or generated according to their specific research;
- ♦ Level 3: Analytical Gis, Analytical tools which can be used in addition to the models of level 2;
- ♦ Level 4; Presentation GIS, Output environment for levels 1,2 and 3.

Figure 42: **4 Level Integration**



As shown in figure 42 level 1,2 and 3 supply output for level 4, the presentation level.

The important parts of the work are:

- Information planning, which data will and can be used and for which processes. This work has to be done at the laboratory level;
- DBMS design based on the information planning a DBMS structure has to be described;
- Technical infrastructure supporting the four level approach;
- Methods and Techniques which are necessary to learn to think in a “GIS” manner;
- Presentation Techniques, which technique can and will be used?
- Meta-Information, the amount of data will be huge. In order to have an optimal information structure a Meta-Information System must be in place.

Comment: This is a scope of work which does give the major activities of the project. The only observation could be that no de-scoping, telling what the project will not accomplish, was done.

5.3.4.MILGIS PID -Constraints

It is of importance to identify the constrains that might limit the freedom of action and which have to be resolved before the project starts so it can become a successful project.
If this, for one reason or the other, can not be achieved is it wise to de-scope the constraints and their influences from the project.
Some constrains of the RIVM project were:

- Availability of sufficient funds during several years; per year 1.5 million guilders had to be available. This money had to be available for a period of 5 years.
- Resources to assist within the laboratories to start the GIS projects; people have to be assigned to this job;
- An network infrastructure with sufficient bandwidth (Local Area Network); this has to be available in time. A some of the leading laboratories had departments in different buildings which caused a major technical obstacle;
- Willingness of laboratory heads to participate and share data with other laboratories.

Comment: . The plans of the RIVM were very ambitious and would clearly take some years. Within governmental institutions it is uncertain if funds will be available next year unless this has been very explicitly arranged for. The external project manager who was appointed to do this job made the availability of funds over a few years a demand for accepting the job.

There was little experience with GIS at the RIVM. It was in the first stages of the life-cycle. The MILGIS project had a very ambitious end-goal. Yet as stated in chapter 1 it takes time to move from an Diffusion Phase to a Maturity phase which was desired for the RIVM. This will take some years and for this reason a certainty of availability of funds over several years is needed.

Some of the mentioned constraints need to be quantified This can happen as part of the project plans. The involved laboratories operate somewhat independently of each other. In some cases they even compete.

However today's environmental problems require an integrated, multi disciplinary approach. Cooperation with other institutes is also necessary.

5.3.5.MILGIS PID -Methods

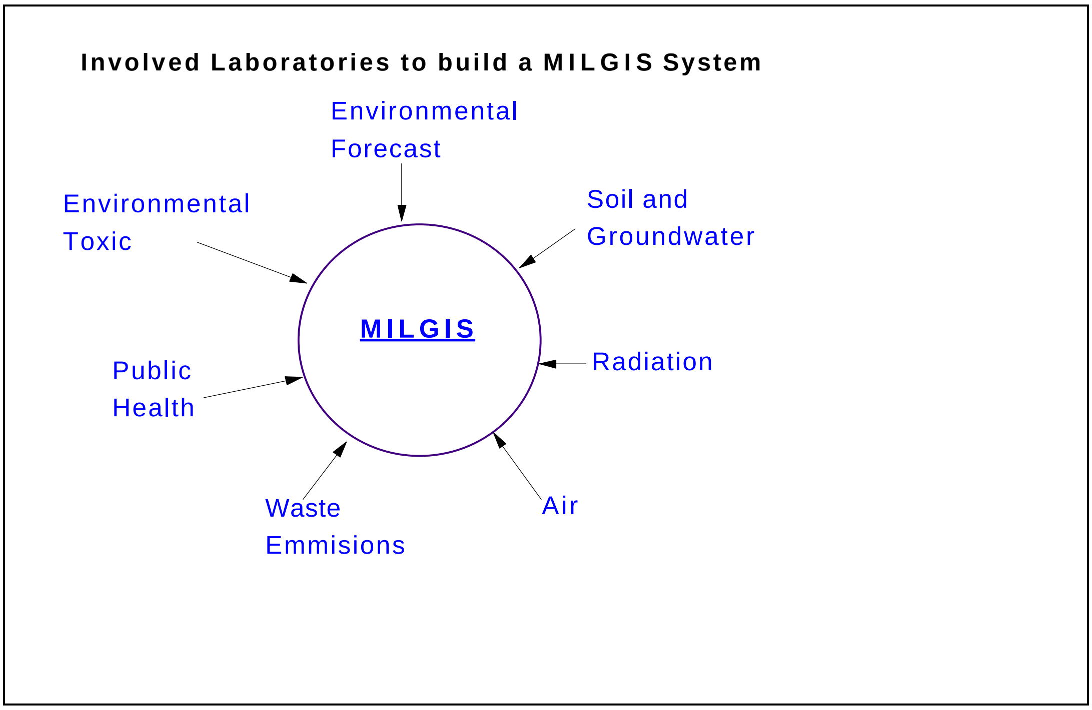
In the MILGIS project plan there is no mentioning of a methodology which will be used to do the project.

Comment: The approach which was taken in the MILGIS project was based partly on the Waterfall method, which was familiar to the RIVM, and partly on pro to-typing. In the early nineties methodologies like JAD/RAD, which would have been very suited for this project (they are ideal if the functional design is hard to define and involvement of parties is necessary) were not commonly used.

5.3.6.MILGIS PID Project Organization

There are at least 7 laboratories involved which have to participate in order to create a central MILGIS system. This means that a LABGIS, the GIS environment in the laboratories, had to be established in those 7 laboratories (figure 43).

Figure 43: **MILGIS Laboratories**



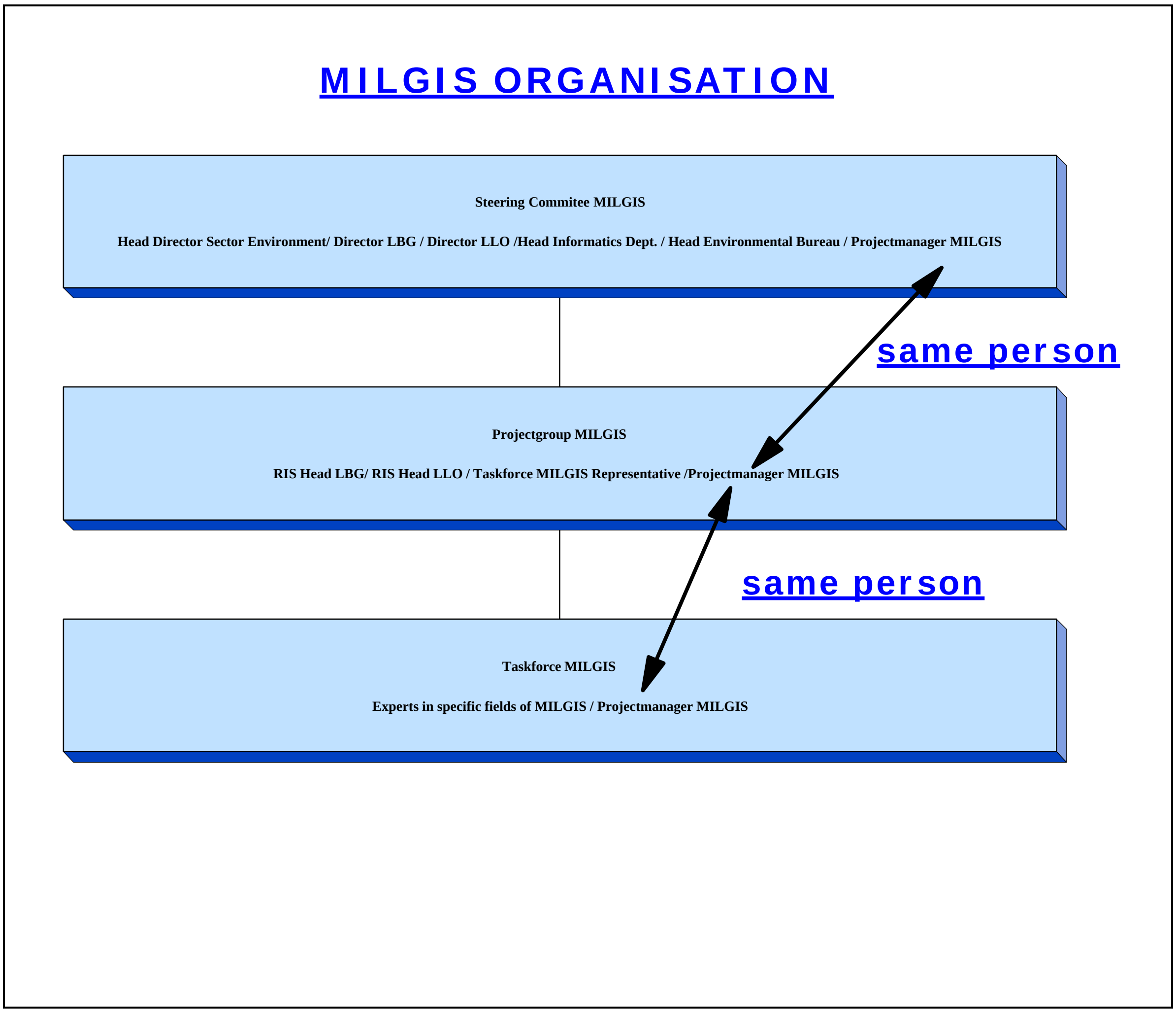
The organization of the project should support the objective to have a LABGIS environment in the mentioned laboratories.

Comment: Before this project started the RIVM did some tests with GIS using a DeltaMap (now called GenaMap) system and they had already some experience with the problems associated with establishing a GIS. The RIVM knew they couldn't do this difficult job themselves and they contacted an external expert in the field of GIS who had a lot of hands-on experience with another government agency. Furthermore the external project manager ,Prof. Dr. H.J. Scholten, was also very well known in the academic GIS field.

The organizational structure which was as follows (Figure 44):

In this structure the chairman of the Steering Committee was the Director of Environment of the RIVM. He could make sure that all necessary steps were taken to enable MILGIS at the laboratory level as all laboratory heads reported to him. In the Steering Committee were also 2 Directors of the laboratories most interested in the project. In addition there were the IS manager, the manager of the Environmental Forecast Bureau and the project manager MILGIS. Reporting to the Steering Committee was the Project group MILGIS of which the Project manager of MILGIS was chairman. Next to him the IS-heads of the 2 most involved laboratories were present and a representative of the Task force MILGIS. The Task force MILGIS, reporting to the Project group MILGIS was responsible for the actual work and was formed out of experts of the various groups. These experts were freed from all other activities and had to perform the actual tasks. The project leader of MILGIS was also member of the Task force MILGIS. The structure is represented in figure 44.

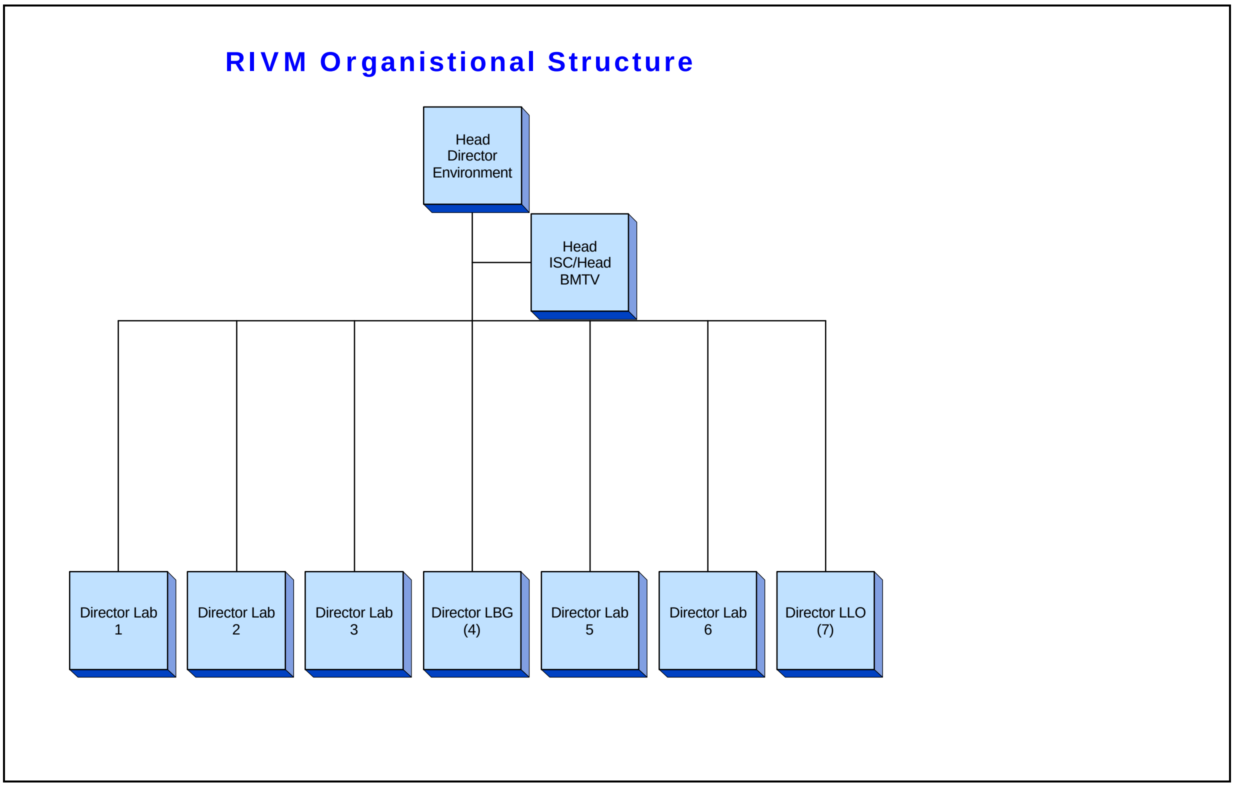
Figure 44: **MILGIS Organization**



The structure for the MILGIS project made it possible to bring serious problems to the highest hierarchical level within the Environmental sector of the RIVM, the Head Director, who was chairman of the Steering committee. All involved Laboratory Directors reported directly to him.

The Head Director Environment had an interest in having a successful MILGIS project since he himself was responsible for the total activities of the Environmental Departments of the RIVM. This structure is shown in Figure 45.

Figure 45: RIVM Organizational Structure



Comment: Though is seemed sensible at first glance to have the project leader of MILGIS present in the Steering committee, in the project group and the task force MILGIS this caused a lot of trouble.

As described earlier the different levels are used for different functions:

Steering Committee :	*Hard-/Software Strategy, Application Strategy, Staff Strategy (hiring of freelance);*
Project Group (Board):	*Day to Day business of the project;*
Project Manager:	*Responsible for the project.*

By making the project manager a part of both the Project Group and the Steering Committee his role became very unclear. Talking to him in 1996 he also sees this *as one of the major problems he had as he was involved in all decision making levels. When a decision on a database for the entire RIVM had to be taken the project came to a stand still. In a "normal" project the project manager would have asked the Project Group to solve this problem whereas the Project Group would have asked the Steering Committee to make a decision. As the project manager was a member of all groups he was not able to ask this in such a blunt way. The decision on the database slowed down the project for many months!*

5.3.7.MILGIS PID Project Plan

The project plan covers the entire project and provides a guideline against which progress can be measured.

A good project plan will identify:

- Major project stages;
- Major deliverables and milestones;
- Resource list and time estimates;
- Costs.

Comment: To describe the project plan of the entire MILGIS project would go beyond the scope of this thesis. In this chapter the implementation of LABGIS and MILGIS at the Laboratory of Soil and Groundwater Research (LBG) is used for the case study. LBG was the first laboratory were a LABGIS was establish which served as a pilot environment for MILGIS. The following parts of the MILGIS PID focus primarily on the project plans of the LBG.

The research agenda of the laboratory of Soil and Groundwater research included: Pesticide Leaching and the relationship in the Groundwater Quality as a problem of the quality and availability of drinking water.

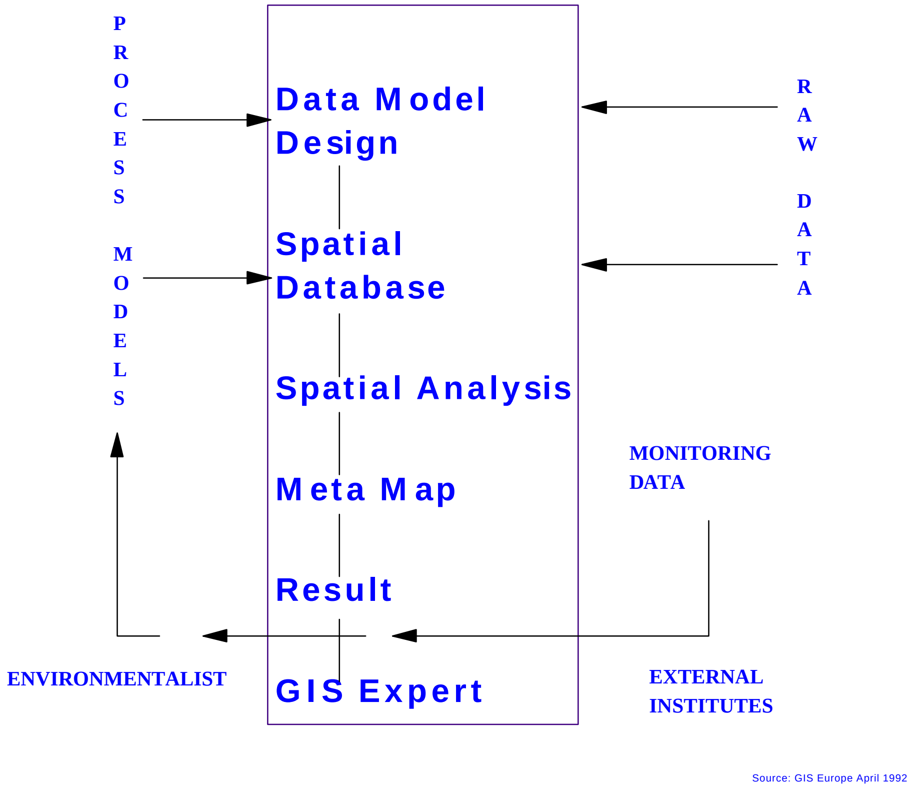
The leaching of pesticides is one of the major causes for groundwater contamination. In environmental forecasts it is of importance to predict the influence of the use of pesticides on the quality of groundwater. Furthermore such a system is also useful to determine if a pesticide can or can not be used in a certain area.

Major project stages:

The major stages of this project were (see figure 46):

- Design of the data model;
- Conversion of raw data;
- Implementation of the process models into the spatial model;
- Creation of a MetaMap library;
- Presentation of results;
- Comparison of the model results with the actual monitoring data;
- Presentation of the MetaMap.

Figure 46: Major Project Stages



When zooming into the major stages the major activities will become clear e.g. in the Data Model Design .The purpose is to design a data model that is directly related to the process models & raw data. This means establishing a spatial database with the following characteristics:

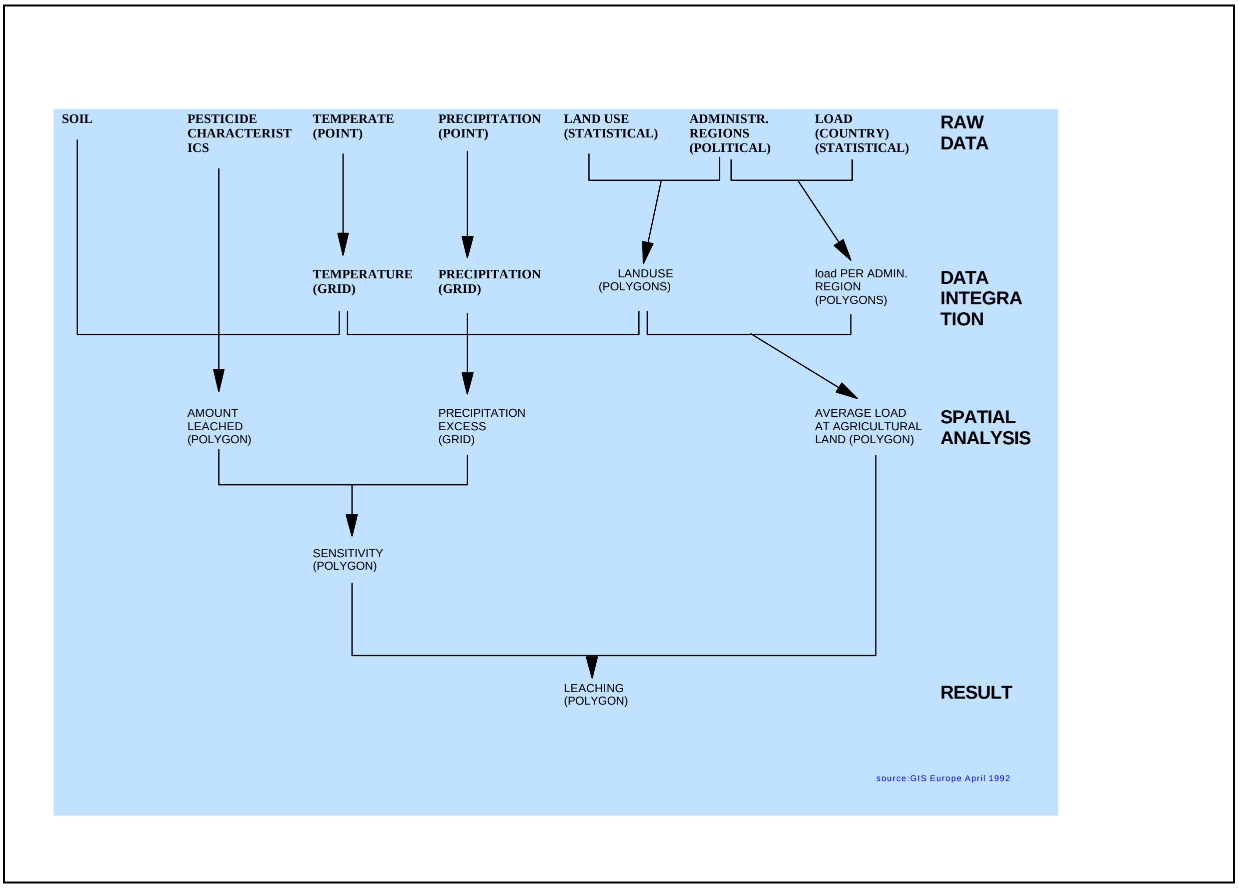
- A uniform resolution for thematical, statistical and graphical data;
- A unique location definition of the administrative regions;
- One unique location definition of all boundaries shared by the different themes to reach a consistent spatial relation;

- A common geographical feature type (polygons) for all themes;
- One "equal area" geodetic projection;
- A structure with a minimum of redundant data.

Some of the complexity involved in doing this is shown in Figure 47 which follows:

There are many types of data, point, statistical, political, polygons, grid etc. which have to be combined.

Figure 47: **Pesticide Leaching**



Comment: In order to define deliverables and milestones it is often necessary to zoom into the major project stages. In the project plan MILGIS this is only done on a very high level. The database project stage for instance were identified with the following 4 steps:

1) Functional design;

2) Technical design;

3) Implementation;

4) Maintenance.

In the approach described in this thesis more detail is necessary to reach the goal of the PID document: to reach a common understanding of what has to be accomplished and the major steps to take.

The information to go into a greater detail level was available in other publication on the MILGIS project like the GIS Europe magazine of April 1992 which had an article on the LBG project.

It is important to remember that the project plan MILGIS was partly written as a "political" document and for this reason couldn't be as detailed as was desirable. Going into details would have caused a lot of discussion within the RIVM as many laboratories were opposed to the MILGIS approach as it forced them to make their data available to other interested laboratories. At detail level this would all have to be described.

Deliverables and Milestones

In the project plan MILGIS the following phases (deliverables) were mentioned:

Phase	**Time period**
Info Analyses	1990
Database	1990 - 1991
Technical Infrastructure -maintenance	1990 - 1991 - continuous
Methods and Techniques	1990
Presentation	1990 - 1991
Meta Information	1990 - 1993

Comment: This is not sufficient for a PID. Actual tangible deliverables should be mentioned. It is not enough to state that in the period 1990-1991 a database has *to be in place. It makes sence to describe what kind of a database this should be. What kind of data should be in it and which are the parties involved in filling the database.*

Resources and Time estimates.

In the project plan the following resources and time estimates were made:

Resources needed for the Laboratory of Soil and Groundwater Research LABGIS and MILGIS implementation.				
Phase	1990	1991	1992	1993
Info Analyses	26 weeks	-	-	-
Database	20 weeks	25 weeks	-	-
Technical Infrastructure	4 weeks	14 weeks	-	-
Methods and Techniques	13 weeks	-	-	-
Presentation	4 weeks	15 weeks	-	-
Meta Information	6 weeks	10 weeks	3 weeks	3 weeks

Comment: Though this overview gives an impression of the total number of man-weeks which is needed to accomplish the job it does not give any information on the level/type of resource required. In a project plan this should be defined like this:

week 36-37 GIS Projectmanager

week 36-39 Database designer

week 33-36 Information Analyst

This gives the detail level which is needed to enable the creation of PERT and GANTT charts and to identify critical paths and resources.

Costs

In the project plan MILGIS a yearly amount of 1.5 million guilders (period 1989 - 1992) is mentioned. The division between the following laboratories is as follows in K guilders:

Year	MILGIS/ LABGIS	Analytical	Presentation	Applications	Additional	Maintenance
‘89	750	150	100	30	80	85
‘90	650	300	15	30	110	155
‘91	750	150	50	150	150	225
‘92	600	200	30	170	150	300

MILGIS/LABGIS = hardware/software/DBMS/ArcInfo;

Analytical = hardware/software/SPANS;

Presentation = hardware/software/MapInfo/Atlas Graphic;

Applications = DBMS applications, graphic conversions, user interface etc;

Additional = Explotation, travel etc;

Maintenance = Hardware & Software Maintenance.

There is no further specification towards the laboratory. In practice most of the money goes to the LBG laboratory as this is both the first LABGIS environment and the pilot MILGIS environment.

Comment: The way used in the project plan MILGIS to do cost-estimates is very rough and shows that the MILGIS environment was highly experimental so no real cost allocations were possible.

Normally it is possible to make a work structure breakdown per main activity. In the project plan this was done by giving an overview of the number of weeks needed for every main activity and by a table which mentions the costs over the years.

In order to be aware of the consequenses of deviatons and change requests more detail is necessary and GANTT and PERT charts have to be available. It must be possible for a project manager to check progress versus costs on a frequent basis.

Remember MILGIS is not a research project it is the basis of the environmental report the RIVM has to produce every two years. In the PERT and GANTT charts it will become clear if the deadlines are reasonable and which is the critical path.

5.4.MILGIS Risks

Risks are not mentioned in the project plan MILGIS. Howerver there are several other publications on the MILGIS project which give information on this subject.

The information which follows can be found in:

“The Environmental Geographical Information System of the Netherlands and its Organisational Implication. (Van Beurden and Scholten, 1990).

The following risks to the MILGIS project were identified:

- Integrety of the database design, all databases (MILGIS, LABGIS, Analytical GIS, Presentation GIS) had to work seperately but had to be designed to work towards the conceptual data model (The Taskforce MILGIS had to look after this);
- Data management planning, agreement has to be reached on the responsibilities, agreements between laboratories have to be established, authorisation levels have to be agreed up

In the article “Implications of introducing a GIS (Van Beurden and Scholten , 1990) it says: “ The most important factor in the GIS development at the RIVM is formed by people, who have to operate and manage. Every laboratory will have to form a special group for GIS; structure that group and integrate that group in the laboratory At the same time a separate MILGIS group is formed to co-ordinate laboratory activities and to handle the MILGIS level”. This was a difficult task to accomplish in what was, until that moment, a separate group of laboratories.

Comment: This is not an easy case to do a risk assessement. The task which had to be accomplished had never been done before in the Netherlands. There was no previous experience.

Based on present knowledge it would be possible to do a risk assessement for instance by using the tool on risk assessement which can be found in the addendum.

One of the obvious dangers in the MILGIS project is from people which Donovan (1994) calls CRABS. "CRABS are the people who prevent you from doing new things, CRABS will always try to hold back those who climb towards the top of the basket. You can recognize them by their lack of constructive criticism or alternatives. Remember CRABS can only move sideways or backwards. If you can't convince them to reform you should isolate or remove them.

5.5.MILGIS Quality

Quality was of eminent importance. The RIVM is a reseach institute with very close relationships with the academic world. At the start of the MILGIS project there was sceptisism about whether or not:

1. Models in GIS could provide the same results with the same resolution as the models used until then in the laboratories;
2. Maps quality was sufficient.

1. In order to check the reliability of the GIS models their results were compared with the models used until then by the laboratories. If necessary adjustments were made;
2. The "Vakgroep Kartografie" of the University of Utrecht got the assignment to examine and comment on the material and it's quality. A reasonably positive report on this issue was published

Comment: Quality was an important issue in this project. More emphasis could have been placed on quality control during the implementation using the following Total Quality Control principle

Plan -> Do -> Check -> Act -> Plan -> Do ->.................. etc.

Using this method will improve the end result as at an earlier stage as normally there is feedback on the perceived quality of the deliverable.

Final Comment: The MILGIS project started in 1989. At that time , certainly in Europe, there was very little experience with such projects. For instance MILGIS was the very first Arc/Info implementation on a workstation in Europe. By having an experienced projectmanager, sufficient funds and high level organisational support the MILGIS project turned out to be a success.

Already in 1991 it was used to produce parts of the "Nationale Milieuverkenning 1990-2010 (RIVM, 1991) the forecast of the environment until 2010. At the moment, in 1996, it is on of the biggest GIS sites in the Netherlands. Furthermore it is part of the "Clearinghouse" project which is the European/Dutch alternative to the National Spatial Data Infrastructure which is being realized in the USA.

Of course there were problems and major set-backs. For instance the GIS products which could be produced in the Laboratory of Soil and Groundwater

research were so successfull and needed that the other laboratory perceived this as a threat.
Looking back members of the project staff nowadays realize that the other Laboratories were not sufficently involved in the MILGIS project. If this would have been the case implementation of LABGIS throughout the other Laboratories would have been easier.
One important reason of the success was the fact that at the very early stages of the MILGIS project a project plan was made which described the mission, objectives and goals of the project but also the necessary funding and personal involvement. Furthermore there was involvement of senior management. The project plan allowed room for learning through proto-typing thus acknowledging the fact that not all difficulties involved in creating a MILGIS were known.

5.6.Does the proposed methodology work?

The MILGIS project was not carried out according to the methodology proposed in chapter 3. However when the available projectplans of the MILGIS project are analysed, a task which was done in this chapter, it is clear that major parts of the project were carried out in line with the proposed framework.
A weak point in the MILGIS project was the mission statement being: *"The development of a multi-user GIS as a basis for data-management, data-distribution, data-analysis and data-presentation which has to be fully integrated into the production process of the RIVM"*.

This obviously was a “Mission Impossible” and the required situation does not exist at this very moment at the RIVM.

The proposed project management approach needs clear objectives which can and will be measured during the project. For the MILGIS project measuable objectives were only partly set. One of the reasons for this was that the end-result of the project was, due to a lack of experience with GIS, difficult to determine. Int the proposed projectmanagement approach for GIS projects Rapid Application Development and Joint Application Development techniques are used to establish ovjectives in case were the end result is unclear.

In the MILGIS project prototyping did take place and there was a lot of discussion between Steering Commitee, Project Groups and the Projectmanager about the desired end results. Or as Scholten (1996), the projectmanager of MILGIS, says: “Geodan worked from it’s beginning intuitively with an itterative development approach. The charecteristic of this method is that the solution for the information system is developed in a evolutionary and cyclical way”. (Scholten is one of the directors of Geodan).

This way of working was used in the MILGIS project and it comes very close to the proposed framework in this thesis.

When using the proposed project management approach to analyse a project like the MILGIS project it is possible to find missing pieces of information in for instance the projectplan. Furthermore it becomes clear if important questions like:

- Are the objectives measurable;
- Are the parts which are not under controle by the project de-scoped;
- What are the risks involved in this project.

are adressed in a satisfactory way.

Using the proposed methodology is not a quarantee for a succesfull project but it does address many of the important issues for a projectmanager. When used to analyse a project which already took place it can be used to find the weak spots in the projectplans thus providing learning material for future projects.

6. CONCLUSIONS

6.1. Introduction

The management of GIS projects is not an easy job. Although GIS is being considered as a strategic application or a future strategic application by many organizations it is perceived as being complex and inaccessible. Project-managers involved in strategic GIS projects have the difficult task to "establish a good working GIS that is integrated into the organization".

The objective of this study is to address the project issues of a strategic GIS project. This is done by addressing the overall problem statement which is "How to manage a GIS project effectively?".

6.2. The importance of Life Cycle and Methodologies

Two of the unknowns at the beginning of this thesis were; if life cycle principles had any influence on GIS projects and if the position in the life cycle had any influence on the methodology to be used.

A study called "GIS, noodzaak of luxe?" (Grothe et al, 1994) investigated where GIS is located in the Mc Farlan raster whereas "Management van complexe IT projecten" (Roelofs et al, 1996) places the Mc Farlan raster into the Nolan curve. The conclusion is that GIS projects are moving into the strategic quadrant of the Mc Farlan grid. At present most GIS projects for organizations are experimental. The major difference between experimental and strategic projects are the emphasis in strategic projects on being:

- On schedule;
- Within budget;
- Good Quality;
- Complete;
- Accepted by the customer.

In order to accomplish this, strategic projects need a much more structured approach compared to experimental projects. Methodologies are often used to handle such environments because they provide a general framework for entire projects.
There is not a lot of experience with strategic GIS projects and no specific GIS methodology is known.

6.3. Project management for GIS

The assumption is that the position on the life cycle of GIS within the organization is of influence on the way the GIS project should be handled. The question is how this affects GIS projects which are considered by the organization to be strategic.
By combining existing methodologies for IT projects, project management and best practices, a framework for strategic GIS projects was established. This framework was used to evaluate a existing GIS project.
Conclusions are that strategic GIS projects can be managed through a methodology based upon the same principals as other IT projects however GIS projects have some specifics which have to be taken into consideration.
Contrary to belief in some parts of the GIS society GIS projects are not special however they are very complex and GIS knowledge is necessary to understand the environment.
The proposed framework seems to work but there are still many unknowns specially where it concerns best practices in the specific field of strategic GIS projects.

6.4. Area for further research

An important aspect of GIS project management for strategic projects is the sharing of information. In general, all the information on a project is held in 3-ring project binders which are being distributed to the project members.
This results in documents becomming lost and out of sequence and there are often major problems concerning the latest revision of certain documents. New technologies like the

Internet provide a possibility to address this problem of project documentation in a different way. By placing all project information on the Internet and the use of pull (user has to take action) and push (user does not have to take action) techniques it is possible to ensure that every project member has the most recent information at all times. Furthermore by defining “user profiles” it might also be possible to distribute information on the progress of the project to those involved in the project in a very structured manner on a “needs to know” basis. Some preliminary work in this field by Hewlett-Packard on a concept called “The WebNoteBook” (1997) showed a cost reduction in software development projects of several millions!

For the first time in history technology enables different users (PC and Workstation) to use a common interface (Webbrowser) and the Internet to access information without the worries of compatibility of programs. The potential of a “webified” project file could be quite substantial and further research is needed.

ADDENDUM

In this chapter there is a RISK assessment form for the MILGIS project.

Risk Management Checklist		
Other Headings:**MILGIS**	Status:	Document No.:
Stage:Finished	Original Date:Nov 1996	
Project Manager:HJS	Change Date:/	
Sub-project Manager:	Author:HB	Version No.:1

The risk factors, ie those factors which affect the probability that the project will be completed on time and within budget, and will produce a quality deliverable, come from four sources: project management, project staff, the nature of the project itself, and the maturity of the departments management culture. These factors are itemized below, in the form of pairs of statements typifying low and high risk, on either side of a scale of 1 to 4. One number of the scales is ringed to indicate the assessment of the risk attached to each factor. The ringed figure is multiplied by the weighting factor inserted in column (d) to the figure in column (e).

	Scale 1 Low 4 High		(d) Weighting used (with suggested range)	(e) Total (bxd)
Project Management				
1. Full-time, experienced project manager	1 2 3 4	Inexperienced or part-time project manager	2 (5-7)	10
2. User management is experienced and likely to be active participants	1 2 3 4	Inexperienced user management, with little participation expected	3 (4-6)	12 *
Project Staff				
3. Users expected to be of good quality, actively involved, with relevant knowledge of the system.	1 2 3 4	Little user involvement and little relevant knowledge expected	3 (3-5)	9 *
4. High standard of supervision and narrow span of control	1 2 3 4	Span of supervision too wide and level of control inadequate	3 (4-6)	12
5. The technical team is experienced, of good quality and with appropriate skills	1 2 3 4	Inexperienced team lacking the appropriate skills	4 (2-4)	8
6. Staff are dedicated to project	1 2 3 4	Staff have other responsibilities such as system maintenance	9 (3-5)	9
7. Low staff turnover	1 2 3 4	High staff turnover	2 (4-6)	8
The nature of the project				
8. Staff are experience in quality reviews and committed to their use	1 2 3 4	No quality reviews carried out in the past	3 (4-6)	12
9. A typical system development cycle, with requirements definition, system specification, system design, etc.	1 2 3 4	A system development cycle having no formal definition, systems design and build merge, etc.	2 (2-4)	4

10. No unique or new features	1 2 3 4	Pioneering, new hardware or software, etc.	4 (2-4)	8
11. Current main operators will be affected minimally	1 2 3 4	Significant impact on mainstream operations	4 (3-5)	12
12. Hardware and software requirements determined and documents based on proven standards	1 2 3 4	Requirements not documented, or based on proven standards; limited safety margins for contingencies	4 (2-4)	8
13. Little or no modification to existing application software	1 2 3 4	Extensive modification needed	4 (2-5)	8
14. Little or no development work being undertaken concurrently	1 2 3 4	Other projects being developed concurrently	3 (2-5)	6
15. Little or no dependence on existing or developing systems not under the control of staff on this project	1 2 3 4	Dependent on other facilities not under the control of staff on this project	3 (3-6)	9
16. Project duration of one year or less, or small number of workdays compared with other completed projects	1 2 3 4	Project duration more than one year, or large number of workdays	4 (2-4)	8
17. Little constraint on completion date beyond availability of resources	1 2 3 4	Mandatory completion date	3 (3-5)	9
18. Plans and estimates are based on reliable data	1 2 3 4	Planning and estimation date are unreliable	3 (3-6)	9
19. Investment appraisal and estimates prepared and well documented, using proven standards	1 2 3 4	Approximations used or estimates not properly documented, or based on proven standards	4 (3-5)	12
20. Suppliers are established and stable.	1 2 3 4	Suppliers are not established or stable.	3 (2-4)	6
21. Few user departments	1 2 3 4	Several user departments	4 (4-6)	16
22. The work affects few sites, which are easily accessible to the team	1 2 3 4	Many, or remote, sites are involved	4 (4-6)	16

The maturity of the departmental organization

23. A well developed set of standards is in use	1 2 3 4	Few standards are available	4 (2-4)	8
24. A well defined quality policy exists	1 2 3 4	The quality policy is ill-defined	3 (3-5)	9
25. Clear delegation of authority is practiced	1 2 3 4	Centralization management with little delegation	2 (4-6)	8
26. Clear limitations of liability documented. No intellectual property rights given to client.	1 2 3 4	Liability not clearly documented. Intellectual property rights assigned to client.	2 (4-6)	8

Totals: __79______ _246___ ___

High risk is greater than __205_____ ___ (total of column (d) x 2.6)

Low risk if less than __158_____ ___ (total of column (d) x 2.0)

My assessment of the risk of this project is:

Very High	________ 246	Acceptable	________
High	________	Low	________

My recommendation for the risks identified by 3 or 4 marking against any of the above factors are attached (or in the Project Initiation Document if appropriate).

Signed: ____________________________ Date: ____________

(Project Manager)

(source: Ministry of Forest & Hewlett-Packard) CPLC

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