Multi-Project Management

Development of a Portfolio Overview System at Tetra Recart

Jonas Hagman
Nils Månsson
Martin Nordström

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Abstract

Title: Multi-Project Management - Development of a Portfolio Overview System at Tetra Recart

Authors: Jonas Hagman, Technology Management and Engineering Physics, Lund University.
Nils Månsson, Technology Management and Business Administration, Lund University.
Martin Nordström, Technology Management and Engineering Physics, Lund University.

Tutors: Lecturer Roy Andersson, Department of Computer Science, Lund Institute of Technology, Lund University.
Assistant Professor Carl-Henric Nilsson, Department of Business Administration, School of Economics and Management, Lund University.
Development Director Günther Lanzinger, Tetra Recart AB.

Problem: Until recent years, not enough focus has been placed on assuring the strategic fit of launched projects and multi-project management. Even though the situation is getting better, many companies still do not seem to get their project portfolio management right. At the same time research has shown that businesses that feature a systematic portfolio management process outperform the rest.

To provide managers with a basis for making the right internal decisions, data has to be gathered and presented in a correct and easy accessible way. This would help management to allocate resources, prioritise projects, getting the right mix of projects and making adequate go/kill decisions. How can an intranet based system solve this problem?

Purpose: The aim of this thesis is to develop an intranet based system that provides managers with information needed to manage a company's project portfolio. The system will be evaluated and analysed according to relevant theories in order to establish whether it can be of any use in the multi-project environment described in literature.

Methodology: The methodology is based in reality with a tangible problem, which implies an inductive approach. The problem was not clearly defined at the beginning but rather raised as a more general desire, from which the authors had to formulate the

actual problem to investigate and further evaluate and choose the proper way to conduct the research. Empirical studies were carried out to clarify the needs of the organisation, the possibility to implement a new system and the requirements of such a system.

Together with the empirical information gathered, theoretical knowledge was used that was primarily obtained from literature discussing project management and multi-project management.

The knowledge from these sources was incorporated during the evaluation of the company needs and the generation of the concept model for creating a system to handle the project portfolio.

Conclusions: When comparing pros and cons of Portos, the Portfolio Overview system developed within this thesis, it is not possible to make a quantitative statement of whether the benefits prevail over the requirements and limitations related to the system. Instead, the conclusion whether Portos is a system well suited for handling multi-project issues must be drawn on qualitative aspects. With this in mind, as well as the presented pros and cons, the conclusion is that an intranet based system has large potential in providing managers and project managers with relevant information enabling them to successfully manage the project portfolio.

Theoretically it has been found necessary to extend the multi-project environment framework with a sixth area in addition to the existing five; Capacity, Conflict, Commitment, Context and Complexity. The added C, Communication, is added since communication often solves multi-project related issues or at least make them less complex and severe.

Key words: Multi-project management
Portfolio overview
Portfolio status
Intranet
ASP

Preface

The work of this Master's thesis has been carried out during the summer and autumn of 2002. During this period, the authors have had the opportunity to spend a lot of time at Tetra Recart, meeting many individuals contributing in different ways. We would like to thank our tutor at Tetra Recart, Günther Lanzinger, for his eminent guidance, wisdom and help throughout the work of the thesis. We would also like to thank all people at Tetra Recart for their time and effort, often leading to very interesting discussions from which we have learnt a lot.

Our tutors at Lund Institute of Technology and at the School of Economics and Management at Lund University, Roy Andersson and Carl-Henric Nilsson, guided us along the way, providing knowledge and insights. For this we are very grateful.

A special thanks to Michael Kohn for inspiration.

Lund, December of 2002

Jonas Hagman Nils Månsson Martin Nordström

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1 Introduction

This chapter contains the background of the thesis followed by the problem discussion. After this, the focus of the thesis is accounted for with its purpose, delimitation and target group. Finally, a guide to the thesis is presented describing the structure of the report.

1.1 Background

The academic field of project management has been a subject for research for quite some time and has been exploited to a relatively high extent.[1] This academic research has had great impact on the way companies work in, and look upon, their projects. Today for instance, most companies have a working model including defined phases, roll descriptions and terminology.[2] The performance of projects in total has improved but still remains on a non-acceptable low level.[3] This fact has a lot of explanations but the most important of these is that a project is not a single event that occurs without connection to the surroundings. No matter how well the single project is planned and managed, external implications will always appear that were not accounted for from the beginning. These external implications can consist of contacts with suppliers, customers, government or other stakeholder interventions. It can also consist of internal links and demands from the parent organisation. The internal contacts within the company, and especially the contacts between different projects, are the topic for this thesis.

During a collateral exchange between the authors and Günther Lanzinger, Development Director at Tetra Recart, this question was raised and discussed from a project portfolio point of view. How can a portfolio manager improve the connections between different projects? How can he or she get a clearer view of the current status and thus increase the ability to manage the ongoing projects?

In this way the seed for this thesis was sown and after looking deeper into the academic literature regarding multi-project management, this was chosen the main topic for this thesis. As the connection was established with Tetra Pak and they already were discussing the subject, the co-operation was extended and Tetra Pak was chosen to be the object of study for the thesis. A brief description of Tetra Pak and the subsidiary Tetra Recart follows below.

Tetra Pak is a worldwide company and probably almost everyone around the globe has either used or seen one of the company's products. The company has for 50 years manufactured and marketed systems for processing and distribution of liquid food and beverages. Now the company will also start to produce cartons for food that have traditionally been packaged in cans or glass jars such as fruits, vegetables, ready

[1] Engwall (2001:8), p i
[2] Engwall (2001:8), pp 2
[3] PPS lecture level one, Kista 2002-04-23

meals or pet food.[4] The aim is to provide an alternative packaging solution for a variety of food products. For this purpose, Tetra Pak started an R&D project in 1997 that has become a subsidiary today, Tetra Recart AB. The company has responsibility for development and marketing of safe systems for carton-based packaging of retorted food.

As an organisation Tetra Recart with its 67 employees is a dwarf compared to Tetra Pak with over 20.000 employees.[5] However, the idea is that Tetra Recart shall only possess the core competences for these new markets and use Tetra Pak's infrastructure in other cases, for instance the R&D company regarding carton development and the market companies regarding market presence around the world.[6]

The fact that the company is working with development and aims to create close relationships with its customers has made it natural for them to choose an organisation that focuses on processes and individual projects. Working like this has created difficulties for management to sustain an adequate overview of the company's project portfolio. Since Tetra Recart is about to enter the phase of commercial launch, and therefore dramatically increases its number of employees, it will become even more difficult for management to maintain a sufficient overview of the project portfolio.

Tetra Pak already has an intranet based project management tool called Tetra Pak Innovation Network, TPIN, but Tetra Recart management is not fully satisfied with the system's portfolio management application. That is why the authors have been asked to develop an intranet based project portfolio management system that satisfies the needs of Tetra Recart.

Multi-project management is regarded as very important in literature, but at the same time not at all discussed to the same extent as single project management. This makes the subject interesting, both from a practical and from a theoretical point of view.[7]

1.2 Problem Discussion

From a company perspective, the single project consists of only a small fraction of the company's total output. There are, of course, still major projects with extraordinary content, but the more frequent project assignments are small, and projects run simultaneously with other projects sharing the same resources. Also, they often have a small budget and a short life cycle. This has made the interaction between projects as well as their non-project environment more intense. The smaller the project and the shorter the life cycle, the stronger the environmental impact will be. This means that the management will become more complex and a sub optimisation of individual

[4] Interview Development Director Günther Lanzinger 2002-05-16
[5] Tetra Pak intranet 2002-07-12
[6] Interview Financial Director Björn Kristiansson 2002-07-02
[7] Engwall (2001:6), p i

projects must be allowed in order to optimise the project portfolio.[8] This situation demands management of the project portfolio in order to be able to make the right decisions concerning the company's strategic future.

There are several definitions of a project portfolio. Anell (2000) makes a difference between a multi-project environment and a project portfolio.[9]

"The term portfolio is meant to indicate a planned composition of projects, balancing various aspects of a number of projects over time to ensure long-range survival of the firm in question."

Archer & Ghasemzadeh (1999) uses a different definition of a project portfolio, which state:[10]

"a group of projects that are carried out under the sponsorship and/or management of a particular organization. These projects must compete for scarce resources (people, finances, time, etc.) available from the sponsor, since there are usually not enough resources to carry out every proposed project which meets the organization's minimum requirements on certain criteria such as potential profitability, etc."

The definition by Archer & Ghasemzadeh (1999) is supported by the definition by Cooper et al. (2000) that strongly points out the strategic importance of multi-project management as one of the company's top strategic priorities. This can be seen both in an external market-oriented and an internal resource-oriented way.

"Portfolio management is about resource allocation –how your business spends its capital and people resources, and which development projects it invests in. Portfolio management is also about project selection –ensuring that you have a steady stream of big new product winners! And portfolio management is about strategy –it is one method by which you operationalize your business' strategy."[11]

This definition of portfolio management demands a dynamic decision process where the list of projects is constantly updated and revised; new projects are evaluated, selected and prioritised, existing projects can be accelerated, killed or de-prioritised and resources are allocated and re-allocated to active projects.[12] This demands valid information.

Until recent years, not enough focus has been placed on assuring the strategic fit of launched projects and multi-project management.[13] Even though the situation is getting better, many companies still do not seem to get their project portfolio

[8] Engwall (2001:6), pp 1
[9] Anell (2000), pp 80
[10] Archer & Ghasemzadeh (1999), pp 208
[11] Cooper et al. (2000), p 1
[12] Cooper et al. (2000), p 12
[13] Rautiainen et al. (2000), p 1

management right. At the same time research has shown that businesses that feature a systematic portfolio management process outperform the rest.[14]

Cooper et al. (2000) has found that there are four main challenges or problem areas that have to be dealt with in order to reach efficient project portfolio management. These four problems briefly summarise the multi-project environment and point out problems that a portfolio management support system has to deal with. The problems are:

1. Resource balancing. Today go/kill decisions are made, but resource implications are often not regarded and focus is instead set on pure financial measurements. This situation often results in a situation where the resource demand of the portfolio exceeds the company's supply.[15]

   Another common problem is that too many projects are launched, leading to over commitment of resources, which in turn causes projects to fall behind in their schedules.[16] If resources are not balanced, shortage of resources can lead to longer time-to-market because of a situation where projects end up in a queue waiting for people and resources to become available.

2. Prioritising projects against each other. It is not sufficient to have profitable projects in the portfolio; it should contain the most profitable projects and thereby be the most profitable portfolio. This demands management to rank the projects in relation to each other and kill the ones that are less profitable. A problem that often arises is related to the fact that management think it is difficult to kill the new and small projects that may become tomorrow's cash cows.[17]

3. Too many minor projects in the portfolio. The reasons for this can be an overemphasis on short-term profits and lack of discipline where urgent things always prevail over important long-term issues.[18]

4. Making go/kill decisions in the absence of solid information. Research has shown that weak preliminary market assessments, barley adequate technical assessments, dismal market studies and marketing inputs are more common than uncommon.[19] This makes investment decisions risky. In order for management to pick the right projects it is vital that the company manages to make the needed research in order to give management a solid foundation of information to stand on when making go/kill decisions. With better information it would be possible to make better product design, testing,

[14] Cooper et al. (2000), p 19
[15] Cooper et al. (2000), p 3
[16] Rautiainen et al. (2000), p 1
[17] Cooper et al. (2000), p 3
[18] Cooper et al. (2000), pp 8
[19] Cooper et al. (2000), pp 7

launch and production start-up which inevitable will make the success rate of started projects rise.[20]

To provide managers with a basis for making the right internal decisions, data has to be gathered and presented in a correct and easily accessible way. This would help management to allocate resources, prioritise projects, getting the right mix of projects and making adequate go/kill decisions. Cleland (1999) states that there is a clear distinction between data and information. Data needs to be structured, meaningful and pertinent to be defined as information. This implies that data is the raw material of information.[21] The question in focus then becomes which information is needed for managers to be able to make the needed decisions regarding multi-project management. Who are to access the information and how should it be presented to be of most use for these persons? In this respect, it is of outmost importance that information can be easily accessed and understood. The issue concerning the amount of information needed, and most of all wanted, by decision makers is also of great importance. How should a considerable amount of information be aggregated into an effective management tool in order to give an easily understood overview of the project portfolio?

1.3 Purpose

The aim of this thesis is to develop an intranet based system that provides managers with information needed to manage a company's project portfolio. The system will be evaluated and analysed according to relevant theories in order to establish whether it can be of any use in the multi-project environment described in literature.

1.4 Delimitations

Proposed changes in the flow of information inside Tetra Recart will be dealt with within the frames of Tetra Pak's method of managing projects, Tetra Pak Innovation Process, TPIP. This and other project management models will not be questioned or discussed within this thesis.

The study and development of the intranet based multi-project management tool will only comprise Tetra Recart and specific details in the system will therefore be adapted to the prevailing circumstances at Tetra Recart. However, this will only regard details as symbols, names on project phases and colours.

A tool for allocation of resources is an important part of a multi-project management tool and the topic will therefore be dealt with on a theoretical basis. The system will though not contain a resource allocation function since the company is currently developing a resource allocation system that will be accessible from the portfolio overview system developed in this thesis.

[20] Cooper et al. (2000), pp 7
[21] Cleland (1999), pp 309

1.5 Target Audience

There are two main target audiences for this thesis. The first is people working with issues regarding multi-project management. This group can be divided into two parts; one which contains managers, project leaders and project coordinators, and one containing people who work with support systems for single and multi-project management. For these persons the thesis can be used as a base for discussion, which can influence future changes in existing systems as well as the way in which the organisation work with project portfolio issues. Besides this, employees at Tetra Recart will be able to use the project portfolio tool in their everyday work.

The second target group is university students with special interest in project management.

1.6 Guide to the Thesis

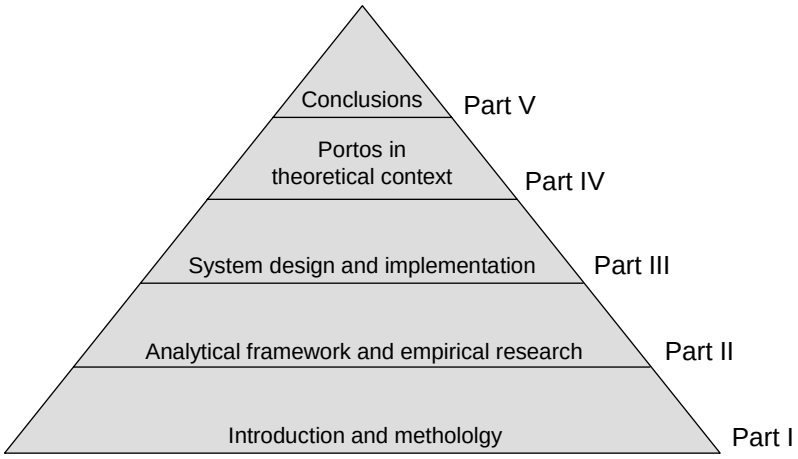


Figure 1 – Guide to the thesis

The thesis consists of five major parts. The first part, including the introduction in chapter one and the methodology in chapter two, lays the foundation for the rest of the thesis and provides the reader with facts to judge the validity and quality of the materials forming the basis for the analysis performed. The methodology describes how and why different ways of empirical research has been undertaken to assure the reader that the information is accurate and correctly interpreted.

The second part consists of chapters three and four where the analytical framework and the empirical research are presented. The analytical framework is divided into two sections, multi-project theory and theory regarding information systems. The second part provides the reader with theoretical and empirical background to why the system has been designed the way it has.

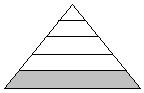
The third part of the thesis include chapters five and six containing the actual appearance and design of the system in chapter five and the technical implementation

in chapter six. The technical implementation and design of the system has been the most time consuming part in the work within this thesis, but has deliberately been cut down in the written report to merely give a technical overview and a user perspective on the design of the system.

The fourth part places the Portfolio Overview System, Portos, in its theoretical context. The chapter will give the reader an understanding of the benefits of using Portos.

In the fifth and final part, pros and cons of the system are summarised and conclusions are drawn to whether the system is useful or not.

2 Methodology



This chapter begins with an introduction to the theoretical frame of methodology and gives a brief description of the basic terms used later in this chapter. Furthermore the implemented methodology is presented and explained together with a discussion regarding the data on which this thesis has been built.

2.1 Introduction

The purpose of this introduction is to provide the basic theoretical frame of reference used in this chapter.

2.1.1 Methodological Approaches

There are primarily three different approaches to methodology, each representing a different way of perceiving reality. The approaches are:[22]

- Positivistic
- Hermeneutic
- Systemic

According to scientists that adapt to the positivistic view, something that can not be measured or be subjected to verification should not be considered science. Research should be done methodically by deriving hypothesises, in the form of mathematical formulas, to be empirically tested with scientific methods.[23]

The hermeneutic view is mostly used in human- and social sciences and can be seen as the exact opposite to the positivistic. The hermeneutic view is often associated with qualitative research and the scientist is approaching the research subjectively from his own understanding. Knowledge and understanding of the researcher is considered an asset, not an obstacle, to interpret and understand the research object. The researcher tries to view the topic as a whole in relation to the parts, instead of breaking it down into parts and study each part separately like the positivists would.[24]

The systemic view can be placed between the positivistic and the hermeneutic. It assumes the existence of an objective reality but built differently than the positivistic view proclaims. The reality can be divided into components, but these are dependent of each other and therefore cannot be summarised. The sum of the components is affected by synergic effects that give the system more or less value than the sum of the individual parts.[25]

[22] Arbnor & Bjerke (1994), p 65
[23] Patel & Davidson (1994), pp 23
[24] Ibid
[25] Arbnor & Bjerke (1994), pp 80

2.1.2 Investigations

There are three different ways to conduct scientific investigations. They are:[26]

- Explorative
- Descriptive
- Trial of Hypothesises

The explorative way is used when one needs to fill a gap in knowledge and the primary purpose is to obtain as much information as possible within a certain area. Several different techniques are often used to gather information instead of only one.

The descriptive way is used when the knowledge in an area is starting to be systemised in the form of models. Usually one technique is used to gather information and only a few aspects of the phenomena of interest are investigated.

A trial of hypothesises requires a sufficient amount of knowledge in an area, so that assumptions can be drawn from the theory and tested in reality.

2.1.3 Qualitative and Quantitative Research

The manner in which data is acquired and analysed can be viewed in two fundamental ways, qualitative or quantitative. These can be seen as the terminal points of a continuum and the main part of today's research lies somewhere in between. Strictly quantitative research consists of numerical data and statistical analysis whereas qualitative research deals with information that cannot be expressed numerically.[27]

2.1.4 Inductive and Deductive

The way in which a researcher relates theory to reality can be either inductive or deductive. The difference between the two is illustrated in Figure 2 showing induction to the left and deduction to the right.

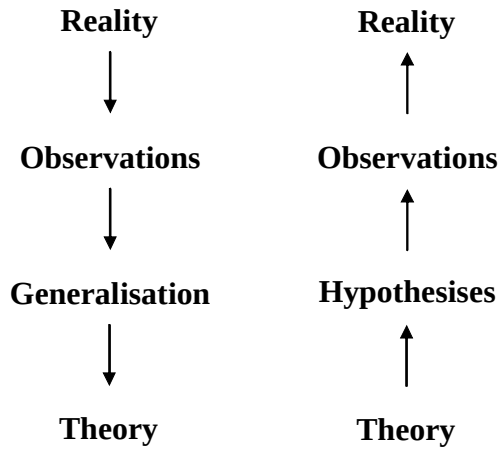


Figure 2 – The difference between induction and deduction

[26] Eriksson & Wiedersheim-Paul (1997), pp 218
[27] Patel & Davidson (1994), pp 12

The inductive approach takes the starting point in reality in the form of empirical data, without having theoretical support from established theories. This does not necessary mean that the researcher works completely unbiased, since the ideas and theoretical background of the researcher will of course influence the work. The observations and investigations eventually lead to the formulation of theory. The inductive approach is often used in humanistic sciences. One problem with an approach is the validity of the theories formulated since the research is often conducted within a certain organisation, situation or group of people.[28]

The deductive approach takes the starting point in general principals and existing theories to form hypothesises which are tested empirically. Thereafter conclusions about the validity of the theories can be drawn.[29] This approach is often used in natural sciences.[30]

2.2 Implemented Methodology

The scientific outlook throughout this thesis has been a systemic view. The aim has not been to build a theoretical superstructure or to form mathematical formulas like the positivistic view proclaims.[31] Rather, the nature of the thesis and the point of view of the authors have been more systemic in the sense that the problem can not be broken down into small pieces and studied separately. The task requires a deeper understanding of organisational needs as a whole in order to provide the demanded solution. Within a new theoretical area such as multi-project management there is no well-structured way to approach the problem. Instead, the authors own understanding of the different factors involved at the present time is an asset that should not be underestimated. The major importance and the extensive consequence that the findings can have on an organisation require the synergic effects when viewing the system as a whole to be acknowledged and considered.

The systemic view advocates a qualitative approach, and that is also the chosen approach throughout this thesis. All the information collected is of a qualitative nature and consists mainly of interviews and group discussions with employees at Tetra Recart. The way in which data has been collected has mainly been explorative and the reason for this is that little is currently known and published in the area of project portfolio management and multi-project management.[32] The task therefore requires gaps to be filled and a large amount of information to be acquired. Further information comes from articles and books about both single- and multi-project management.

[28] Patel & Davidson (1994), pp 21
[29] Holme & Solvang (1997), p 51
[30] Patel & Davidson (1994), p 22
[31] Patel & Davidson (1994), p 28
[32] Engwall (2001:8), p i

The nature of the thesis, the task at Tetra Recart and the lack of existing theories calls for an over all inductive approach. Figure 3 visualises the chosen methodology and describes the work during the thesis.

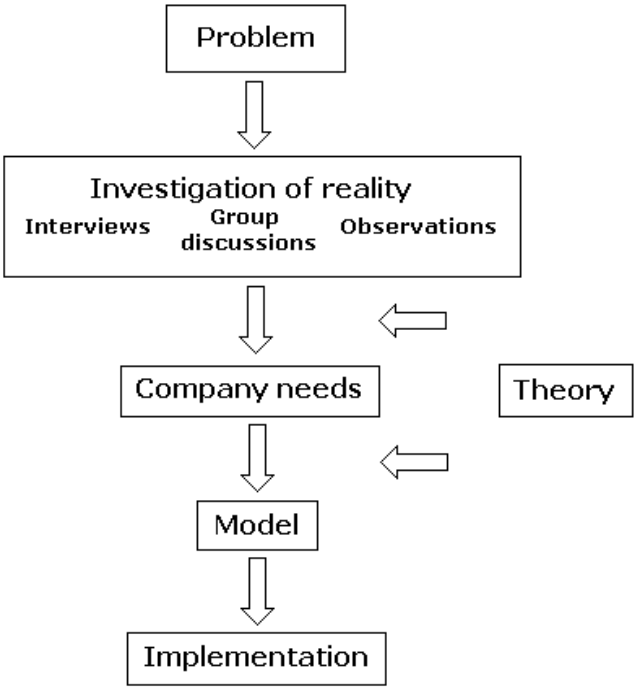


Figure 3 – Implemented methodology

The methodology is based in reality with a tangible problem, which implies an inductive approach. Since the problem was not clearly defined from the beginning, the authors had to formulate the actual problem to investigate and further evaluate and choose the proper way to conduct the research. Empirical studies were carried out to clarify the needs of the organisation, the possibility to implement a new system and the requirements of such a system. The empirical material has been obtained from interviews, group discussions and general observations in the organisation. Most information gathered in interviews was later discussed with several of the interviewees to make sure that their answers had been correctly interpreted.

Along with the empirical information gathered, theoretical knowledge was obtained from a wide perspective containing organisational theory, learning organisations, process management and more direct project management and multi-project management. The knowledge from these sources was incorporated during the evaluation of the company needs and the generation of the concept model for creating a system for handling a project portfolio.

To make sure that the answers have been correctly conceptualised into the system, the basis of discussion during the latter deliberations had a strong emphasis on visual aids. Power Point models of the pages where drawn and later on, the actual system

was used in the discussions. This way of constantly forming and revising the system where conducted throughout all the work on the system. The used iterative approach to product development is described in Boehm's spiral model[33]. This is a very common way to perform software development, and the spiral model is not contradicting the more linear model described in Figure 3. The transition from company needs to a system is hard to find at once, both regarding information needs and the design of the system.

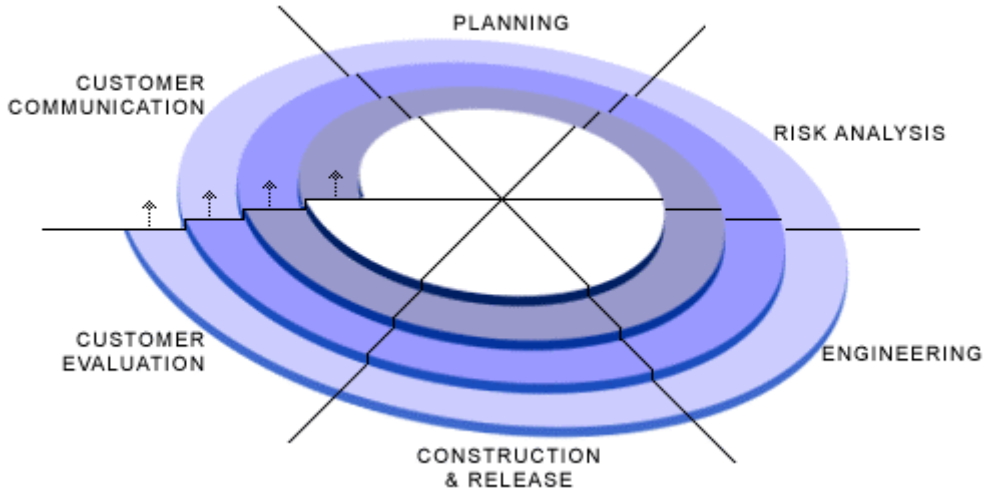


Figure 4 – Boehm's spiral model
Source: www.bangaloresoftware.com

After the model of the system was presented, the features were evaluated and divided into three categories in order of importance to the company. These features were later developed in that order to make sure that the most important parts should be implemented first. This way the system could be viewed by its users from the beginning and minor additions and improvements could be implemented at once. The planned features were later on gradually included to the system.

2.3 Primary Data Collection

The primary data collected for this thesis is gathered from several different sources. In many cases the same data has been reliability tested by making sure that the information is consistent within the organisation. This way validity has been tested as well. Hardest to prevent is bias that might appear both from the interviewer and the interviewee. Comments, tones or body language can influence both the interpretation of asked questions and given answers during an interview. This can lead to non-accurate answers or, in worst-case, a defective research if the interviewee decides to withhold information that could affect the result.[34]

[33] http://www.bangaloresoftware.com/html/quality-methodology.htm, 2002-11-20
[34] Holme & Solvang (1997), p 105

It is important to bear in mind that Tetra Recart is the only company from which primary data has been collected. However, this should not be a problem due to the large similarities between secondary data and conclusions drawn from the primary data.

2.3.1 Interviews

Most of the primary information has been collected during interviews with project managers and management personnel at Tetra Recart. These interviews have been carried out using a questionnaire that further has increased the reliability of given answers.[35] One problem with these interviews has been that the interviewee already from the beginning has known management's opinion concerning the need for a new system. This might have influenced answers negatively from a liability point of view.

2.3.2 Group Discussions

Project managers and line managers have on two different occasions been invited to group discussions. During these discussions, different opinions inside the company have been visualised and surfaced with a subsequent dialogue to clarify all arguments. Letting the participants discuss with each other with input from relevant theories gave a more creative discussion that gave the interviews further value. This way a better understanding of the internal situation at Tetra Recart has evolved which has further helped us estimate the value of our interviews.

2.3.3 Observations

Besides interviews and group discussions a tollgate meeting has been attended. The meeting was selected by management personnel at Tetra Recart and might not have given an overall accurate view of Tetra Recart in general. The meeting though has given a valuable insight in the procedures surrounding tollgate meetings.

2.4 Secondary Data Collection

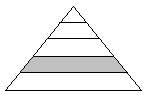
A useful complement to collected primary data is secondary data, the use of data that already has been collected for some other purpose. One advantage of secondary data is the possibility to repeatedly return to the source and continuously weigh its relevance. On the other hand secondary data has to deal with the risk of subjectivity, which makes it important to use multiple sources.[36]

The secondary data that has been used in this thesis is mainly related to the literature study that has been conducted. The libraries at Lund University and the Internet have been the basis for the literature search. In addition to this Mats Engwall, researcher within multi-project management at Stockholm School of Economics has been contacted in order to ensure a complete coverage of the literature regarding the subject. Besides the literature study, an internal Tetra Pak training course in the handling of TPIN as well as a course for newly employed have been attended.

[35] Holme & Solvang (1997), pp 99
[36] Holme & Solvang (1997), pp 124

The main threat to reliability related to secondary data has been the fact that the topic multi-project management is relatively young and has not yet been researched to its full extent. A result of this is that researchers are often found quoting each other and even using the same metaphors. This problem has been minimised by an explicit aim to find researchers with different opinions in order to retain reliability.

3 Analytical Framework



This chapter contains three main areas. The first area describes the basics within project management, what a project is and how it is managed. The second area depicts what multi-project management is and the complications that arise within a multi-project environment. Finally, theories regarding information systems are presented and set into context.

3.1 Project Management

In order to investigate the multi-project environment, a platform first has to be set up to define the basic concepts used further on in this thesis. This platform is based on the definition of a project, how to structure a project and how to measure project performance.

To find a definition of the word project, the easiest and most striking way is to state what are the characteristics of a project. The basic characteristics are that projects always exist for a limited time, are unique and do not consist of repetitive work. Further, every project has a new set of people organised as a project team to fulfil the project's clearly defined goals. Using the definition from Turner (1993), a project is:[37]

"an endeavour in which human, material and financial resources are organized in a novel way, to undertake a unique scope of work, of given specifications, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives."

Two more words characterising a project are interdependencies and conflict.[38] Projects often interact with other projects being carried out simultaneously in the company and they always interact with the parent organisation's ongoing operations. This is also the cause of conflicts. The project manager constantly competes with other projects and functional departments for both personnel and material resources. These characteristics are more fully described in chapter 3.2 about multi-project management.

3.1.1 Organising Project Work

When optimising the way to work in a project, the concept of phases is used to structure the managing of projects. The project is typically divided into four or five different phases that are separated by tollgates where decisions are made whether to proceed with the project or not. The way this classification is done differ from one author to another, but one of the most common and a general description has four phases: concept, development, implementation and termination.[39] Using tollgates before entering new phases makes sure that projects that no longer are adequate or not

[37] Turner (1993), pp 8
[38] Meredith (1995), pp 8
[39] Engwall (1999), pp 50

performing good enough are terminated in time before new costs are accepted in the next phase. In addition to tollgates, milestones are used to describe the amount of work to be done at a specific time so that the project can be planned in an efficient way. A milestone is a description of a future state in which the project is to be at a certain date. To be able to plan on an even more detailed scale, the workload is often described in a Work Breakdown Structure, WBS, where the exact nature of the tasks required completing the project are listed. This way of structuring the management of projects in tollgates, milestones and WBS are described in a number of both theoretical[40] and practical[41] sources.

Further there are a number of different roles in a project organisation. Usually the roles are orderer, steering group, chairman of the steering group, project manager and core team.[42]

- Orderer is the one that has ordered the project and could be both an internal and an external person.

- The project's steering group makes the decisions about time, cost and scope for the project and whether to proceed or not in the tollgates. The chairman of the steering group is also called the project sponsor or project owner. It is the project owner that managing the projects business contacts with the surrounding world.

- The project manager is responsible for managing the internal work and the projects performance. The project manager reports to the steering group and the project owner and has no authority to make decisions on his own.

3.1.2 How to Measure Project Performance

Referring to the definition of a project above given by Turner (1993), cost and time are two essential components. In combination with quality a project's performance is often evaluated using a triangle to depict the project's three dimensions: cost, time and quality.[43] These three dimensions affect each other and trade-offs constantly have to be made.

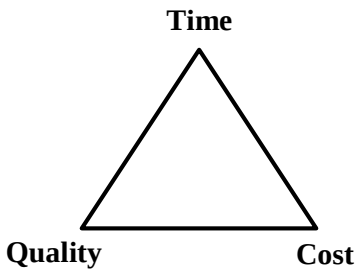


Figure 5 – The project triangle
Source: TietoEnator's PPS

[40] Turner (1993), pp 23 and Meredith (2000), pp 257
[41] Ericsson's PROPS and TietoEnator's PPS
[42] TietoEnator's PPS
[43] Meredith (1995), pp 3

In order to be able to determine whether the result achieved is good enough, it is necessary to illustrate the consumption of time and cost and present the result that have been reached with these resources.[44] This requires project monitoring that is equal to collecting, recording and reporting project information. Of primary interest *"is to ensure that all parties interested in the project have available, on a timely basis, the information needed to exercise effective control over the project"*.[45] Other uses for monitoring, as for instance auditing, learning from past mistakes and informing senior management, must be considered secondary to the control function. Control is the process of evaluating and comparing planned results with actual results to determine project performance in accordance with given amount of resources as well as strategic fit within the company's portfolio.[46] Cleland (1999) means that three key questions can be answered by comparing planned and actual performance. [47]

- How is the project going?
- If there are deviations from the project plan, what caused these deviations?
- What should be done about these deviations?

Cleland (1999) asserts that assessment of project status is an ongoing responsibility of the project team and senior management. The information obtained in the analysis of the comparison of planned and actual quality should be used to decide whether corrective action is needed.[48] To structure the comparison there are a number of different usable methods. One of these is earned value, where project information is interpreted from the project dimensions time, cost and result described above. The method is based on three different calculations: pre-calculation, performance, and earned value.[49] Pre-calculation is done from the estimations that the project manager makes about time and cost consumption within the project. The performance is calculated with actual values aggregated from the date the project started. Using a number of ratios between the two previous, which are cost difference, cost ratio, time difference and time ratio, the earned value can be drawn in a graph together with the pre-calculation and the actual values. This way it is possible to make predictions about the future.

3.2 Multi-Project Management

During the last decades, project organising has become one of the most common standard practices in both industry and public administration. From being an exclusive label applied on unique exceptions in the enterprise, an increasingly larger share of tasks in the ordinary operations are categorised as projects. This has created a

[44] TietoEnator's PPS
[45] Meredith (2000), pp 442
[46] Cleland (1999), pp 325
[47] Cleland (1999), pp 329
[48] Ibid
[49] Antvik (1999), pp 33

multi-project environment with many relatively small projects that run simultaneously.[50]

Multi-project management often is declared to be very important, but at the same time most project management authors leave the topic as soon as they have mentioned its importance and the topic has undoubtedly been paid little attention in traditional organisational theory.[51] This fact has made it difficult to find information that really penetrates multi-project management problems. Problems that most project-oriented organisations have recognised but few have solved due to the complexity in the multi-project environment. This is a virtual catastrophe when bearing in mind that research has shown that up to 90%, by value, of all projects are carried out in the multi-project context.[52]

The uncharted lands of multi-project management also mean that a researcher will stumble upon a great number of different definitions. However, they all share the fundamental idea that a multi-project environment consists of several projects within the same organisation and that these projects affect each other by competing for the same resources regarding co-workers, premises, machines, financial means and so on.[53]

3.2.1 Differences between Multi-Projects and Single-Projects

The old project management theories are well tested but are usually designed for environments in which the large single project:[54]

- is performed in a stable environment
- is predictable as to content and duration
- has few if any interactions with its surroundings
- is hierarchically run and the decision making process is top-down

Today, these theories and models have little relevance to project management in practice and the present project management theories are therefore not sufficient to help us deal with the multi-project situations, simply because they are based on the wrong assumptions.[55] To start with, an increasingly larger share of the activities in organisations are defined and carried out as projects.[56] There are of course still major projects with extraordinary content, but more frequently project assignments are small, projects run simultaneously with other projects and they share the same resources. Projects also often have a small budget and a short life cycle. This has made the interaction between projects as well as their non-project environment more intense, the smaller the project and the shorter the life cycle, the stronger the environmental impact will be which also means that the management will become

[50] Engwall (2001:6), pp 1
[51] Engwall (2001:8), p i
[52] Payne (1995), p 63
[53] http://www.projforum.se, 2002-07-29
[54] Eskerod (1996), pp 63
[55] Eskerod (1996), pp 62
[56] Engwall (2001:8), pp 2

more complex.[57] It is not unusual that the complexity has to do with competition between different projects, competition that may lead to sub optimisation.[58]

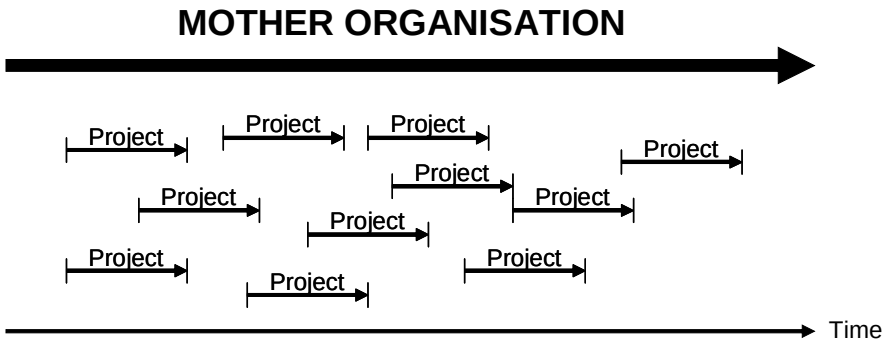


Figure 6 – The multi-project perspective
Source: Engwall (2001:6)

A multi-project environment demands that top management must handle the responsibility of multi-project management in order to secure a match between the individual project aims and the aims of the entire organisation. This also refers to the long-range strategic plans regarding business-, product- and organisational development. Decisions to initiate or close projects must be taken with the potential impact on the entire project portfolio in mind.[59]

In the following attempt to describe the multi-project environment presented in Payne (1995), the five C:s Capacity, Complexity, Conflict, Commitment and Context will be used as a framework.[60] A critical reader will soon recognise similarities between the different aspects. These similarities arise in the fundamental problem of the limited amount of resources that an organisation has access to. The five C:s will therefore be complemented with a brief discussion about resources.

3.2.2 Capacity

Capacity relates to the organisation's ability, or lack of ability, to assign appropriate resources to the different projects in the project portfolio. Most organisations cannot afford to have excess resources that are not used in the daily operations. But at the same time management seldom misses the opportunity to start a new project that could mean more money for the company. This situation inevitably leads to periods of under-capacity, which can be costly.[61] A simple rule of thumb is that if resourcing is out by x% and $x < 20$, then costs will roughly increase by x%.[62] This under-capacity can be solved in one of the following ways: overtime, seconding of staff

[57] Engwall (2001:6), pp 1
[58] Eskerod (1996), pp 61
[59] Engwall (2001:7), pp 6
[60] Payne (1995), p 164
[61] Ibid
[62] Collins (1999), p 2

from other departments, temporary employment agencies, short-term staff, or subcontracting of work.[63]

These solutions all have advantages but also drawbacks that make the organisation's efficiency suffer. When it comes to assigning employees multiple tasks and switching from one project to another, the switchover time needed to get up to speed cannot be neglected.[64] It has for instance been suggested in the literature that, for a full-time assignment, the organisation should set aside at least 120% (>six days/week) of dedicated labour because of the intensity with which that person is able to work. Another rule of thumb suggests a loss factor of 0% for full-time assignment, 15% for half-time assignment, and 20% for one-quarter time assignment.[65] It is clear that one solution that can maintain a high efficiency is to carefully allocate existing resources and only take on new projects that fit the project portfolio.[66]

3.2.3 Conflict

The most common conflicts regard the balance of formal power and informal influence between the project manager and the managers at the functional departments in the hierarchy.[67] Payne (1995) has recognised three different subcategories of conflicts: people issues, system issues and organisational issues. [68]

People Issues

All the subcategories have in common that they arise in unstable relationships, which are usual in a multi-project environment. In order to stabilise the instable environment it is important, as described above, to assign a resource the same task for the longest time possible. If this is not done, there is a danger that the learning curve of the new specialists will suffer as well as the well-being of the members. The possibility to assign a resource for a long period of time is however often broken up by the fact that functional managers and project managers are rivals when it comes to the available resources.[69]

System Issues and Prioritisation

The system issues often have to do with the priority structure and the work scheduling process.[70] It is common and understandable that project managers want the ideal resources to be assigned to their own project but this can at the same time mean that other projects suffer and lack the right resources. This makes concept selections and prioritisations important.[71]

[63] Payne (1995), p 164
[64] Bakar et al. (2002), p 2
[65] Fricke & Shenhar (2000), p 260
[66] Collins (1999), pp 1
[67] Engwall & Sjögren-Källkvist (2001), p 2
[68] Payne (1995), p 164
[69] Ibid
[70] Ibid
[71] Eskerod (1996), pp 64

There are two different systems when it comes to prioritising projects. The first is to let all projects compete and give each project a priority level in relation to all other projects. This so-called forced-ranking solution typically means that the organisation's management make a project review 2-4 times a year. At this review meeting resources are assigned to the projects, beginning with the highest prioritised projects, until the organisation runs out of resources.[72] The second system is to give the projects a priority level that can be shared by many projects.[73] If this non-forced ranking system is used, a project should be given a priority level immediately after the decision to start the project. This prioritisation then has to be followed up during the progress of the project.[74]

Regardless of the approach, priority must be set according to a certain set of criteria. Cooper et al. (2000) suggests several different methods for prioritisations, one of these methods emphasises five different areas that must be regarded by management.[75]

- Confidence in the project team and in their proposed costs, revenues and schedules
- Revenues versus development and commercialisation costs with a risk factor included
- Match to the strategic plan
- Profitability index
- Availability of technical resources and commercial strengths

Even though prioritisation of projects is an important part of project management and has many positive effects, it is important to bear in mind that an organisation could face some negative effects related to prioritisation. One problem that is related to prioritisation between projects is that such a solution tends to make resource allocation more complex and that the decision therefore is moved upwards in the hierarchy, which creates an overload on top management.[76] Another problem that primary is related to the forced-ranking system is the fact that some project team members and project managers keep their work and their problems so close to their chest that nobody else really know what is going on. They do this because they are afraid their project will get a lower priority, or even be closed down, if people get to know their problems. In other words, the information becomes non-symmetrical because of the sense of competition in the minds of the employees.[77] A factor that often makes the problem more severe is reward systems that support the achievements reached within the project instead of rewarding achievements reached

[72] Cooper et al. (2000), p 16
[73] Eskerod (1996), pp 64
[74] Ericsson's PROPS (2000), p 47
[75] Cooper et al. (2000), p 17
[76] Engwall & Sjögren-Källkvist (2001), p 10
[77] Eskerod (1996), pp 64

in the entire organisation. This way, incentive systems often work divisive instead of integrative.[78]

Also, the non-forced-ranking system has large drawbacks as aid for evaluating projects since it often ends up rating projects against absolute criteria, rather than each other. This inevitably leads to middle-of-the-road results that almost make the prioritisation process undone. The reason for this being that the small differences in priority still makes decisions hard to make.[79]

Organisational Issues
There are several organisational alternatives for connecting the project activities to the parent organisation. The way these activities are organised has a strong influence both on project work, and on how the project is conceived. There are mainly two ways of arranging the organisation; on one hand it is possible to have pure independent project teams and on the other hand it is possible to organise a matrix of projects and functions.[80] In the matrix organisation the project manager is often trapped between the responsibility related to his or her project on one hand and the lack of influence on the other hand, since the team members are often controlled by functional managers. However, most conflicts arise in the friction between different projects.[81] A situation in which many projects with similar contents and objectives exist may cause severe difficulties due to confusion regarding resources and areas of responsibilities.[82] In those conflict intensive situations, the functional managers will act as mediators between different ongoing projects, trying to match resource needs. A job that is almost impossible because progress or delays in one project often affect the rest of the project portfolio.[83] This situation may be avoided if the organisation has a strong culture and objectives that are shared throughout the organisation.[84]

3.2.4 Commitment
Commitment relates to the commitment felt by the parties working on or providing recourses to the individual project. It is not unusual that the size of the project determines its perceived importance and thereby also the commitment. This can be troublesome when even a small project can be of great strategic importance to the organisation.[85]

The aim should not be to get the employees to work longer hours; it should be to get them to work more efficiently. It is also important that the employee gets the big picture and feels enjoyment in his or her ability to be a part of the organisation's achievements.[86]

[78] Engwall & Sjögren-Källkvist (2001), p 10
[79] Cooper et al. (2002), pp 16
[80] Engwall (2001:6), p 6
[81] Engwall & Sjögren-Källkvist (2001), p 11
[82] Payne (1995), p 165
[83] Engwall & Sjögren-Källkvist (2001), p 11
[84] Payne (1995), p 165
[85] Ibid
[86] Ibid

3.2.5 Context

Context relates to the project environment, such as the culture, procedures and norms. A multi-project environment does not provide a stable environment mostly depending on the fact that such an environment has multiple managers related to one single project. The multitude of different projects with different environments also creates a multitude of different cultures depending on, for instance, the size of the specific project. Priority assignment methods for projects and tasks also set the scene. Especially important are communication- and reward systems that should be detailed enough to take all aspects of the multi-project environment into account but at the same time not complicate it further.[87]

3.2.6 Complexity

All project teams, as well as other organisations, are embedded in a complex web of people, resources, organisational structures and market conditions. The activities inside these organisations are always affected by the characteristics of that web. The complexity is dependent on the amount of integration between different projects as well as differences between projects.[88] From a system's point of view, there is a great need to emphasise integration. The management of a web or network of projects involve the following.[89]

- Establishing formal and informal communication networks between persons involved in different projects
- Allocating resources among different projects
- Assigning roles in different projects to one person
- Establish relationships between projects
- Developing management information and status of various projects

Interfaces

The main reason for the complexity in a multi-project environment is of course the fact that the projects, in addition to its internal interfaces, have external interfaces between the different projects. These may not be direct, but via intermediaries such as common resource providers. This dependency of the same resources makes it necessary to run a tight and strict schedule of the resources, which makes the multi-project organisation inflexible and unable to adapt to changes in the plan. One can limit the complexity by selecting the degree of integration. Large integrated plans become cumbersome and it may therefore be preferable to integrate only those elements of projects that are commonly shared.[90]

When it comes to complexity in the control of a project portfolio it is suggested that one has to accept sub-optimisation of individual projects in order to optimise the portfolio. This means that the level of detail required is not so great.[91]

[87] Payne (1995), p 165
[88] Engwall (2001:6), p 4
[89] Lim & Yeo (1995), p 406
[90] Payne (1995), pp 166
[91] Ibid

Differences between Projects

It is only natural that the portfolio contains projects that have significant differences regarding size, required skills, and urgency. Research[92] has shown that projects become more efficient if control and management procedures are tailored to a specific type of project instead of using one generic project management model for all projects. This research contradicts what earlier have been written about standard project management models which are said to have advantages regarding:

- consistent reporting mechanism, which makes it possible to compare reports from different projects
- easier and more consistent calculations of resource requirements
- a homogeneous environment that supports the movement of people between different projects
- similarities between small and large projects which makes it possible to use smaller projects as training ground for future managers of larger projects

Payne & Turner (1999) means that it is possible to keep these advantages by using a consistent approach at the strategic level while allowing diversity at tactical level. One answer lies in developing a strategic plan for each project that is based on a common approach but allowing different projects to adopt different approaches at the detailed or tactical level. This relates complexity to different project sizes, where the smaller by obvious reasons cannot have the same large control system as the major projects. It also makes the problems that are related to different resource types, as for instance customer projects, development projects or information projects, less complex.[93] Rautiainen et al. (2000) agree that different projects should be managed in different ways even though it is cumbersome. They mean that only projects within each project type should be compared to each other for their fit to the overall plan.[94] One question that can be raised is whether this solution makes the complexity that surround projects with different urgencies, but the same resources, easier to handle. Some researchers[95] mean that the solution for this problem is to prioritise the projects in the project portfolio, which have been described in chapter 3.2.3.

3.2.7 Resources

Resource allocation is, as discussed above, to large extent the basis of the problem surrounding multi-project management. The major management issue is the coordination and planning of resources between different simultaneous projects over time.[96] The only problem is that there is no efficient solution available in current literature.[97] Managers have to consider project types, objectives, duration, needed skills, interaction with other projects, appropriate project manager style and resource

[92] Payne & Turner (1999), p 55
[93] Payne & Turner (1999), p 56
[94] Rautiainen et al. (2000), pp 4
[95] Eskerod (1996), pp 64
[96] Engwall (2001:6), pp 6
[97] Lee & Lei (2001), p 305

characteristics when allocating resources to projects.[98] This means that several questions regarding allocation of available resources to the approved projects arise. [99]

- In which order should the projects be executed, or should they be executed concurrently?
- How many resources should be assigned to each project?
- What amount of required skills and competence is right for the project?

Collin (1999) suggests a scientific approach for the resource problem, where the ideal amount of resources is calculated thru mathematical formulas. The formulas will not be presented in this thesis but the fundamental idea will be accounted for. There are two fundamental ideas behind the model in Collin (1999).[100]

1. An organisation can always add another project to the project portfolio, with the only visible effect that a slight delay occur in the already existing projects currently in development.

2. It is not the size of the project that is important, but rather the costs that arise from lost opportunities, due to a delayed project.

Collin (1999) means that the total cost of a project is the combined sum of total development cost and total delay cost of the project and that optimal project resourcing means minimising the sum of these costs. A graphical analysis on the sum of delay cost curve and development cost curve could then be used to estimate the optimal development time frame. Projects that are developed quickly will be development cost driven, and those developed slowly will be delay cost driven.[101]

Finding the ideal projects for the available resources are however not enough; the managers must also schedule the resources in an efficient way. There are a number of tools on the market, which can provide detailed schedules for resource allocation. But the resource problem is even more difficult in reality considering all the changes over time that has to be made. This makes detailed scheduling extremely difficult, especially in a complex multi-project environment. According to the survey, less than 5% of the time spent on scheduling is for developing new schedules, while 95% of the time is spent revising and maintaining schedules based on daily progress and changing assumptions. [102] As an alternative to complex systems, one easy way to handle these questions is to simply set up and follow rules regarding how many activities of each kind that can be active simultaneously.[103]

[98] Bakar (2002), p 6
[99] Collin & Dunning Crescent (1999), p 1
[100] Collin & Dunning Crescent (1999), pp 16
[101] Collin & Dunning Crescent (1999), p 2
[102] Lee & Lei (2001), pp 289
[103] Rautiainen et al. (2000), p 6

Irrespective of which method that is chosen for handling resource allocation, it is recommended to hire a coordinator who controls all the projects and provide them with necessary resources. In this way it is easier for the project managers to plan than it would be if he had to contact several functional managers.[104]

The aim of the following presentation of information systems is to give a basic understanding of how information systems are used to aggregate information and the benefits that comes from using such systems.

3.3 Information Systems

There are several different kinds of information systems that support communication and decision-making. The benefit of the information system can be either for management or employees or both. This chapter will describe a number of different types of information systems and clarify in what way information systems can benefit management and employees.

An information system can be categorised by the extent to which it imposes structure on decisions or other tasks. The three categories are: [105]

- Providing access to tools and information
- Enforcing rules and procedures
- Automating decisions

Providing Access to Tools and Information
This category provides the highest degree of freedom and imposes the lowest degree of structure. The information system provides the information but does not dictate how the information should be used in making decisions. Examples include systems providing financial information.

Enforcing Rules and Procedures
The information system will not only provide the information, but also exert more control by enforcing rules and procedures for how decisions should be made. Such systems can be those systems that provide a sort of “best practise” model to the users and ensure that this practise is followed.

Automating Decisions
This category of information system imposes the most structure and will make the decision rather than relying on human judgement in each case. Automating decision systems have important advantages when large amount of information must be processed and decisions are relatively easy to make.

[104] Payne (1995), p 166
[105] Alter (1999), pp 158

3.3.1 The Benefit of Information Systems to Management

There are a large number of different types of information systems with the purpose of serving management. Three different types of information systems for management will be described below.

Decision Support Systems

Decision Support Systems (DSS) have been in use since the mid-1970s and are broadly defined by Turban et al. (2002) as "*a computer-based information system that combines models and data in an attempt to solve semistructured problems with extensive user involvement*".[106] This is just one definition, and the meaning of the term differs from author to author, though some general characteristics can be identified. For example[107]

- Providing support for decision makers at all management levels by bringing together human judgement and objective information
- Support several interdependent or sequential decisions
- Usually utilises quantitative models, standard or custom made
- Equipped with a knowledge management component

Most DSS have only some of the above attributes. Tools such as interactive problem solving, user-controllable methods for displaying and analysing data, what-if scenarios could also be provided. DSS are usually designed to solve the structured parts of a problem and help isolate places where judgement and experience are required.[108]

Management Information Systems

Management Information Systems (MIS) typically generate information for monitoring performance, maintaining coordination and providing background information about the organisation's operations. Usually, data is extracted from a number of different sources and then summarised and presented in a way that allow managers to monitor and direct the organisation.

Executive Information Systems

The difference between a MIS and an Executive Information System (EIS) is the ability of an EIS to give managers and executives a more flexible access to information instead of only showing pre-specified reports on a scheduled basis. Instead, EIS are designed to find the right information at the right time in the right format. It provides rapid access to information and management reports. It should be very user friendly and is often supported by graphics. Finally, an EIS should feature a so called "drill down" capability which means that executives can drill down to more and more detailed levels of information if necessary.[109]

[106] Turban, McLean, Wetherbe (2002), p 442
[107] Turban, McLean, Wetherbe (2002), pp 447
[108] Alter (1999), pp 174
[109] Turban, McLean, Wetherbe (2002), p 457

3.3.2 Information System Benefits for Project Members and Employees

A number of areas where an information system can benefit the whole organisation can be identified. Fisher et al. (1998) describes the possible benefits regarding information systems at single-project and multi-project level.[110] They make a distinction between downstream and upstream use of data and knowledge. Downstream means that data and knowledge generated in earlier phases of a project is available for later phases. This requires information to be standardised and easily accessible for all members of the project. The benefit of downstream integration is that errors due to re-interpretation of data will be reduced, preparation time for estimates, bids and calculations will be much shorter et cetera.[111]

Upstream use of data and knowledge means that data and knowledge generated in later phases of other projects can be used in a project. This type of integration requires the use of expert systems and extensive databases. The benefits of upstream integration is a more complete basis for decisions in earlier phases and reduction of the number of change orders because important data will be overlooked less often.[112]

Another important issue for information systems is the handling of project post mortems or so called "lessons learned". These improve and formalises individual and corporate memory and are written upon completion of a project. In this way duplication of prior mistakes can be prevented and successful behaviour reinforced.[113]

3.3.3 User Interface

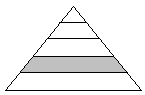
The user interface of an information system is of course vital to the functionality of the system. The term user friendly is often used as a slogan, however, the importance of user friendliness in many information systems should not be underestimated. Fischer et al. (1998) states that *"Electronic models will only be useful if humans can access, view and manipulate them easily, or, in other words, have direct engagement with the model"*.[114]

Alter (1999) chooses to define user friendly in the following way: *"Something is user friendly if most users can use it easily with minimal startup time and training, and if it contains features most users find useful."*[115]

Different users have different demands when it comes to the user interface. For example, when designing an EIS user interface the system must be more than user friendly, it must be user intuitive. The user interface must be designed to make operating the system and interpreting the output as easy as possible.[116]

[110] Fisher et al. (1998), pp 32
[111] Fisher et al. (1998), p 33
[112] Ibid
[113] Fisher et al. (1998), p 35
[114] Fischer et al. (1998), p 41
[115] Alter (1999), p 229
[116] Sprague & Watson (1996), p 158

4 Project Management at Tetra Recart



This chapter describes in what way projects are managed within Tetra Recart. Further Tetra Pak's current project management tool and model are presented. The chapter ends with a description of the usage of Tetra Pak's project management tool at Tetra Recart. Information in this chapter is based on the interviews conducted at Tetra Pak and Tetra Recart.

Tetra Recart was started as an R&D project with the aim of supplying Tetra Pak with a new package suitable for retorted food instead of liquid products. When the project had reached a phase where the focus started to shift from R&D to sales, the project was transformed into a company and the steering group was appointed as the board within the new company. The fact that Tetra Recart is a development intensive organisation that strives to work only with its core competences has made it natural to form a project organisation. This focus on projects will be intensified when the company reorganises, during the autumn of 2002, to become process organised with the intention that the processes mainly will be carried out as projects. The company currently has 12 projects. In addition to these 12 projects, a large amount of work in the functional organisation is also managed as projects.

A project manager leads a project and the people who are assigned full time or close to full time are called core team members. Other members are simply called project members. The decision to start a new project is taken by Tetra Recart's senior management and the different projects' steering groups. It is the steering group that takes all the go/kill decisions related to tollgate meetings. Besides tollgate meetings, project review meetings are held once a month or every second month. These meetings are similar to the tollgate meetings but no go/kill decisions are taken. The agenda of a project review meeting at Tetra Recart has the following topics.

- Project update, including "Risk management of the project"
- Follow-up of the minutes from last meeting
- Timing vs. planning (achieved milestones)
- Cost follow-up vs. budget
- Discussions

In connection to milestone and tollgate meetings, a number of documents are produced as decision support for the steering group. Besides these formal meetings, control is mainly carried out thru informal discussions between the steering group, the project manager and functional managers.

4.1 TPIP and TPIN

Tetra Pak has since 1998 been working with their innovation process within a framework which is called Tetra Pak Innovation Process, TPIP. The innovation process encompasses processes that need to be mastered in order to efficiently and

continuously develop successful products and services. In order to reach out to Tetra Pak companies all over the world, the company has developed an intranet based system called Tetra Pak Innovation Network, TPIN. This means that TPIN can be viewed as an instrument that visualises and support the innovation process.

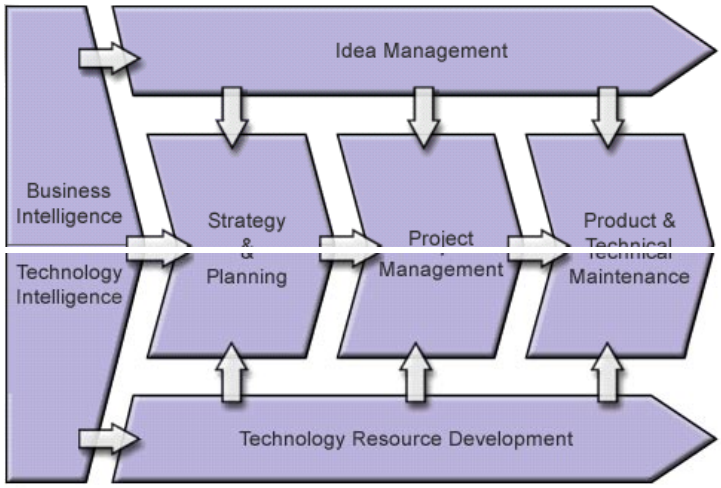


Figure 7 – Tetra Pak Innovation Process
Source: TPIN, Tetra Pak intranet (2002)

TPIP consists of seven different modules. The module relevant for this thesis is project management. The project management module has a central position within the innovation process since the major part of the work within the R&D function is carried out as projects.

The project management module is developed in order to provide a best practice when it comes to managing projects. The module is based on a standard product management model, which has five phases for a product development project and four phases for projects concerning technology development. This chapter will focus on the product development model.

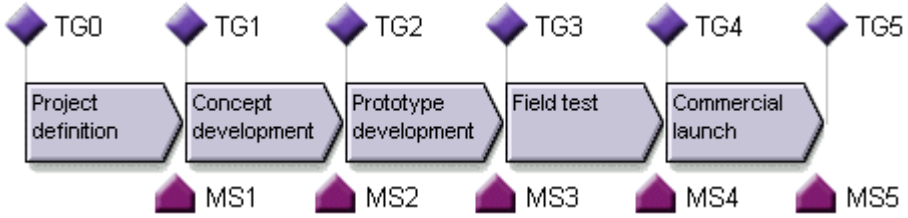


Figure 8 – The five phases for a product development project.
The project has six tollgates and five milestones.
Source: TPIN, Tetra Pak intranet (2002)

The five phases within the product development model are project definition, concept development, prototype development, field test and commercial launch. Within TPIN, each phase contains a number of activities that should be carried out if applicable before the project manager is permitted to enter the next phase. The decision to proceed is taken by a steering group at a tollgate meeting. Milestones are also used within the Tetra Pak model and it is the project manager that decides the number of milestones within a project. To enable a quick overview of a project within TPIN a colour system is used. When a tollgate, milestone or task is started it is marked yellow and when it is finished it is marked green. This makes it easy for an observer to see the status of the project regarding reached objectives. Further, TPIN provides the user with a number of templates and guidelines useful for project members. It also contains a system for storage of project documentation.

In order to make it easier for a user to track all projects he or she is involved in, it is possible to get an overview of the user's projects. Besides visualising how far the different projects has progressed, a "traffic light" indicates whether the project is over (red light), under (yellow light) or on budget (green light). A weakness within TPIN is that the user has to be a member of a project in order to view its status.

It has been stated that all projects within Tetra Pak shall be implemented according to TPIP and documented in TPIN.

4.2 TPIP and TPIN at Tetra Recart

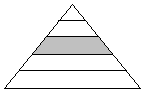
The intention within Tetra Recart has been to follow Tetra Pak's guidelines and manage projects according to TPIP and document them in TPIN. As a result, project managers often manage their projects in the spirit of TPIP but have had some difficulties regarding the usage of TPIN. Below, problems Tetra Recart employees have recognised regarding TPIP and TPIN will be presented.

One of the most apparent problems regarding TPIN is that projects within Tetra Recart are heterogeneous. The projects can be technology-, development- or customer projects[*] and their length can differ from half a year to about three years. The project management model is developed on best practice for technology- and product development projects. This, in combination with the detailed framework made up of numerous tasks, make it difficult to use the model for customer projects. This has led to a number of different project management models for customer projects throughout Tetra Pak's organisation and one of these models is to be found within Tetra Recart. This model is built on the framework of TPIP, but has been difficult to use in TPIN because it is designed for projects with other purposes.

Another problem that has been recognised by managers as well as project members is the complexity of TPIN. It is not unusual that those who use or tried to use the system feel that they drown in the large amount of templates and the numerous pre-designed tasks, as well as the complexity of the system in itself.

[*] A customer project is a project in which a specific line is designed for a specific customer.

5 System description and design



This chapter along with the developed system, called Portos, is to be seen as an analysis of the empirical information gathered at Tetra Recart. In this chapter the content of the system is described. First from a general perspective with the system characteristics and structure, further on in more detail describing each page, giving the reader an understanding of the use and benefits from Portos.

5.1 System Characteristics

As mentioned earlier, Portos is not a system for project management but a system to be used by the management team of the company. The purpose of the system is to monitor and control a project portfolio in order to be able to manage it in the most effective way. Thus its primary use should not be portfolio selection but rather providing an internal portfolio overview. This is important to bear in mind when reading this chapter. When designing the system, a few characteristics where set up to imbue the entire system and make it consistent.

The first characteristic
The system should support the company's project management model or, in Tetra Recart's case, the innovation process. Enhancing the usefulness of the project management model with a system for project information forms a symbiosis between the two if used in a correct way. To create this symbiosis, it is extremely important that the vocabulary is used in the same way, that colours are used uniformly so that the user is confident in the environment et cetera. Apart from these more superficial connections, the system should support a behaviour that benefits the company in general and the project management model in particular. In Portos, an example of this is the definition of the word baseline, as the latest budget or time plan approved by the project's steering group. As shown later, the project manager is given a red traffic light if he or she is behind schedule in relation to the latest baseline. This encourages the project manager to assemble a meeting with the steering group in order to get an updated baseline. A new baseline more consistent with the project managers estimates will lead to a green light, but more importantly it will result in a situation in which the entire management team and steering group are brought up to date regarding deviations in the project. By these means, the steering group is always informed of the actual performance of the portfolio and the right decisions for both the single project and the portfolio in total is more likely to be taken.

The second characteristic
The system should be easy to use. This is a rather simple characteristic that often is thought of as self-evident but still it is forgotten in too many similar systems. There are two different perspectives from which the system should be easy to use. First from the perspective of the users of the system and secondly from the ones that feed information into the system.

The goal has been that the user should be able to get an overview and an apprehension of the status of the project portfolio in less than five minutes. This requires the information to be well structured and focused on the most critical parts of the overall status of the projects. It has also been the goal to make it possible to access individual projects regarding their ability to follow plans according to time, budget and quality. Thus only the most important information has been included and therefore the system cannot function as the sole information source for management. Instead, the aim is to draw the manager's attention to the points where it is most needed. This is seen as an advantage as it encourages further communication within the company to sort out the problem in question. An information system can not and should not replace the human interaction within a company but make it more prepared and focused.

For managers to get a correct view of the current status, the data that has been fed into the system must be valid and updated. To ensure this, the most effective way is to minimise the amount of data for project managers to input. This gives the project managers an incentive to regularly update the information in the system. Project managers are often very busy and already have a number of administrative tasks to fulfil. The less time a system like Portos consumes the better. Most preferable would be to extract as much information as possible from other electronic sources used in the company, as for instance the budget system. In many cases this can be done in quite an easy way and if so, the best for everyone is to share the information within the company to avoid any duplication of work. In the case of Portos, much of the information needed already have been fed into TPIN. However, this information has not been accessed due to security reasons and internal politics within Tetra Pak.

The third characteristic
In the system only standardised information should be displayed. This is linked to the discussion above that the system should be easy to use. Using only standardised information enables the user to quickly get familiar with the system and to know where a certain kind of information is reached. In a system like Portos one also know what is to be found and what is not to be found and has to be searched for elsewhere. Standardised information is also needed to be able to compare different projects.

The fourth characteristic
The system should be intranet based. There is an enormous benefit from making the information accessible for everybody at the same time that it is entered by the project manager. An intranet-based system is easy to access and requires minimal administration. It also makes it easy to pass on the information to all employees in the company or selected groups within the company.

Before describing the different pages that have been designed with these characteristics in mind, the fundamental structure of the system will be described.

5.2 System Structure

From a user's perspective, Portos makes a distinction between three different types of users.

Normal users
The normal user has access to the non-login protected pages within Portos. This is the largest group of employees and they can use the system in order to easily get an overview of the progress within different projects as well as the overall progress of the company's project portfolio.

Managers
Executives, functional managers and project managers get, in addition to the information on the open pages, full access to Portos output pages. This enables them to evaluate the current project portfolio based on financial data as well as the ability to meet deadlines. It is also possible to evaluate the company's historical ability to manage projects. Tetra Recart's resource allocation system is also accessed from the system's management pages.

It is in this part of the system those responsible for documentation of a project, preferably project managers, access the project administration pages. The input pages for a specific project can only be accessed by an authorised person and it is here all project data is fed into or changed in the system.

Administrators
The third group has access to the system administration pages in which users with login privileges, as well as creation or deleting of projects, are handled. This is the smallest group and should only consist of one or two persons.

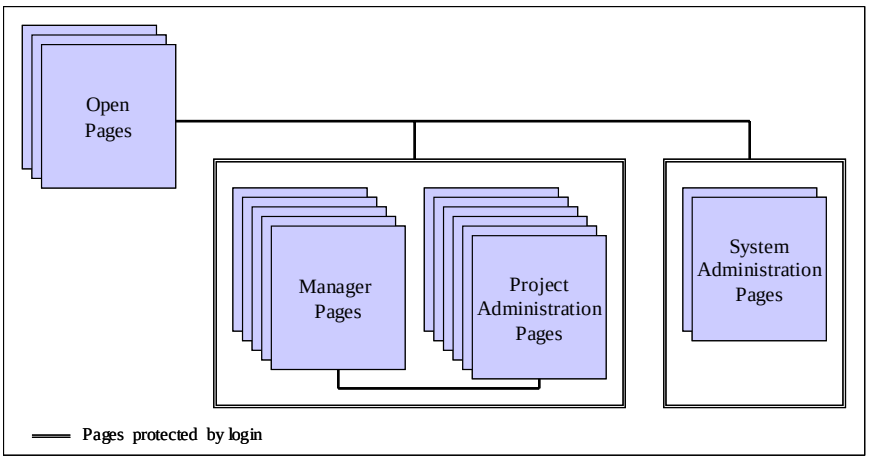


Figure 9 – Portos' user structure

The aim of the system has not only been to visualise the current portfolio and the status of it. The aim has also been to support future planning as well as evaluation of the past. This has led to the following mix of pages.

- **Portfolio overview** with the aim of visualising projects as parts of the portfolio.
- **Portfolio status** that focuses on the ability to follow time plans and budgets in the current portfolio.
- **Follow-up** that enables the user to evaluate the past and find systematic faults in project planning.
- **Project overview** with the aim of visualising the most essential information regarding a specific project.
- **Milestone overview** with the aim of visualising milestones in a phase of a project, quality aspects and the reason for deviations in the milestone.
- **Resources** where a link to the resource allocation system that Tetra Recart has developed is found.

The system partly supports project prioritisation within the organisation. The priority level of a project will not be displayed in the system due to absence of a Tetra Recart management decision to use prioritisation, based on the negative aspects that come with prioritisation of projects. Project managers have asked for this function to be a part of the portfolio overview system, because of experiences from difficulties regarding resource allocation.

It is possible to give a project a priority level ranging from zero to nine and based on the restricted number of priority levels and the discussion regarding prioritisation above, a non-forced ranking system, as described in chapter 3.2.3, would be the best. Once a project is completed it is given priority level zero which means that the project is closed and no more changes can be made in the project data. The project will no longer be displayed as active. Priority levels one to eight are the levels that normally should be used, where projects with priority one are the ones with the highest priority. The projects will always be listed in order of priority. Level nine means that the project is active but it will not be displayed in Portos output pages.

5.3 The System in Detail

The design and functions of the system have been based on interviews with project managers and managers within Tetra Recart. During implementation of the system, several adjustments have been made after discussions in focus groups with both managers and project managers.

5.3.1 Portfolio Overview

The purpose of the portfolio overview page is to give the user a quick overview of the current project portfolio. All active projects registered in Portos are listed in order to make it easy to see when different projects start, end or enter a new phase.

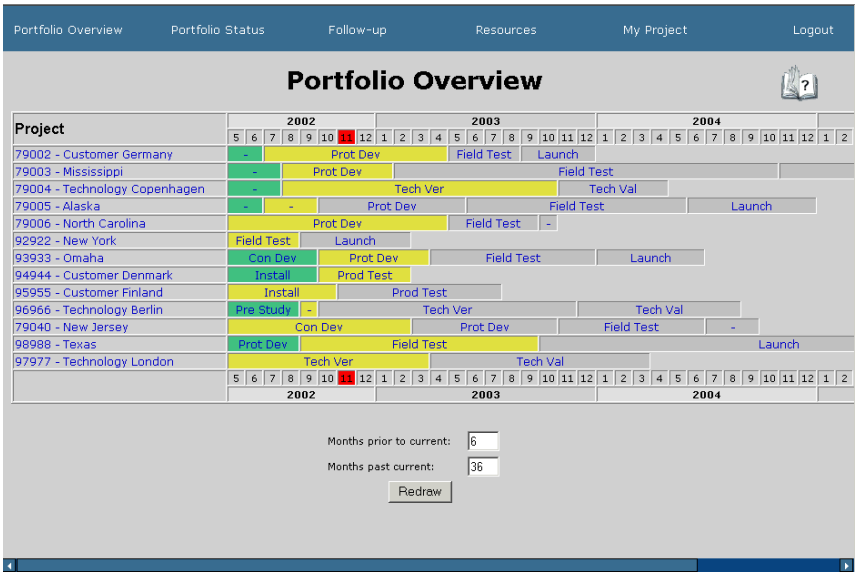


Figure 10 – Portfolio Overview

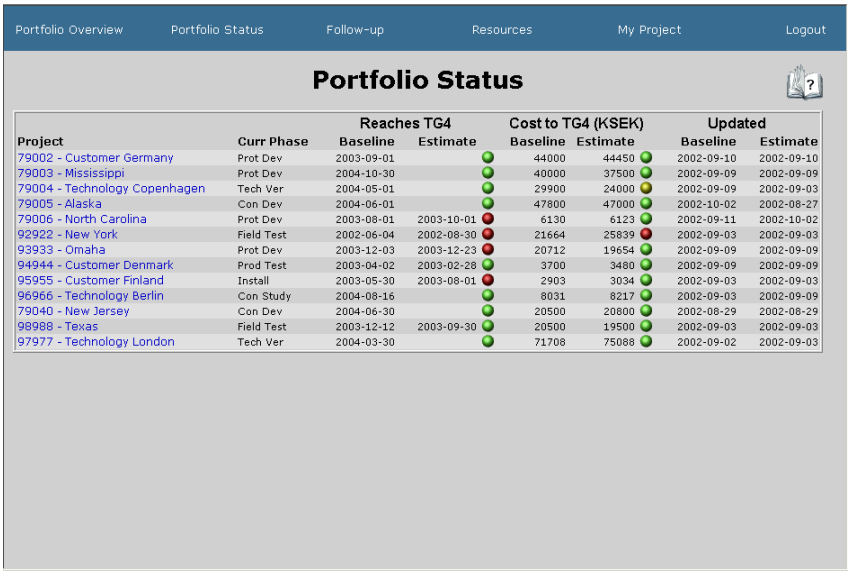
This page is the first page that the user comes in contact with. It visualises the company's project portfolio and makes it easy to overview the overall position of it. Phases that have not yet begun are grey, those in progress are yellow, and those that are completed are green. The different colours are consistent with TPIN in order to minimise confusion at Tetra Recart. Projects are displayed in order of priority. If the user would like to see a wider time perspective, it is possible to redraw the chart showing up to five years prior and five years past the current month highlighted in red. It is possible to enter the project overview page by clicking on a project name. Clicking on a phase name will display the milestone overview page.

No direct theoretical support has been found for the specific design of this page, but managers as well as project managers within the company have requested this type of page. However, the similarities between the layout of the page and Figure 6 of a multi-project environment are striking.[117] When used in combination with knowledge of the different project's objectives and resource requirements, the page visualises bottlenecks and dependencies within the organisation. It is important to mention that it is the project manager's estimates that are used for drawing the phases of the project. This makes the page a strategically important tool when it comes to foresee when new products can be launched or new development projects can be started.

5.3.2 Portfolio Status

In this page, which only management can access, all projects registered as active in Portos are listed. The purpose is to give an opportunity for the user to quickly get an overview of the portfolio status regarding time and cost.

[117] Engwall (2001:6), pp 1



		Reaches TG4		Cost to TG4 (KSEK)		Updated	
Project	Curr Phase	Baseline	Estimate	Baseline	Estimate	Baseline	Estimate
79002 - Customer Germany	Prot Dev	2003-09-01		44000	44450	2002-09-10	2002-09-10
79003 - Mississippi	Prot Dev	2004-10-30		40000	37500	2002-09-09	2002-09-09
79004 - Technology Copenhagen	Tech Ver	2004-05-01		29900	24000	2002-09-09	2002-09-03
79005 - Alaska	Con Dev	2004-06-01		47800	47000	2002-10-02	2002-08-27
79006 - North Carolina	Prot Dev	2003-08-01	2003-10-01	6130	6123	2002-09-11	2002-10-02
92922 - New York	Field Test	2002-06-04	2002-08-30	21664	25839	2002-09-03	2002-09-03
93933 - Omaha	Prot Dev	2003-12-03	2003-12-23	20712	19654	2002-09-09	2002-09-09
94944 - Customer Denmark	Prod Test	2003-04-02	2003-02-28	3700	3480	2002-09-09	2002-09-09
95955 - Customer Finland	Install	2003-05-30	2003-08-01	2903	3034	2002-09-03	2002-09-03
96966 - Technology Berlin	Con Study	2004-08-16		8031	8217	2002-09-03	2002-09-09
79040 - New Jersey	Con Dev	2004-06-30		20500	20800	2002-08-29	2002-08-29
98988 - Texas	Field Test	2003-12-12	2003-09-30	20500	19500	2002-09-03	2002-09-03
97977 - Technology London	Tech Ver	2004-03-30		71708	75088	2002-09-02	2002-09-03

Figure 11 – Portfolio Status, management page

The current phase is displayed and so are dates and cost figures. Both dates and cost figures are presented as baseline and estimates for reaching tollgate four, TG4. A "traffic-light" system has been implemented in order to elucidate the current portfolio status. The definitions that have been chosen are slightly different for dates and cost but the definitions have in common that they are based on a comparison between the estimate and baseline of TG4.

The time traffic light is a comparison between estimated time to TG4 and the baseline time to TG4. Green light means that the project is estimated to reach TG4 before, or on the baseline date. Red light means that the project is estimated to reach TG4 after the baseline date.

The cost traffic light is a comparison between estimated accumulated cost to TG4 and the accumulated baseline cost to TG4. If one or more phases have been finished, the estimated cost will be superseded with the actual cost for that phase. All figures are given in KSEK. Green light is given when the project cost is estimated to be within ±10% of baseline. Yellow light implicates that the project cost is estimated to be less than 90% of baseline and red light means that the project cost is estimated to be more than 110% of baseline.

The specific numbers for the cost traffic light have been chosen in order to keep the standard set by TPIN and avoid confusion in the organisation. However, interviews have indicated that ±10% is an almost too tolerable definition for the green light and it should instead be about five to seven percent.

Irrespective of the exact figure set to define the traffic light, it is important to emphasise that the traffic light system is a blunted tool when it comes to make an analysis of the portfolio status. The system should only be used to point out those

projects that should be paid further attention in order to make a more in-depth analysis of the portfolio status.

Further, dates for the latest update of baseline and estimate for the different projects are presented in order to make it possible to estimate the value of the presented data. It is also possible to access the project overview pages from this page.

There are two reasons for using TG4 as the basis for the portfolio status. The first reason is that interviews and group discussions have shown that it is more important to show when projects are estimated to be completed instead of whether they are on or off schedule. The second reason is that technology development and customer projects both have four phases while product development projects have five phases. TG4 has in spite of this been chosen as a reference for all types of projects in order to keep the system simple and easily understood. This simplification emphasises the importance of TG4, the last tollgate before customer launch in product development projects.

5.3.3 Follow-up

In this page all projects, active or non-active, that have been registered in Portos are listed. The purpose is to make it possible to compare or evaluate past projects or phases in order to find systematic errors or success factors regarding the company's project management.

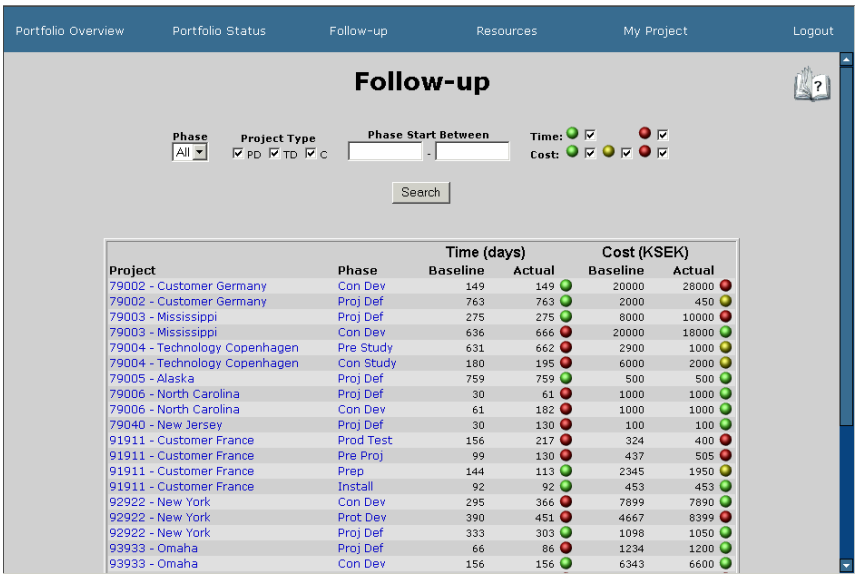


Figure 12 – Follow-up, management page

It is possible to alter the search criteria in a way that matches most purposes. Projects can be displayed dependent on the type of project, certain or all phases, start date and ability to follow time schedule and budget. From this page, all of the phases in the closed projects and the completed phases of the still active projects can be displayed.

It is very important to emphasise that this page is the one through which all completed projects can be reached.

The page enables the user to evaluate projects regarding ability to follow time schedule and budget. If a deeper analysis is wanted, it is possible to access project overview pages as well as milestone pages. Regarding the definition of the traffic lights, interviews resulted in a definition that is identical to the one used in the portfolio status page. It would be possible to use the same scale for time as for cost since time is measured in days. The reason behind the chosen definition is to avoid the confusion of having different definitions for the time traffic light.

5.3.4 Project Overview

The purpose of this page is to give the user a quick overview of a specific project, by presenting the most essential facts of the project. This support the transparency of the company's activities and the employers gain greater insight in the company's progress or failure to achieve progress.

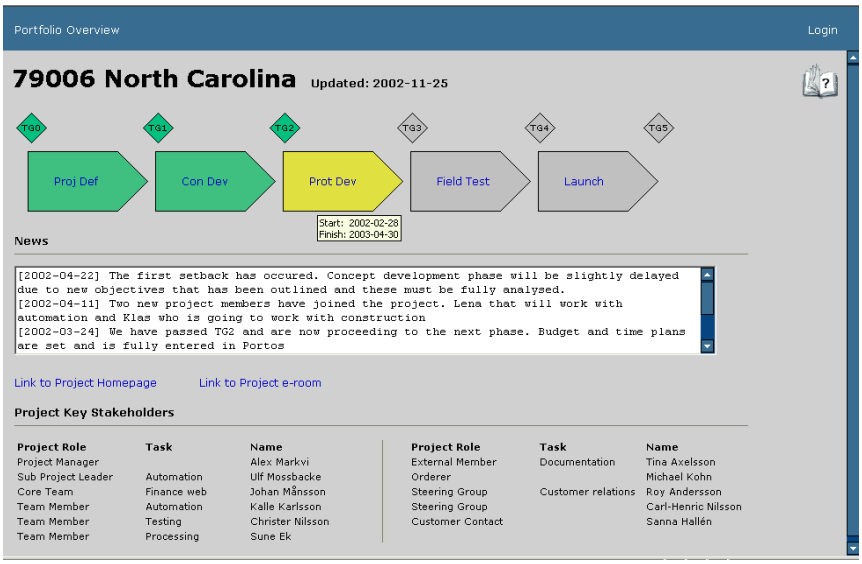


Figure 13 – Project Overview, open version

In order to make the project information easy to access for a user not familiar with the circumstances surrounding a specific project, all project information has been standardised. The information regarded as most important for the ordinary user is the current phase of the project, the latest update of the displayed information, essential news regarding the project and information regarding the tasks and roles of the people who are engaged in the project.

The project phases are colour coded as described in the portfolio overview page which makes it easy to immediately recognise the progress of the project. Placing the mouse pointer on a phase, the exact start and finish dates for that phase will be

displayed. In the management version, financial information regarding baseline cost and estimated cost is displayed in the phases and summarised for the entire project.

Another difference between the open version and the management version is that it is possible to open a tollgate window in the management version. This small window displayed in Figure 14 enables the user to download documents that the project managers are obliged to produce when passing a tollgate. These documents are tollgate specific. This function makes it possible for management to easily access the documents if needed for decision support.

In order to present changes or shortly describe setbacks or progress in the project, the project manager has the possibility to enter short news texts. The date when the news was entered is automatically added to the text and the most recently entered text is displayed on the top.

In order to make the system more adaptable to project specific requirements, it is possible to add a link to a project homepage that may be designed according to specific requirements. It is also possible to add a link to e-Room which is the tool that, primary for customer projects, is used for project planning as well as spreading internal project information.

Finally, the project stakeholders are listed in order to enable Portos users to contact project members. In addition to the stakeholder's role, it is possible to display the task that the member is assigned to. The roles are fixed to the roles used within Tetra Recart while the tasks can vary.

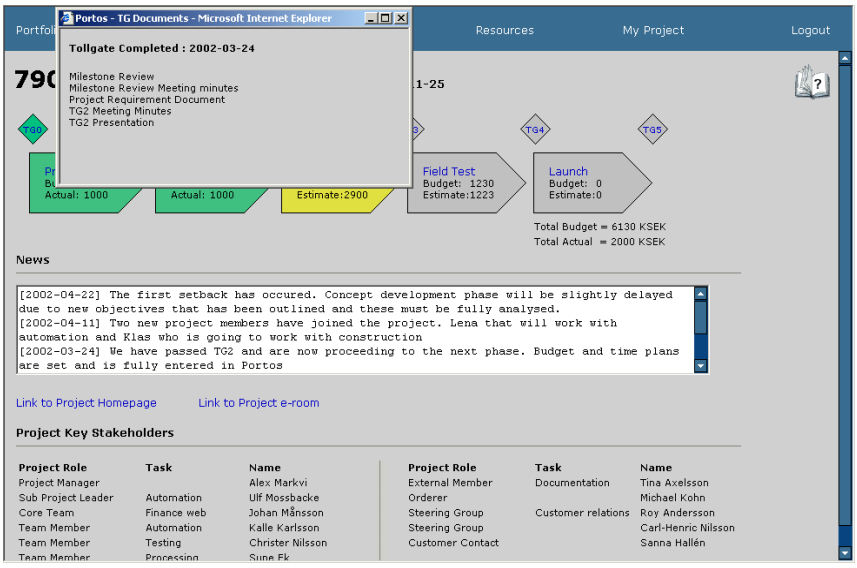


Figure 14 – Project Overview with open TG window, management version.

5.3.5 Milestone Page

The purpose of this page is to display the milestones of a phase as well as an explanation of occurred deviations. The page can either be used simply as a source of information about future plans or as a way to get a deeper understanding of why the project is failing to follow the original time plan.

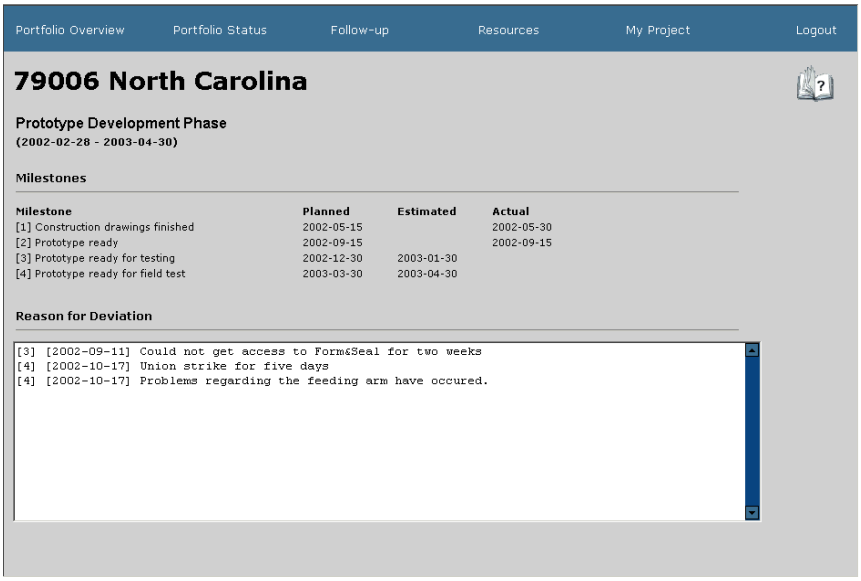


Figure 15 – Milestone page

There is one individual milestone page for each phase of the project. All milestone pages can be reached from the project overview page as well as the portfolio overview page. It is also possible to access the milestone page for the active phase from the portfolio status page.

On the top of the page, the name and number of the project are displayed as well as the name of the phase and the start and finish dates of the phase. Milestones are added by the project manager and there are no fixed milestones, which brings a great deal of flexibility to the project manager.

If the project manager estimates a change in the original time schedule, he or she should enter an updated estimated completion date for the milestone. Also, a “Reason for Deviation” should be entered, which is displayed on the bottom of the page. This reason for deviation should consist of a few words describing the cause of the change in the time schedule. The date when the deviation text was added, as well as an index that links the text to the milestone, is added and displayed. The project manager also enters the actual date for completion when the milestone has been passed.

A perhaps less obvious reason behind the existence of this page lies in the difficulties regarding how to follow up the quality of the work done in a project. It is quite easy

to present time and budget in a way that makes abnormities easy to identify by the user, in this case the traffic light system is used. Quality is much more difficult to visualise but if used wisely, the short comments regarding the reasons for deviation is one way to try to visualise quality.

5.3.6 Project Administration Pages

These pages will not be presented as thorough as the user pages. The reason for this is that the input pages for project data, although needed, do not solve any multi-project problems. Originally the aim was to feed the system with information from TPIN in order to avoid duplication of work for the project managers. Unfortunately, Tetra Pak internal politics made this impossible. The aim has therefore been to extract as much information as possible from a minimum amount of data in order to make the needed input as fast and simple as possible. It is not possible to feed the system with data of the wrong format and if, for instance, a date is entered in the wrong format, the system will indicate in what way the date should be entered.

Below, each project administrator page will be described briefly in order to illustrate which kind of, and how much, data that has to be fed into the system.

Phase Editor
The purpose of this page is to edit project data regarding time and budget for the different phases of the project as well as uploading relevant tollgate documents. For each project phase three dates and three costs should be entered, one baseline when the project is started, one estimate if the project manager no longer believes in the baseline and finally an actual when the phase is completed.

Further, the tollgate document editor is reached from this page. This is where required tollgate documents are uploaded and the date for the tollgate completion is entered.

Milestone Editor
In this page project leaders add, delete or change milestone data. The amount of data may vary from different projects. This is also the page in which the cause for a milestone deviation is added.

News Editor
The purpose of this page is to edit news regarding the progress of the project, news that can be of interest for either project members or other employees in the company.

Member Editor
This is where project stakeholders are entered or deleted. It is not possible to change project manager, this has to be done by the system administrator.

5.3.7 System Administrator Pages

In these pages users and projects are created, altered or deleted. These pages will be described briefly below.

User Editor
The purpose of this page is to administrate those users that have login privileges. Each user will be given a username and password as well as an authority level as either administrator or manager/project manager. This is also where the user is given the access to change project data in a specific project.

Project Editor
The project editor page enables the system administrator to create, delete or modify projects. All projects must be given a project number, a project name, a start date, a project category (Product Development, Technology Development or Customer) and a project manager. This is also where the project is given a priority as described above.

5.3.8 Portos Help

Throughout all pages within Portos, the users are supported by a help function that can be found in the top right corner. The help texts shortly describe the purpose of the active page as well as fundamental concepts as for instance the differences between baseline, estimate and actual. The help function also supports the user regarding how to handle the different functions within the system and who to contact regarding access to the management pages.

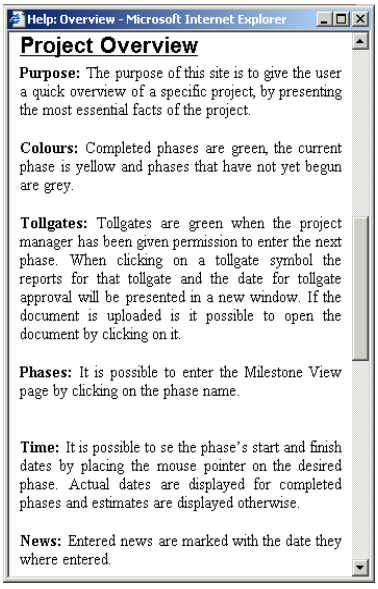
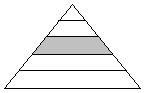


Figure 16 – Portos help

6 Technical Implementation



This chapter gives a more technical description of the system and is written for readers with an interest in, and some knowledge of, web page development. It starts by explaining the basics of dynamic web pages, ASP and why the system is built the way it is. The chapter also gives examples of code used to connect to a database and how the pages communicate with each other. One set of pages is described in order to give the reader an understanding of how the pages are connected to each other.

6.1 Dynamic Web Pages

There are two types of web pages, static and dynamic. Pages written only in HTML are static, which means that the pages always look the same. This is because the pages are formed in the client's browser, from a text document containing the HTML code. Dynamic web pages work differently. When a web page is requested by the client, a server will execute a script producing the resulting HTML code and then send this HTML code to the client. The code produced at the server can depend on who is accessing it, what day it is or which page the user came from. This way, the web page can be tailored to a specific user or situation.

The server can access information from a local database and display this information in the form of HTML. This way, the information in the database is protected on the server and only the desired information will be displayed.

There are a number of different ways to produce a dynamic web page. These are called server side programming, and the most common by far are ASP and PHP, both described below.

6.1.1 Active Server Pages – ASP

ASP is a technique where HTML is combined with a script language, usually VBscript or Jscript.[118] It is developed by Microsoft and requires the web server to be on a computer running Microsoft Windows. Additionally, the server must have a program called Internet Information Services (IIS) handling the web server. IIS is a part of Windows NT/2000/XP.

Microsoft has developed a number of tools to help create ASP, for example Microsoft Visual Studio. In this tool, developers can create dynamic web pages using ASP, Visual Basic, J++ and so on. Many other companies have also created tools to help create ASP.

The major reasons for running ASP are: [119]

1. Microsoft products are available all over the world, which makes a specific company's site compatible with a significant number of other big businesses'

[118] http://msdn.microsoft.com, 2002-11-12
[119] http://www.geocities.com/ewmpsi/aspvsphp.html, 2002-11-03

sites. This makes business-to-business transactions easier because everyone involved is running the same platforms and applications.

2. Large companies already have their computers running Microsoft products and their employees are trained in the Microsoft environment. This keeps training investments to a minimum and keeps companies from investing in new equipment and software.
3. If a large company wants to take over another, by acquisition or merger, the ability to easily integrate systems such as databases, document processing, spread sheet and accounting applications is invaluable and can make a company appear to be a much more attractive prospect to potential benefactors. Therefore, keeping your business dressed up in Microsoft clothing can have a certain appeal.

On the other hand there are some disadvantages with ASP as well. The first one being of the same kind as the advantages, namely that ASP is a Microsoft product. This means that you cannot use ASP without using Microsoft's server program IIS, which has to be available on the server hosting the site. Secondly, the use of VBscript, which is most common, is limiting for developers compared to languages with more resemblance to C or Java. VBscript is not as developed as these and therefore makes the code more complicated. The third problem with ASP is that it performs at its best for mid-sized applications and tends to get complicated and slow as the applications grow.

There are many small and medium sized businesses that choose to run ASP. Most of these already use Windows, Excel and Access. Using IIS to access their spreadsheet, database and word-processor applications to incorporate data into web content is an easy transition.[120]

6.1.2 PHP

PHP is the "Linux version" of ASP. PHP is developed by Rasmus Lerdorf and is open-source which means that anyone is free to look at the source code and suggest improvements. Furthermore, PHP is free to use which ASP is not. Unlike ASP, PHP is a script language in itself, very similar to C and PERL, providing a better foundation for complex programming.[121]

PHP offers connectivity to the most common databases, including Oracle, Sybase, MySQL et cetera. It also offers integration with various external libraries, which allow the developer to do a variety of things, from generating PDF documents to parsing XML. Another key advantage of PHP, when compared to other scripting languages, is that it is cross-platform, suitable for today's heterogeneous network environments. PHP is compatible with most web servers and most operating systems like Linux, Windows, Unix et cetera. [122]

[120] http://www.geocities.com/ewmpsi/aspvsphp.html, 2002-11-03
[121] http://www.zend.com/zend/aboutphp.php, 2002-11-13
[122] Ibid

6.1.3 Comparing ASP and PHP

In a survey from spring 2002, Luiga et al. (2002) compares the use of ASP and PHP in Swedish web-production. They found that web designers in common use ASP and PHP equally, but that the dominant position that ASP formally had no longer exists.[123]

The dominant factor when choosing between ASP and PHP is the environment that the application is developed for. ASP is Windows-based and enjoys all the advantages and disadvantages of any Microsoft application. If a company is already running Microsoft Windows servers, ASP would be the natural solution. However, PHP is more flexible in terms of platform compatibility and provides the possibility to use different combinations of operating systems and programs.[124]

6.2 How Portos is Built

The external environment has been the most important factor when choosing the way to implement Portos. Tetra Pak use Windows 2000 and MS Access as corporate standard and IIS is used on their servers. Furthermore, Tetra Pak's own project management application, TPIN, is developed in ASP. Since the size of Portos is not large enough to motivate the use of PHP, the natural decision was to use ASP.

6.2.1 Communication with a Database

Portos is built-up of two major parts, the web pages that form the interface towards the user and a database where all information is stored. For these two parts to communicate, a connection needs to be created. There are several ways to communicate with a database. The most commonly used way for relational databases is the Open Database Connectivity, ODBC. Built on the ODBC is the OLE DB which is a more general and more flexible way to communicate with all kinds of databases. By using OLE DB, one can create an ADO-connection (ActiveX Data Object), which is the type of connection Microsoft recommends on their web site.[125]

In Portos, the ADO connection is created in the following way:

```
set Connect=Server.CreateObject("ADODB.Connection")
Connect.Provider="Microsoft.Jet.OLEDB.4.0"
```

After the connection is created, the database is simply opened by using the connection object's open-method. For example, opening a database called "portos.mdb" would look like this:

```
Connect.Open "portos.mdb"
```

After the connection is created and the database is open, information from the database can be accessed by using record sets together with SQL queries (Structured

[123] Luiga et al. (2002), pp 14
[124] Luiga et al. (2002), pp 19
[125] http://www.microsoft.com/data/ado/prodinfo.htm, 2002-11-12

Query Language). SQL is a very common way to handle input and output or to change information in a database and is supported by almost all kinds of databases. A record set is a set of information retrieved from the database using a SQL query. For example, to create a record set containing all individuals living in Sweden could look like this:

```
‘ Define a recordset
set RS = Server.CreateObject("ADODB.Recordset")

 ‘ Open the recordset using SQL
RS.Open “SELECT Name FROM Individuals WHERE Country = ‘Sweden’”

‘ Change the name of the first individual in the recordset
RS(“Name”) = “Michael”
```

As described above, all information is extracted from the database creating the different dynamic web pages of Portos. All storage of information in the database is conducted in a similar way.

6.2.2 Communication between Pages

In ASP, information can be sent between pages in two different ways; forms or query strings. When using a query string, the ASP-page is called by adding the variable and its content after the page name. The information is submitted in the following way:

```
“name of page” + “?” + “name of variable” + “=” + “value of variable”
```

For example, to send the information that the project number to display on the page is 12345, the page can be called by:

```
projectpage.asp?ProjectNbr=12345
```

When using a form, the ASP-page receiving the information is set as a so-called target in a HTML form. When a submit button is clicked, the whole form, including all variables, is submitted to the targeted ASP-page. The information could be text or numbers. The information could also be text fields in which the user can write, or buttons that the user may select. A form submitting a text field could look something like this:

```
<form action=”projectpage.asp” method=”post”>
     <input type=”text” name=”ProjectNbr”>
     <input type=”submit”>
</form>
```

The information is then received in the target page. If a query string is used, the data is received as:

```
Variable=Request.Querystring(“ProjectNbr”)
```

If a form is used, the data is received as:

```
Variable=Request.Form("ProjectNbr")
```

Which way to use depends on the amount of information to be sent. A form requires a submit button to be clicked, but can transfer lots of information in an easy way. The query string on the other hand is easy to use but becomes more complicated when transferring several variables or content of textboxes.

6.2.3 The Structure of Portos

Charts of the different pages of Portos and how they interact are displayed in Appendix A-F. The information transferred between the pages, and in which way it is transferred, can also be found. To give an example of this, the structure of the portfolio overview page is shown below.

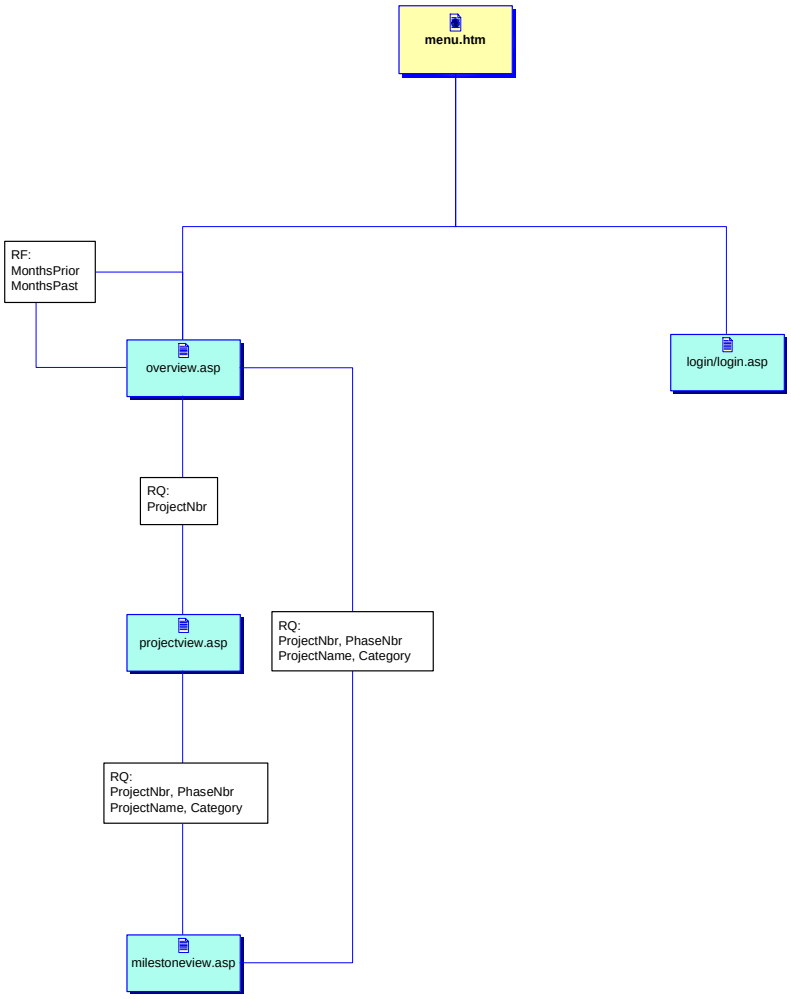


Figure 17 – The structure of the main pages

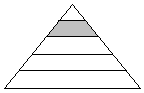
On the top of the chart is the menu page called “menu.htm”. From this page the overview page and the login page can be reached. When changing the number of months displayed in the overview, the overview page calls itself sending the two variables “MonthsPrior” and “MonthsPast” using a request form. The variables are received by the same page when it reloads. The page will then display the specified number of months.

Clicking on a project in the overview takes you to the projectview page called “projectview.asp”. In order to know what project to display, the projectview page receives the variable “ProjectNbr” as a query string from the overview page.

The milestoneview page can be reached from the projectview page or directly from the overview page. The milestoneview page needs to know what project, what phase, which category of project and what the name of the project is. Of course, the last three variables could also be found in the database once the project number is known, but it is faster to send information to the page than to open the database again on the milestoneview page.

All the pages are built on the same principals and they are all found in appendix A-F. As an example of how an entire page look in ASP, the source code of the status page is found in Appendix G. Figure 11 shows the resulting page in a browser.

7 Portos in Theoretical Context



This chapter contains a theoretical analysis of Portos. First the system will be analysed using a framework based on the five C:s presented in Payne (1999). In addition to this a sixth C, Communication, is presented and analysed. Further technical and organisational aspects are accounted for as well. The chapter will give the reader an understanding of the benefits of using Portos, as well as its requirements and limitations.

7.1 Introduction

The purpose of the analysis is to examine the usefulness of Portos to a project organisation. The benefits and advantages of the system, as well as requirements and limitations that an implementation of the system implies will be presented. In this way, the reader will get an idea of whether Portos could be useful or not in a multi-project environment. Important to remember when implementing a system like this is that not only the results are important to the organisation. Discussions raised during the implementation are just as important. Even if the system never becomes operational, these discussions can make the organisation better prepared to handle problems related to multi-project management. No system works if the users do not have the proper knowledge to draw the right conclusions. A good system though, teaches and guides the users to employ the knowledge that they possess, for them to make the most of it.

Before examining Portos at a deeper level, it is relevant to identify which type of system Portos is, according to the discussion about information systems in chapter 3.3.1. The main purpose of Portos is to provide managers with an easily understood portfolio overview and at the same time give managers enough information for their decision-making. Portos is built to provide managers with instant information containing the latest estimates made by the project managers. It does not dictate how the information should be used in making decisions and is therefore of the category described in chapter 3.3 as “Providing access to tools and information”.

The information Portos provide does not change in respect to who the user is, only to show the information needed for him or her at that specific time, like an Executive Information System normally does. Rather Portos is chosen to give a minimum of information needed to make managers feel informed on what is happening in their organisation. Thus Portos can be characterised as an Executive Information System with elements of a Decision Support System. This is based on the system’s ability to drill down from a very comprehensive overview to the estimates for a single milestone in a single project. Portos element of DSS is based on the fact that the system brings together human estimates and judgements with objective information as planned costs and time, which is one of the characteristics of a DSS-system.

7.2 Analysis Based on the Five C Framework

Portos ability to make a multi-project organisation more easily managed will be questioned and analysed based on the five C:s Capacity, Conflict, Commitment, Context and Complexity in Payne (1995)[126]. Changes in Portos that would enhance its abilities will also be suggested.

In addition to the five C:s that Payne (1995) presents, the authors feel a need to add a sixth C, Communication. In the context of multi-project management, communication is crucial to help solve project related issues. Communication, between members of different projects as well as between managers and project managers, is a way of handling the complexity of the multi-project environment.

7.2.1 Capacity

Capacity issues are often related to the organisation's capacity which, for obvious reasons, has to do with the amount of available resources. As mentioned in the delimitations, Portos was never intended to support direct resource allocation since such a system was already under development at Tetra Recart. The Tetra Recart resource allocation system has however been integrated in Portos. The resource allocation system is based on a Tetra Recart specific solution and it is therefore not possible to use the resource system in other companies as a part of Portos, which is a large limitation. Portos' portfolio overview page does though give an indication of the amount of workload the organisation is under.

The portfolio overview page clearly visualises the number of projects in the portfolio as well as their respective time plans in relation to each other. In combination with general knowledge of the different projects, this will provide the Portos user with a powerful tool that can be used to avoid a fragmented portfolio with too many small projects that steals resources from the larger and strategically more important projects.

Another important page is the project status page with its traffic-light system that indicates whether the entire project portfolio is estimated to cost more than planned and approved. This gives an organisation's management an early warning to whether the organisation can start new projects or, because of resource constraints, has to close on-going projects.

7.2.2 Conflict

When conflicts were discussed in chapter 3.2.3, they were divided into three different groups of conflicts; people issues, organisational issues and system issues. In this part, all these types of conflicts will be discussed with regard to whether Portos will make conflicts less probable to occur or not.

To a large extent people issues are related to situations were line managers and project managers need the same resources and therefore become rivals. The multi-

[126] Payne (1995), p 164

project environment makes planning difficult and the co-workers often suffer in the unstable situations that occur. Again, Portos lack a built-in system for resource allocation and in this case it is not possible to find a substitute among Portos' different functions that should be able to prevent people-related conflicts from arising or even make them less severe.

When it comes to conflicts that are related to organisational aspects, Portos partly fail to provide the ideal solution due to the absence of a resource allocation system. These conflicts often arise between projects that have similar objectives, meaning that the projects will need the same resources, making them bottlenecks that create conflicts. Payne (1995) means, as mentioned in the analytical framework, that organisation-related conflicts may be avoided if the organisation has a strong culture and objectives that are shared throughout the organisation.[127] At first it is hard to see in what way Portos would be able to form a culture that makes these conflicts less severe, but the discussions that are created when designing a system like Portos inevitably leads to greater understanding of mutual problems among project managers and members. The system in itself will also, as already mentioned, visualise the company's means of achieving the vision which gives a greater understanding of how to reach the company's objectives.

It is up to management to decide to which extent Portos will be useful when trying to minimise system-related conflicts. The tool makes it possible to sort the projects according to their priority, but in order to get the advantage that priorities could give; it has to be further communicated within the organisation, especially since the priority of the projects is not displayed in any way. A small modification would solve this problem, but was not done since Tetra Recart management decided not to use a prioritisation system. Even though the priority of the projects are not displayed, the presence of a system like Portos will raise the important discussion regarding whether to use prioritisation or not within the organisation. Of course the bases for the discussion have to be which areas to consider when priorities are made. Here the five areas[128] in Cooper et al. (2000) discussed in chapter 3.2.3 could be used.

7.2.3 Commitment

Commitment is the key to more efficient co-workers. The aim is not to get the project members to work longer hours, but rather to make sure they enjoy their work and therefore become more efficient. One way to get more committed employees is to provide them the big picture, letting them grasp not only the single project they work in but also the purpose and implications this project has for the entire company's strategy.

Portos can definitely be a useful tool in this aspect. Located on the company's intranet, where other information like vision and mission are communicated, the portfolio overview system gives an insight to how the company at present is trying to reach these all-embracing objectives. One indication of the strength embedded in the

[127] Payne (1995), p 164
[128] Cooper et al. (2000), p 17

aggregated information is that Tetra Recart management regarded the information in Portos too powerful to be shown for consultants working in the individual projects.

7.2.4 Context

The context of the multi-project environment is to large extent characterised by a multitude of cultures, norms and procedures. Portos is an excellent platform to deal with these issues and the use of an enterprise-wide system will in itself streamline the company's common norms and procedures of how to manage and measure projects. An important aspect is to keep the level of detail low, but still be able to support the norms and procedures.

Norms and procedures are parts of the paradigm on which the company is built. This implies that it takes time both to change the understanding of each employee and to unite the workforce in total. Thus the implementation of a system like Portos creates a well suited arena to introduce and discuss new set of norms or procedures. In the discussion preceding the implementation, norms established in a company most often are questioned. Thus the road to the design of an EIS in many ways is just as important as the final result.

When it comes to cultural aspects, they are more deeply rooted in the organisation and it is questionable whether Portos is the ideal tool to create a common culture within the organisation. The authors do however not believe that it is a Portos specific problem among intranet-based systems but rather a weakness among all systems.

7.2.5 Complexity

As described in chapter 3.2.6 the most important objectives for management of project networks include.[129]

- Establishing formal and informal communication networks between persons involved in different projects
- Allocating resources among different projects
- Assigning roles in different projects to one person
- Establish relationships between projects
- Developing management information and status of various projects

Portos manage to support these issues to variable extent. Communications will be discussed under a separate section below, and the absence of a resource allocation system has already been treated.

When it comes to assigning one person roles in different projects, Portos provide the users with a complete list of the project stakeholders together with their role and main tasks. On the other hand, the system lack the ability to display an aggregated list that visualises which people work in multiple projects and what projects they are working on. This information has been considered not the most important and therefore such

[129] Lim & Yeo (1995), p 406

an aggregated chart has not been constructed. However, if a resource allocation module would be added to Portos, it would be natural to make such a chart.

Regarding establishing relationships between projects, some visualisations are automatically provided by Portos in the portfolio overview page. The project news function and the deviation analysis function can also be used as an aid to communicate relationships between the different projects. The relationships themselves must be created by other means than Portos. If this creation of relationships would be improved by a common web page or a discussion forum, it is possible to link these shared information sources on the individual project overview page.

The last area, to develop management information and status of various projects, must be viewed as the fundamental purpose of Portos. The portfolio overview page and the portfolio status page have been designed in order to satisfy these needs. In addition, the other pages are designed to give a deeper understanding of the portfolio status.

Apart from these issues, a portfolio overview system must support all projects in an organisation even though they have significant differences regarding size, required skills, and urgency. This also means that the system must be able to support multiple project management models if several should exist within the company. In this aspect, Portos allows three different types of projects accepting greater differences among projects than most intranet based systems. This is made possible by a consistent reporting mechanism, which makes it possible to compare different projects within the portfolio. This has been made possible by using a consistent approach at the strategic level, which Portos supports, while allowing diversity at tactical level the way Payne & Turner (1999) suggests.[130] This means that Portos do not enforce a way to plan projects, it works on neither tactical nor operational level and different approaches may very well be working alongside each other.

7.2.6 Communication

After having discussed the original five C:s, an additional C will now be presented. It has been said in the theoretical framework, as well as in the previous chapter, that communication often solves project related issues or at least make them less complex and severe. It is important to emphasise that it is information that should be communicated, not data. If data is communicated, the receiver will drown in the enormous amount of data that exists in a multi-project environment. Information, on the other hand, is filtered and modified data that fits the purposes of the user. In the multi-project aspect, the information must be generalised and standardised in a way that makes it possible for the receiver to quickly grasp the important aspects instead of being unable to understand and compare data of different origin. Portos undoubtedly serve a purpose in this aspect since only the most important data is fed into the system and then presented in an easily understandable way on a platform well known to the user.

[130] Payne & Turner (1999), p 56

It has also been suggested that the complexity of the environment makes extensive and detailed planning inefficient due to constant changes in the interactions between different projects. This fact makes both the day-to-day communication between members of different projects, as well as the communication between managers and the projects, essential. If the overall picture and the individual needs are not communicated or understood by the parties, it will be hard to get the entire organisation to work efficiently in the same direction. Portos cannot serve as a substitute for this process, but it can enhance and support it. One example is the baseline system in combination with the traffic-light system that encourages project managers to ensemble a steering group meeting as soon as the baseline is considered unrealistic. This leads to a better-informed management team that can make necessary adjustments early and thereby avoid major conflicts to arise later.

The creation of a system like Portos also leads to several discussions and in many ways work as an audit of the company's project organisation. Many issues are raised that have not been raised earlier. Questions as for instance whether to prioritise projects or not, or which tollgate documents really are the most important, inevitably must be answered.

Another form of communication deals with post mortems and how to communicate learning from previous projects. In this case, Portos provides the user with the possibility to access all former projects within the system. Individual projects together with tollgate documents and milestones, can be evaluated using the follow-up page.

When it comes to information, an overall weakness of Portos is the relative imbalance in the direction of communication. The major flow of information is directed from the individual project manager to the company's management team and other project managers. In one way this is natural since the system is more suitable to aggregate complicated data from a large number of projects than it is to communicate management's requirements and objectives for the portfolio. This information could instead be communicated through the ordinary intranet page, meetings or simply by e-mails or news letters. The way that management actually communicate through Portos is by the system itself, with its chosen measurements and demanded documents.

7.3 Technical Aspects

Like any other computerised information system, Portos has some weaknesses related to the systems technical dependencies. As mentioned in chapter 6, Portos is built in ASP, which requires a Microsoft server running IIS. Different folders need to have different privileges, and should the system have to be moved to a different server, this has to be considered in order for Portos to function accurately. In the case of Tetra Recart, the company already has all its web servers on Microsoft machines and therefore Portos does not require any new technical solutions.

The fact that Portos is intranet based means that it is easily accessed together with lots of different information on the company's intranet. This makes it part of the general

flow of information and can be reached by everyone at any time. Since intranet pages require a browser, the system has to function with many different types of browsers, for example Microsoft Internet Explorer and Netscape. These browsers come in different versions that might display pages slightly different. Therefore, the more complex the code is, the bigger the risk that different browsers will display the pages differently. Portos was originally designed for Internet Explorer 5.5, and when tested with the subsequent version (6.0), the pages look totally different. In this case it was a small error in the beginning of each page that was neglected in version 5.5 but caused a major error in version 6.0. Future versions might have additional changes that could affect the performance of the system. It is very time-consuming to test the system with every different browser and version, and therefore small errors might occur together with browsers or other settings that has not yet been tested.

This implies that it is important to be able to continually update and improve the system. When developed by external individuals, the knowledge of the system is with these individuals and the company running the system become dependent, for updates and bug fixes. Solving this issue requires a transfer of knowledge to people within the organisation, which can be costly and time consuming if the required competence not already exists in the organisation.

Another technical aspect is that the information contained in the database becomes very valuable to the company and often impossible to recover if lost. The information needs to be backed-up on a regular basis in order to be restored if an accident or computer crash occurs. The information in the database has a strategic value and needs to be secured against people who should not have access to it.

Portos is currently built to suit one company with its specific needs. For instance, Portos allows three types of projects that have four or five phases and each tollgate requires a number of company-specific documents to be produced and so on. Some requirements could change over time and Portos should, at least, be adaptable to the changes that are most likely to occur in the near future. Today, Portos is built to handle some of these changes easily, for example the tollgate documents are listed in a database and the list of documents is generated from the database. Some features are more difficult to modify, and the reason for this is the compromise between likeliness that these changes will occur and time it would take to implement. Examples include the number of project types, the number of phases, and the time span of each phase. Should any of these conditions change, it would require extensive modifications in the program.

7.4 Organisational and Administrational Aspects

An information system supporting decision-making needs to contain accurate and updated information. No matter how good the system is, the benefit to management is minimal if the information contained is not up to date.

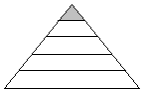
For the system to function optimally, project managers from all projects need to input relevant information on a regular basis. Therefore it is crucial that the system has a

wide acceptance in the organisation. Even if management require that project managers input information, if the system is not accepted by all, it is likely that the project managers do not input information often enough. To minimise the risk that old information is regarded when making decisions, the project overview pages display the project manager's latest login. Also, information about when the baseline and estimate figures were updated is displayed in the portfolio status page.

Portos has an administrator category and the persons in this category are responsible for keeping information about users and projects updated. The administrator is the one that add, modify and delete users and projects. When adding new users or projects, the administrator needs to enter information specific to that user or project. Depending on the size of the organisation and the number of projects, this task can be more or less time consuming.

During the development of Portos, all project managers have been interviewed and continually given the chance to give feedback on the system, making them a part of the development process. The authors believe that this has a great impact on the way Portos is received in the organisation. Also, as most interviews with project managers indicated, the less information required to input, the more likely the project managers are to input information often enough. Therefore, the input has been kept to a minimum. An example of how the input is minimised is the simplification that one phase starts when the previous phase ends. In reality, there can be gaps between phases, but disregarding this halves the amount of data that has to be entered in the phase editor.

8 Conclusions



The aim of the conclusions is to summarise the positive and negative aspects related to implementing Portos in an organisation. First the main benefits are presented, followed by the requirements and limitations that the system implies.

8.1 The Pros and Cons of Portos

After having analysed the developed multi-project management system Portos, pros and cons have been identified. The ones considered most important are pointed out and summarised below.

8.1.1 Benefits

One of the most important benefits of Portos is that it provides management with an early warning system in the combination of project manager estimates, steering group baselines and the described traffic-light system. If used correctly, the system will provide the management not only with what is currently happening but also what is estimated to happen. This kind of information, not only based on historical data, is of outmost importance when making strategic decisions for the entire project portfolio and this area is the main strength of Portos.

Portos is easily accessible to all employees equipped with a computer since it is available on the company's intranet, right next to other important information about the company such as vision and objectives. This gives a greater understanding of the performance and objectives of individual projects within the company as well as the overall performance, motivating employees and restraining multi-project related conflicts. In this respect, Portos has an advantage to common systems in the sense that it is open to all employees which is not the case with for example TPIN.

Another advantage of Portos is the exceptionally well aggregated information structure of the system. Sprague & Watson (1996) points out that it is not enough that a system is user friendly, it must be user intuitive.[131] Making Portos user intuitive has been given a lot of effort resulting in only presenting the most important information in just a few pages. In other systems it is common with an enormous amount of information which does not strengthen the possibility to make management decisions but rather weakens it. Portos provides general information to all employees within the company and strategic information to the company's executives and project managers. This way, better suited decisions are made and at the same time employee satisfaction is increased.

Even though the main purpose of information systems is to give the organisation an overview of the current situation, there is a considerable amount of information from old projects that could be used as well. Portos provides the possibility to search for

[131] Sprague & Watson (1996), p 158

systematic errors in the assessments made for old projects. Thus Portos can be a tool for organisational learning where prior successful solutions or made mistakes can be viewed individually or analysed all together, finding systematic errors in judgments.

Along with the implementation of a system like Portos, a solid discussion of company norms and procedures are introduced. This is actually a useful consequence that strengthens the employees' understanding of the processes performed. Letting the employees be a part of this discussion also make them more committed to the system and to the surrounding structure, making project-work overall easier and less demanding.

8.1.2 Requirements and limitations

Implementing Portos inevitably leads to negative effects, of which some are related to administration and maintenance.

- A system administrator is needed to handle user issues and creating new projects, as well as updating the project priorities.
- The server must be supported and backups must be made in order not to lose the information from neither active nor closed projects.
- In order to avoid lock-in effects where the system hinders the organisation to change, it is necessary to continuously develop the system.

Other costs are related to feeding the system with data and this must be regarded as the key factor to determine whether the system will become a failure or a success. Even though user benefits have been recognised among managers and project managers as well as ordinary employees, managers are those who will benefit most from using the system. This leads to a situation where project managers have to feed the system with information without being its primary users. It is therefore of outmost importance to create a system that needs as little effort as possible to be fed with information, but at the same time providing management with solid decision support. If a system already exists that contains some or all of the information needed in Portos, this information should be extracted to further minimise the need to input data.

Prioritisation of projects in a portfolio is one of the most important aspects of multi-project management and a system like Portos must therefore be able to support prioritisation. The way Portos manages the issue is not ideal. Due to an absent decision of using priorities at Tetra Recart, it is not possible to see the priority of the projects. This is a major weakness since the priorities need to be communicated in order to effect the organisation.

Portos' most important limitation is that the system has not been equipped with a resource allocation module, since Tetra Recart has been developing their own resource allocation system. One thing that has become clear during the work with this thesis is that resources inevitably must be supported by a portfolio management system. However, it is difficult to find to what extent resources should be planned. On the individual level switch-over costs related to people working in multiple projects

must be minimised and at the same time the resources must be used as favourably as possible. A similar problem is found in the trade-off between resource optimisation of individual projects and optimisation of the entire project portfolio.

8.2 Findings and Future Research

The aim of this thesis has been to develop an intranet based system that provides managers with information needed to manage a company's project portfolio. Striving towards this goal, it has been found necessary to extend the five C framework that has been used as a theoretical basis for Portos. To the original five C:s, Capacity, Conflict, Commitment, Context and Complexity, a sixth C, Communication, has been added. This since a multi-project environment characterised by complex networks makes communication inevitable and it has been argued that improved communication simplify multi-project related issues by making the complex environment easier to grasp.

When comparing pros and cons of Portos, it is not possible to make a quantitative statement of whether the benefits prevail over the requirements and limitations related to the system. Instead, the conclusion whether Portos is a system well suited for handling multi-project issues must be drawn on qualitative aspects. With this in mind, as well as the presented pros and cons, the conclusion is that an intranet based system has large potential in providing managers and project managers with relevant information enabling them to successfully manage the project portfolio.

Portos does not support resource allocation. Even though a lot of theoretical attention has been drawn to the subject, no easy and well functioning solution has yet been presented. Finding this solution would be an excellent continuation of this thesis.

References

Alter, S. (1999), "*Information Systems*", Addison-Wesley Education Publishers Inc, Massachusetts.

Anell, B. (2000), "*Managing project portfolios*", i Lundin, R.A. & Hartman F., (2000), "*Projects as business constituents and guiding motives*", Kluwer Academic Publishers, Norwell, Massachusetts.

Antvik, S. (1999), "Styrning av stora utvecklingsprojekt: Om användning och vidareutveckling av Earned Value i JAS-projektet vid Försvarets Materielverk", Tekniska Högskolan, Stockholm.

Arbnor, I. & Bjerke, B. (1994), "*Företagsekonomisk metodlära"*, Studentlitteratur, Lund.

Archer, N. & Ghasemzadeh, F. (1999), "*An Integrated Framework for Project Portfolio Selection*", International Journal of Project Management, Vol.17, No.4, s 207-216.

Bakar, A. et al. (2002), "*Multi Tasking and Multi Project Management*", Stevens Institute of Technology, 15 Apr.

Cleland , D. I. (1999), "*Project management: strategic design and implementation*", 3. ed., McGraw-Hill, New York.

Collin, C. & Dunning Crescent, R. (1999), "*Optimal resource allocation for projects*", Project Management Journal, June.

Cooper, R. G. et al. (2000), "*New problems, New solutions: Making portfolio management more effective*", Research-Technology Management, March-April.

Engwall, M. (2001), "*Multiproject Management: Effects, Issues and Propositions for Further Research*", Fenix, WP, 2001:6.

Engwall, M. & Sjögren Källqvist, A. (2001), "*Dynamics of a multi-project matrix: conflicts and coordination*", Fenix, WP, 2001:7.

Engwall, M. (2001), "*Moving Out of Plato's Cave: Toward a Multi-project Organizing*", Fenix, WP, 2001:8.

Engwall, M. (1999), "*Jakten på det effektiva projektet*", 2 uppl., Nerenius & Santérus, Stockholm.

Ericsson Business Consulting AB (2000), PROPS.

Eriksson, L. T. & Wiedersheim-Paul, F. (1997), "*Att utreda, forska och rapportera*", Lieber AB, Malmö

Eskerod, P. (1996), "*Meaning and action in a multi-project environment*", International Journal of Project management, Vol 14, No 2, pp. 61-65.

Fisher, M. A. et al. (1998), "*IT support of single project, multi-project and industry-wide integration*", Computers in Industry 35.

Fricke, S. E. & Shenhar, A. J. (2000), "*Managing Multiple Engineering Projects in a Manufacturing Support Environment*", IEEE Transactions on Engineering Management, Vol. 47, No 2, May 2000.

Holme, I. M. & Solvang, B. K. (1997), "*Forskningsmetodik – Om kvalitativa och kvantitativa metoder*", Studentlitteratur, Lund.

Lee, C.-Y. & Lei, L. (2001), "*Multiple-Project Scheduling with Controllable Project Duration and Hard Resource Constraint: Some Solvable Cases*", Annals of operations Research, 102, pp. 287-307.

Lim, K. K. & Yeo, K. T. (1995), "*Management by Projects in Manufacturing Industry*", 95 Engineering management conference, IEEE.

Luiga, M. et al. (2002), "*PHP kontra ASP - Hur står sig PHP gentemot ASP inom svensk webbproduktion?*", Kalmar Högskola.

Meredith, J. R. (2000), "*Project management, a managerial approach*", 3. ed., Wiley, New York.

Patel R & Davidson B (1994), "*Forskningsmetodikens grunder*", Studentlitteratur.

Payne, J. H. (1995), "*Management of multiple simultaneous projects: a state-of-the-art review*", International Journal of Project management, Vol 13, No 3, pp. 163-168.

Payne, J. H. & Turner, J. R. (1999), "*Company- wide project management: the planning and control of programmes of projects of different type*", International Journal of Project management, Vol 17, No 1, pp. 55-59.

Rautiainen, K. et al., (2000), "*Improving Multi-Project Management in Two Product Development Organizations*", The 33rd Hawaii International Conference on System Sciences, IEEE.

Tieto Enator, PPS (2002).

Turban, E. et al. (2002), "*Information Technology for Management*", John Wiley & Sons, Inc. New York.

Turner, J. R. (1993), "*The Handbook of project-based management: improving the process for achieving strategic objectives*", 2. ed., McGraw-Hill, New York.

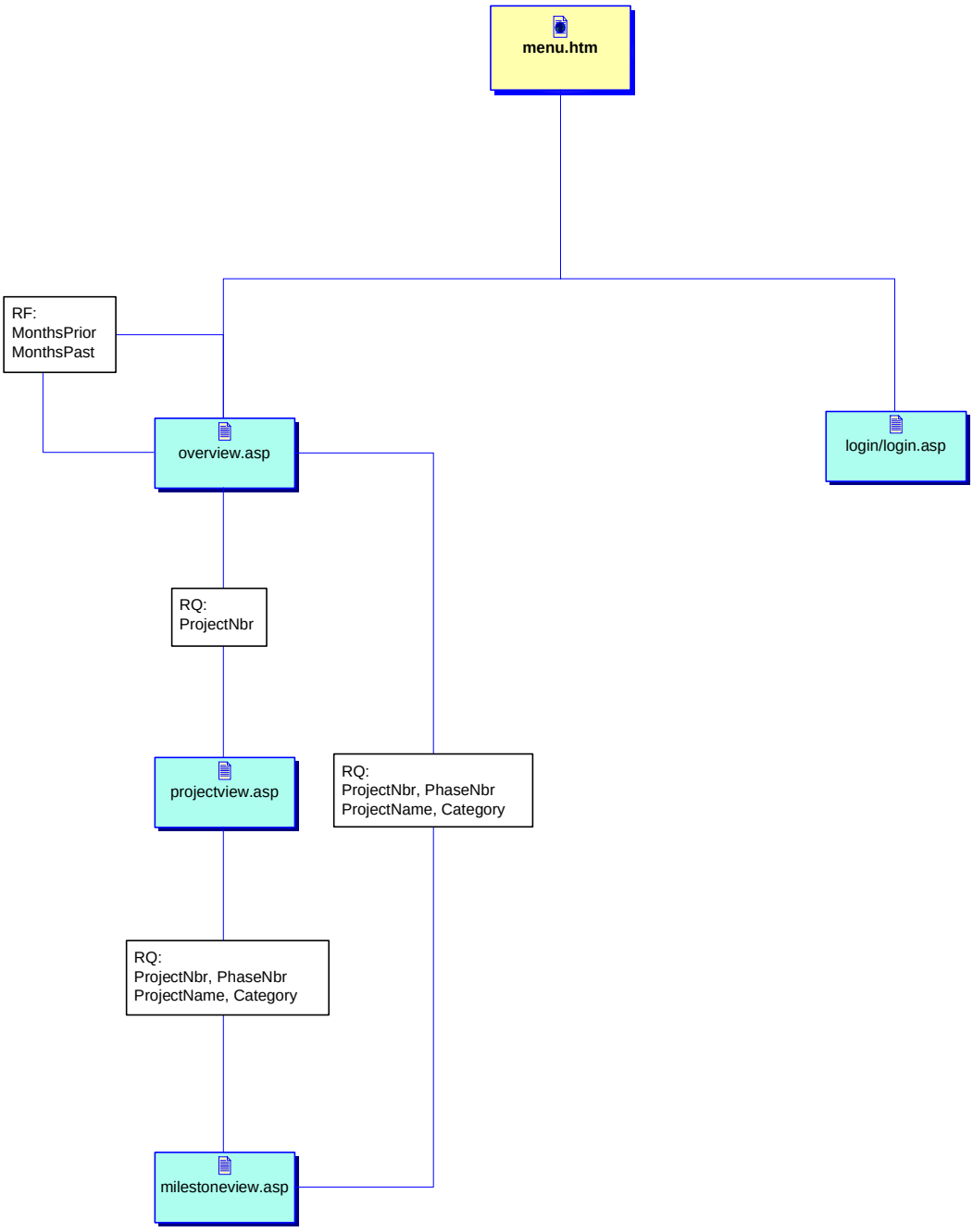
Interviews

Project Manager Thorbjörn Andersson
System Owner (TPIN) Johan Eriksson
Project Manager Anders Glemming
Project Manager Camilla Hägglund
Project Manager Eva Jonsson
Financial Director Björn Kristiansson
Development Director Günther Lanzinger
Projecting Manger Jonas Lind
Manager Technical Publication & MMI Dennis Lundmark
Process Owner Project Management (TPIP) Ralph Maleus
Manager Mechanical Design Per Olof Mundt
Web master (TPIN) Pål Röjdin
Project Manager Annika Sahlström
Project Manager Anders Wiberg

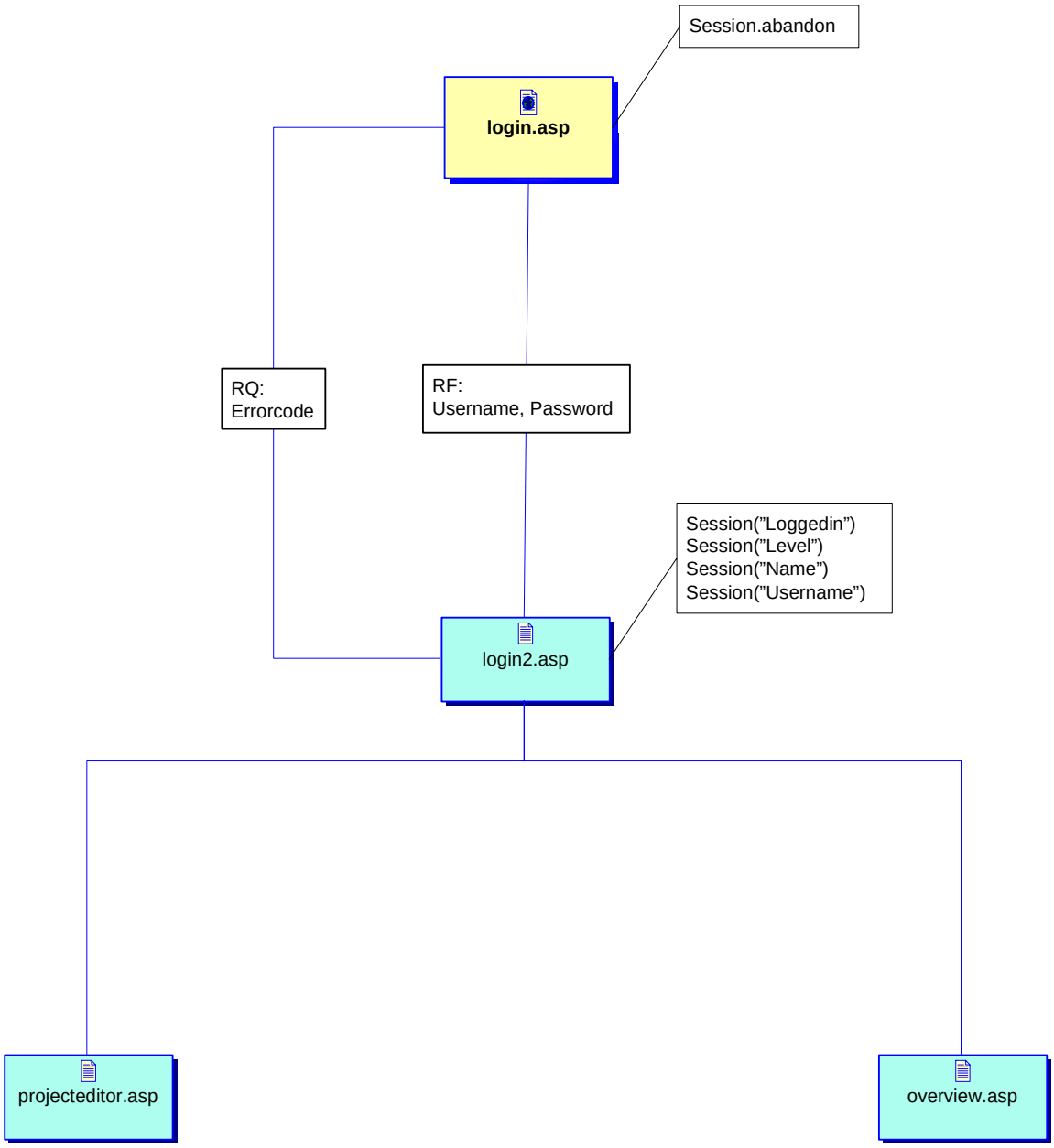
Electronic references

Tetra Pak intranet
http://www.bfree.on.ca
http://www.dtp.se
http://www.geocities.com
http://www.itweb.co.za
http://www.microsoft.com
http://www.projektforum.se
http://www.sslug.dk
http://www.student.uu.se
http://www.zend.com
http://www.101-asp-tutorials.com

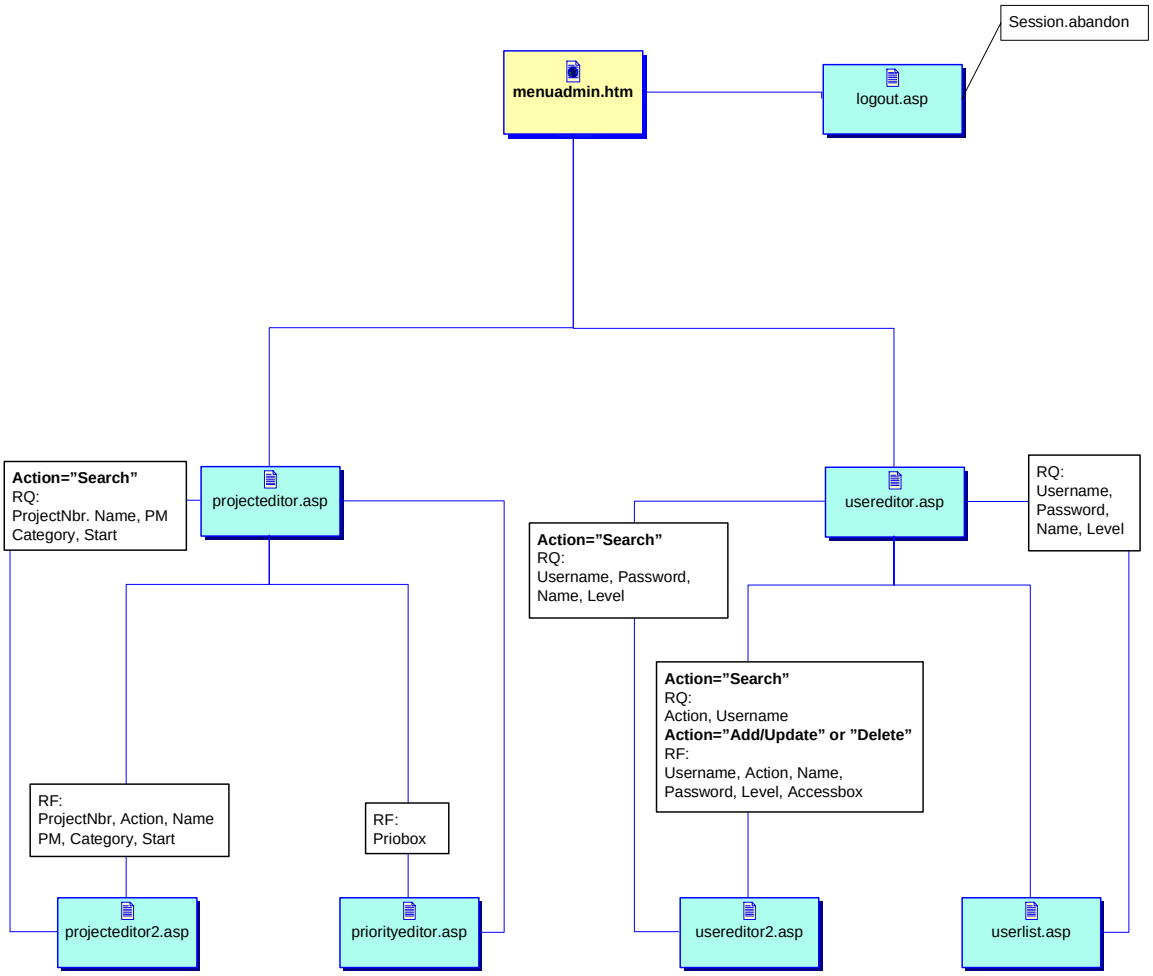
Appendix A – Open pages



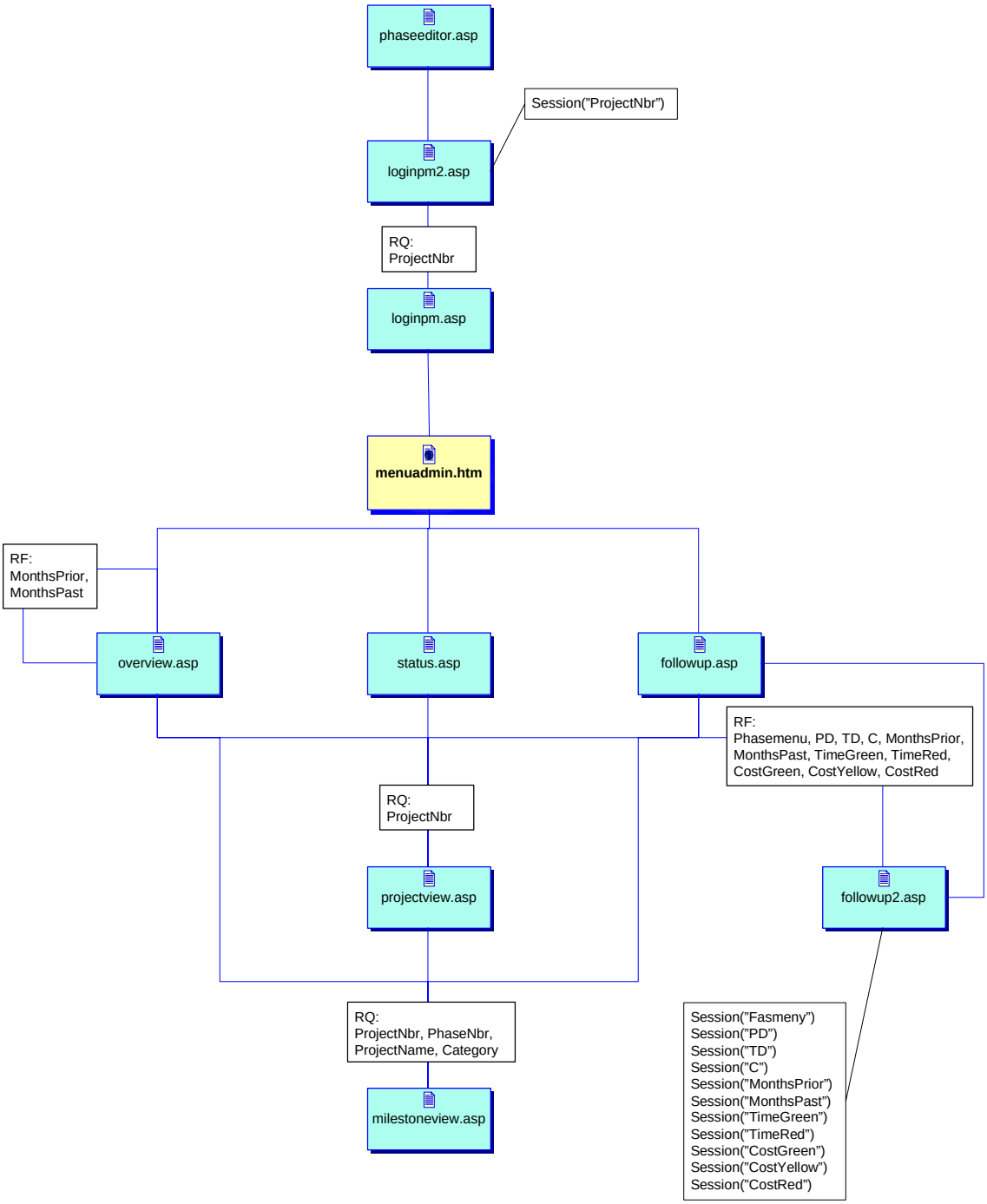
Appendix B – Login pages



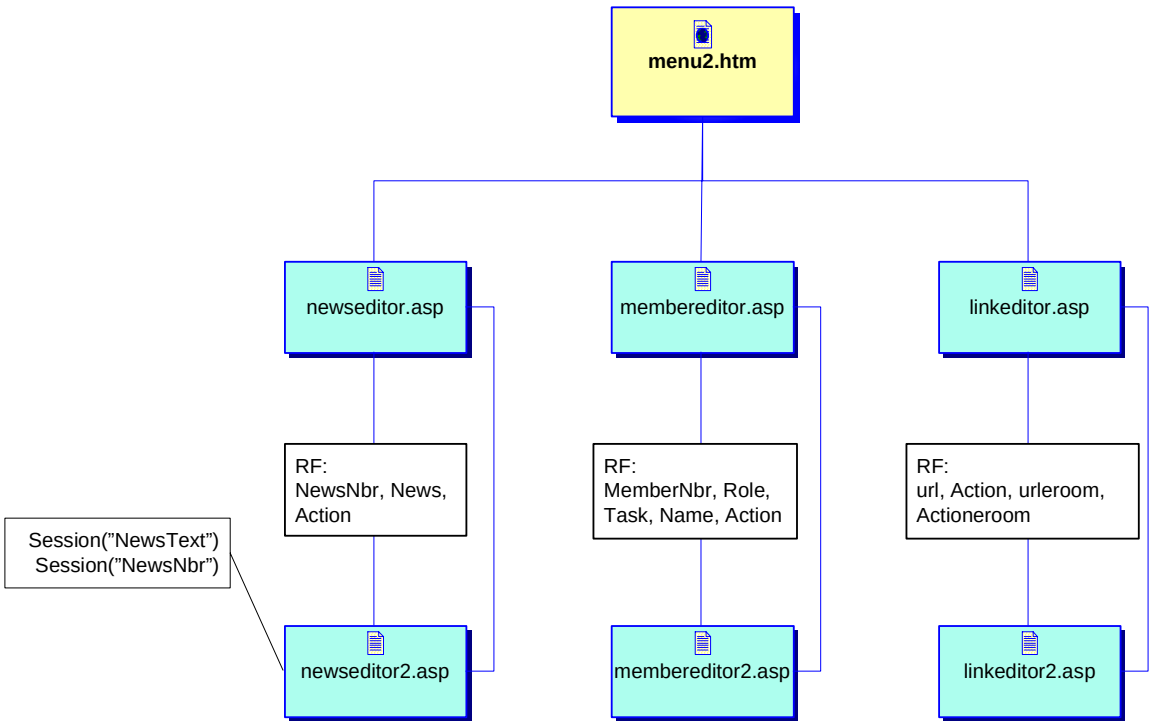
Appendix C – Administrator pages



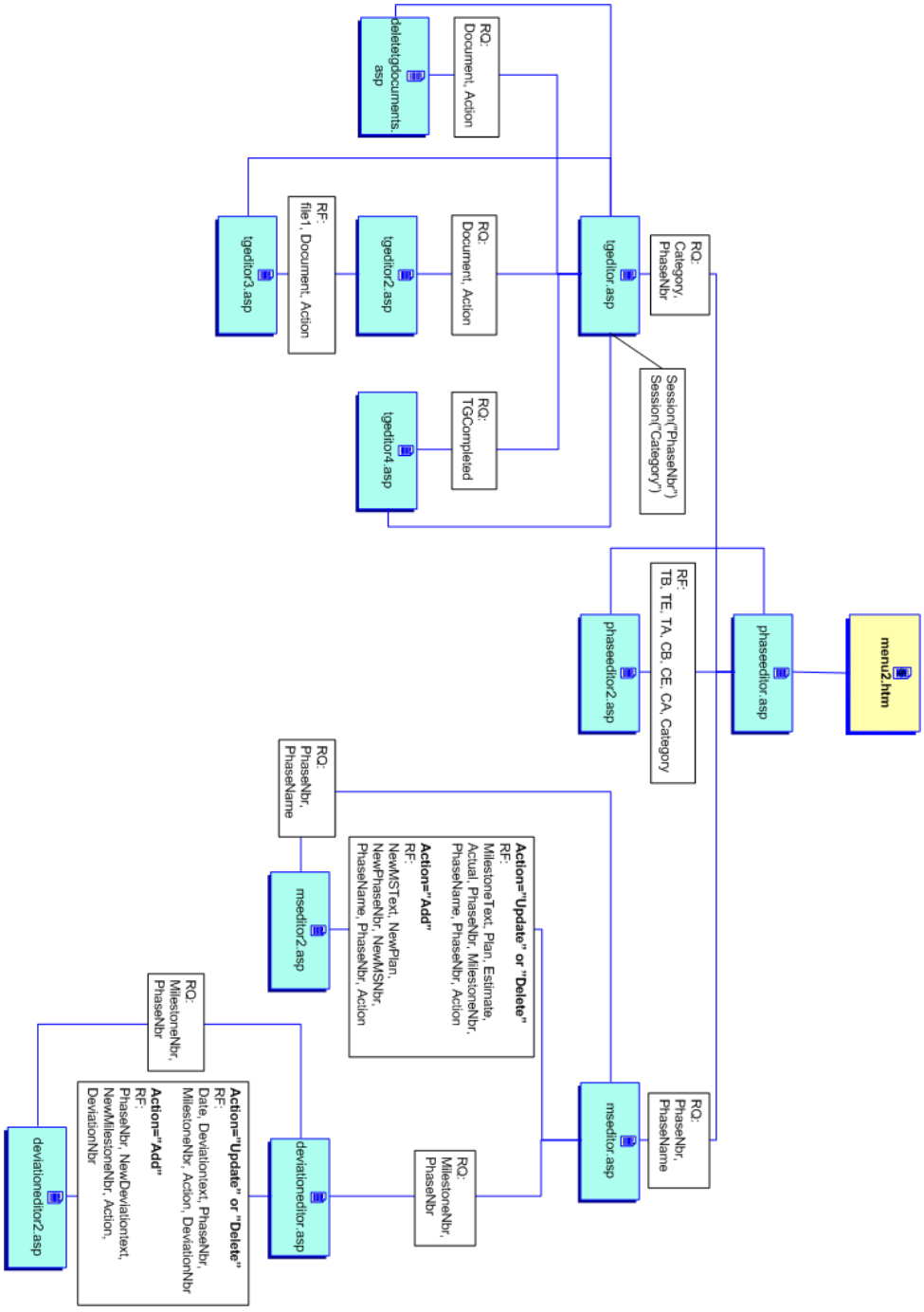
Appendix D – Project Manager Pages



Appendix E – Project Manager Edit Pages (1/2)



Appendix F – Project Manager Edit Pages (2/2)



Appendix G – Portfolio Status page

```
<%OPTION EXPLICIT%>

<!-- #include file="security.inc" -->
<!-- #include file ="..\konstanter.inc" -->

<%
dim Connection
dim SQL1, SQL2, RS1, RS2

'Open the database
set Connection=Server.CreateObject("ADODB.Connection")
Connection.Provider="Microsoft.Jet.OLEDB.4.0"
Connection.Open Server.MapPath("../_db_protected/portos.mdb")

'Create two recordsets; prioritised projects and the phasenames
SQL1="SELECT * FROM tblProjects WHERE Priority BETWEEN 1 AND 8 ORDER BY
Priority, ProjectNbr;"
SQL2="SELECT * FROM tblPhasenames;"

set RS1=Connection.Execute(SQL1)
set RS2=Connection.Execute(SQL2)

'Variables
dim ProjectName(20), ProjectNbr(20)
dim Start(20), SlutB(20), SlutE(20)
dim KostnadB(20), KostnadE(20)
dim BaselineUpd(20), EstimatUpd(20)
dim Category(20), CurrentPhase(20)
dim PhaseName(3,6)
dim Category_2, PhaseNbr
dim antal, i
dim Udda

'Read the projects from the database
antal=0
while not (RS1.bof or RS1.eof)
   antal=antal+1

   ProjectName(antal)=RS1("Name")
   ProjectNbr(antal)=RS1("ProjectNbr")

   if isDate(RS1("Start")) then
      Start(antal)=cDate(RS1("Start"))
   else
      Start(antal)=""
   end if

   if isDate(RS1("FinishB")) then
      SlutB(antal)=cDate(RS1("FinishB"))
   else
      SlutB(antal)=""
   end if

   if isDate(RS1("FinishE")) then
      SlutE(antal)=cDate(RS1("FinishE"))
   else
      SlutE(antal)=""
   end if

   KostnadB(antal)=RS1("CostB")
```

```
   KostnadE(antal)=RS1("CostE")

   BaselineUpd(antal)=RS1("BaselineUpd")
   EstimatUpd(antal)=RS1("EstimateUpd")

   Category(antal)=RS1("Category")
   CurrentPhase(antal)=RS1("CurrentPhase")

   RS1.MoveNext
wend

'Read the phasenames
while not (RS2.bof or RS2.eof)
   Category_2=RS2("Category")
   PhaseNbr=RS2("PhaseNbr")
   PhaseName(Category_2,PhaseNbr)=RS2("Name")

   RS2.MoveNext
wend

'Close the database
RS1.close
RS2.close
set RS1=nothing
set RS2=nothing
Connection.close
set Connection=nothing
%>

<html>
<head><link rel="stylesheet" type="text/css" href="..\styles.css">

<script>
function openwindow(url)
{
   window.open(url,"Helptext","toolbar=no,location=no,directories=no,
        status=no,menubar=no,scrollbars=yes,resizable=yes,copyhistory=yes,
        width=345,height=500, top=70, left=550');")
}
</script>
</head>
<body>

<!--Heading and help function-->
<table width='100%' border='0' cellspacing='0' cellpadding='0'>
   <tr>
      <td width='60'></td>
      <td><center><h1>Portfolio Status</h1></td>
      <td width='60' valign='top' align='right'>
         <a href="javascript:openwindow('
         ../help/Helpuser.html#Portfoliostatus')">

         <img src='../pics/help4.gif' border='0' alt='Portos Help'></a>
      </td>
    </tr>
</table>

<!-- Table structure -->
<table border='1' align='center' cellspacing='1'>
   <tr><td>
      <table cols='10' border='0' cellspacing='0'>
         <tr align='center'>
            <td colspan='2'>
            <td align='center' colspan='3'><center><h2>Reaches TG4
            <td align='center' colspan='3'><h2>Cost to TG4 (KSEK)
            <td colspan=2><h2>Updated
```

```
         </tr>
         <tr>
            <td width='<%=ProjektnamnBredd%>'><h3>Project
            <td width='<%=FasBredd%>'><h3>Curr Phase
            <td align='right' width='<%=DatumBredd%>'><h3>Baseline
            <td align='right' width='<%=DatumBredd%>'><h3>Estimate
            <td width='<%=LampaBredd%>'> 
            <td width='<%=KostnadBredd%>' align='right'><h3>Baseline
            <td width='<%=KostnadBredd%>' align='right'><h3>Estimate
            <td width='<%=LampaBredd%>'> 
            <td align='right' width='<%=DatumBredd%>'><h3>Baseline
            <td align='right' width='<%=DatumBredd%>'><h3>Estimate
         </tr>
      </table>
   </td></tr>
   <tr><td>
      <!--The projects -->
      <%
      Udda=true
      for i=1 to antal
         if Udda then
            Response.Write("<tr bgcolor='#e0e0e0'>")
         else
            Response.Write("<tr>")
         end if
         Udda=not Udda
         Response.Write("<td width='" & ProjektnamnBredd & "'>
         <a href='projectview.asp?ProjectNbr=" & ProjectNbr(i)
         & "'>" & ProjectNbr(i) & " - " & ProjectName(i)
         & "</a><td width='" & FasBredd & "'>")

         Response.Write(PhaseName(Category(i),CurrentPhase(i)) &
         "<td align='right' width='" & DatumBredd & "'>" & SlutB(i) &
         "<td align='right' width='" & DatumBredd & "'>" & SlutE(i) &
         "<td align='center' width='" & LampaBredd & "'>")

         if SlutE(i) <> ""  and SlutE(i) > SlutB(i) then
            Response.Write("<img src='..\pics\red.gif'>")
         else
            Response.Write("<img src='..\pics\green.gif'>")
         end if

         Response.Write("<td align='right' width='" & KostnadBredd
         & "'>" & KostnadB(i) & "<td align='right' width='"
         & KostnadBredd & "'>" & KostnadE(i) &
         "<td align='center' width='" & LampaBredd & "'>")

         if KostnadE(i) > OvreGron*KostnadB(i) and KostnadE(i) <> "" then
            Response.Write("<IMG SRC='..\pics\red.gif'>")
         elseif KostnadE(i) < UndreGron*KostnadB(i) and KostnadE(i) <> "" then
            Response.Write("<IMG SRC='..\pics\yellow.gif'>")
         else
            Response.Write("<IMG SRC='..\pics\green.gif'>")
         end if

         Response.Write("<td  align='right'  width='"  &  DatumBredd  &  "'>"  &
         BaselineUpd(i)  &  "<td align='right'  width='" & DatumBredd  &  "'>"  &
         EstimatUpd(i))

         Response.Write("</tr>")
      next
      %>
      </td></tr>
   </table>
</body>
</html>
```