CHALMERS

Evaluation of Scope Changes in Product Development Projects

Master of Science Thesis in the Master´s Programme International Project Management & Project Management

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ABSTRACT

Product development projects are striving to deliver innovative and customer focused products. Since new requirements and customer needs could be identified or changed during the project life cycle this triggers project to change the original plans. Literature is mentioning that projects changes have to occur in order to keep up with the dynamic business environment that is surrounding many organisations. At the same time projects changes are known for having impact and could cause project failure. Having the right knowledge about scope changes and tools to manage scope changes could for this reason be crucial when managing complex product development projects.

This thesis is conducted at Volvo Bus Corporation (VBC) in Gothenburg in order to evaluate scope changes in product development projects. This includes identifying types, causes and impacts of scope changes in projects at VBC. With this information and an extensive literature review the author seeks what is important when evaluating and dealing with scope changes. The data was mainly conducted through interviews with project managers at VBC from two different projects.

Some recommendations is given both when it comes to evaluating change requests but also how to manage them through clarifying or implementing new tools and processes at VBC. The findings and recommendations could be used in all types of product development projects and is not necessarily VBC specific.

Key word: Scope Changes, Product Development Projects, Impact, Causes, Managing

Preface

This thesis has been carried out during the spring 2011 at Volvo Bus Corporation in Gothenburg, Sweden, in collaboration with Chalmers University of Technology, Gothenburg and Northumbria University, Newcastle. The thesis is worth 30 credits point and is the final study for a master degree in international project management.

Having the opportunity to conduct this study at one of the world leading manufacturer of buses today has been a great pleasure for me. The gained knowledge in the field of project management in a product development organisation like this will be essential for me in my future profession. For this reason I would start with showing my acknowledgement to the Volvo Bus Corporation for letting me conducting this study. This shows their willingness and support for students to get a first contact and introduction to the work life.

Even though this research has been very inspiring some battles have been fought. Having two great supervisors that supported me through the entire journey have meant a lot. For this reason i would like to thank Inger Bergman at Chalmers University of Technology and Fanny Josefsson at Volvo Bus Corporation.

Gothenburg, 2011

Oscar Tenggren

Abbreviations

CMS	= Change Management System
CPM	= Chief Project Manager
DG	= Development Gate
FDCG	= Final Development Contract Gate
GDP	= Global Development Process
GPSC	= Global Product Steering Committee
GPB	= Global Product Board
PAM	= Project Assurance Manager
PM	= Project Manager
PMG	= Project Management Group
PMP	= Project Management Plan
PMR	= Product Modification Request
SIPD	= Supplier Involvement in Product Development
VBC	= Volvo Bus Corporation
VPT	= Volvo Powertrain

1 Introduction

This chapter present the research focus including the research aims for this thesis. It also presented a background of the investigated area in order to clarify the importance and rationale for the study. Finally, the limitations and delimitations of the thesis will be stated to provide the reader with more information of the focus and validity of the research.

1.1 Background

Projects are unlikely to continue as planned. Instead some changes to original plan are the reality for most projects (Steffen *et al*, 2007; Khan, 2006; Ibbs *et al*, 2001). This happens even though the effect of project changes is already known for having both direct and indirect impacts on projects (Ibbs, 2001; Chick, 1999). Moreover, there are several examples that these changes could cause project failures. However, other literature is mentioning that project changes have to occur in order to keep up with the dynamic business environment. This includes satisfying new and modified requirements and needs that have been identified throughout the project. Where the customer satisfaction should be prioritized and the impacts of the project change should be concerned secondly (Steffen *et al*, 2007).

Product development orientated projects are striving for delivering new products. The input of generated ideas is necessary in the beginning of these kinds of projects. These ideas are generated from input from many different parties as for example customers, staff, and competitors. At the same time these ideas are filtered to keep the ones that are feasible and suitable for the company. This screening could include technical, strategic and financial aspects and assures that the right product will be delivered (Maylor, 2010). For product development projects this creates many factors and inputs that could change during the project life cycle. So it is not only about setting the correct scope in the beginning of the project, it is also about delivering the right product. This is especially important in dynamic business environments where Steffens *et al* (2007) points out that product development projects not often continue as planned.

Since project changes could have a significant negative impact on the project success it is vital for project managers to be prepared for them. Having the right knowledge and tools for dealing with them could be the difference between project success and failure. Dealing with project changes could be seen in two ways, proactive and reactive approaches (Steffens *et al*, 2007). Where proactive approaches focusing on anticipating and be prepared for the project changes, while reactive approaches on the other hand focusing on managing the project change. The literature has to some extend explored the area of project changes, but a deeper understanding of this topic is needed in order for project managers to deal with project changes. This is especially important in product development projects where the delivery of a new product has to be innovated and satisfying the customer for just mentioning some factors. As described above these factors could change and project change will be needed.

1.2 Research Focus and Aim

In order for project to adjust to factors as changing business environments, technology, customer needs e.g. they have to be prepared for change. This is especially important for product development projects where these factors more or less have to be fulfilled. So the first stated project scope could or even has to be adjusted for staying competitive and delivering innovating products. Since project change is already known for having impact on the project whether it is a modification to the scope, schedule or cost (Ibbs,

1998), there are many research possible for project changes. The scope of this thesis is aiming at giving recommendations for project managers, especially in product development projects how to evaluate and deal with scope changes in order to minimize the impact of these. These recommendations will not only be based on already established change project systems and process, the aim is also to identify what types of scope changes that are common in product development projects and their impact and cause. This information will be valuable for giving the right recommendations but will also provide the literature and project managers with a good understanding of the investigated area.

The definition of 'scope change' that will be used in the thesis is: "*Where a request is considered to change the agreed scope and objectives of the project to accommodate a need not originally defined to be part of the project"* (Wallace, 2007).

To clarify the research aims discussed above they are represented below:

- To investigate common types of scope changes in product development project.
- To investigate what are the causes of these types of scope changes.
- To investigate the impact of these scope changes on e.g.
  Effect on the 'iron triangle' in cost, quality and time.
- Give recommendations for Project Managers how to evaluate and deal with scope changes.

1.3 Limitations and delimitations of the research

Primarily the time restriction has been a limitation for conducting a study like this. To fully understand the situation at VBC more than just a couple of months has to be spent. To deeply analyse this area from VBC point of view more time is needed. For this reason the material presented in this paper is based on the information that the author have gained at the given time.

To limit the scope of this thesis so that a more detailed investigation could be made some delimitation are presented below:

- Concerning only late scope changes after scope freeze. Scope changes that happens before is not considered. In the Global Development Process (figure 2.2) used for VBC projects changes before the detailed development phase is excluded.
- Only start cost projects will be considered, which means that Product Modification Request (PMR) project is delimited from this study.
- This thesis is also excluding to create a new process for VBC. However, it is not delimited from giving recommendation to improve or implement processes presented in the literature if a need for this is identified.

1.4 Outline of the report

The outline for this report will structure according to the recommendations in the Dissertation Handbook (Osborne, 2011). However, since this thesis will award the researcher with a dual award from both Northumbria University and Chalmers University of Technology the outline will be slightly adopted to satisfy them both. As support for structuring the outline on a more detailed level, this thesis is also following Biggam´s (2008) recommendations and guidelines.

From above mentioned recommendations the following outline is used in this thesis consisting of seven main chapters:

- Introduction
- Presentation of Volvo Buses and their processes
- Theoretical frame of references
- Research method
- Results
- Discussion and recommendations
- Conclusions

2 Presentation of Volvo Buses and their processes

This chapter provides a brief description of Volvo Group and Volvo Buses. This information together with an introduction of their product development process will provide the reader and the thesis with background information that is needed for the analysis and validity of the report.

2.1 Volvo Buses a part of the Volvo Group

The Volvo Group consist of nine business areas with manufacturing of trucks, buses, construction equipment and engines for marines, aircrafts and the industrial industry. In order for Volvo Group to take advantage of their size they also have of several shared business units as illustrated below (Figure 2-1). This has created opportunities for shared product development and benefits for manufacturing for just mentioning some examples.

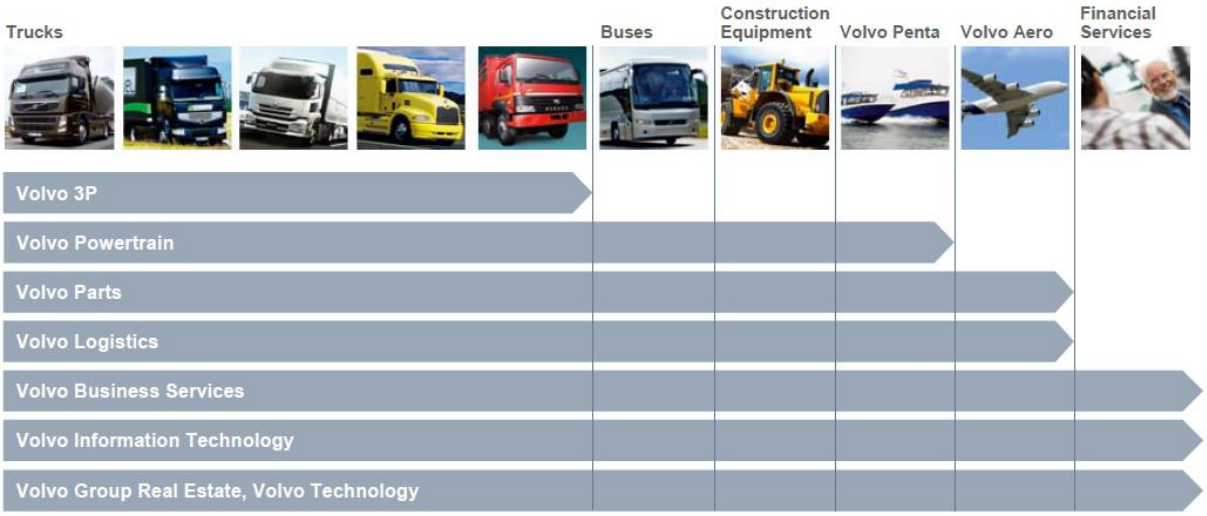

Figure 2-1 - *Illustration of Volvo Group (VBC Presentation, 2011)*

Volvo Bus Corporation (VBC) is one of the nine business areas within the Volvo Group. With approximately 8000 employees and plants worldwide it is one of the world's largest manufacturer of buses and bus chassis. The product programme consists of city and intercity buses and coaches with a range of models within each of these categories. Since their customers are spread worldwide many customer adaptations is carried out to fulfil the different needs that the market are demanding.

To manage all the different customers´ need worldwide VBC´s marketing organization is divided into three business regions – Europe, North and South America and International. Each business region gives input to the project organization with their unique market requirements, where most of the product development projects are located in Gothenburg, Sweden. Since all projects are more or less unique the project organization for each project is slightly different. Yet, the typical project has a Project Manager (PM) from each function within the organisation and one Chief Project Manager (CPM) that have responsibility for the overall project. There is also one Project Assurance Manager (PAM) in each project to support the CPM and the project team to follow the project process, the Global Development Process.

There are mainly two different types of product development projects at VBC, both with different amount of activities, budget and resource involvement. The two different types are 'start cost projects' and 'maintenance projects'. Start cost projects have an important

product impact and the result is often a new product or fulfilment of new regulations. These projects do always have a budget above 5 MSEK that are paid in smaller portions trough the project life cycle and are released for each gate. The second project type carried out at VBC is maintenance projects, also known as Product Modification Requests (PMR). These projects are much smaller and are carried out for maintenance of existing products that usually are already in production. Cost rationalization, quality improvements are typical examples of the aims for these projects. The case study carried out in this research is not investigating scope changes within these PMR projects, as mentioned in the delimitations of the study. However, the awareness that products could be changed afterwards must been seen as vital when investigating scope changes. This type of projects gives room for manoeuvre since products could be updated afterwards and also since this possibility could be available for all types of product development companies, not only at Volvo Buses.

2.2 Global Development Process

To manage projects in a standardize way Volvo Buses have implemented a process that should be the basis for all projects carried out within the organization. This process is named the Global Development Process, GDP and is illustrated below (Figure 2-2). The GDP contains of six different phases each with a unique focus on different project work. To separate them, each phase starts and ends at a gate.

Figure 2-2 - *The Global Development Process (VBC Presentation, 2011)*

Depending on size and complexity of the projects they are divided into different classes. Each class allows the project to be managed according to its start cost investment and scope. For example there will be more gates and activities for class 3 projects compared with projects that are categorized as class 2 or 3. This allows flexibility for projects carried out at VBC to allow smaller projects to be managed with fewer resources and with a faster lead-time, while more complex projects will be more structured and controlled. As mentioned, projects that are categorized as class 3 projects have a high start cost, investment and scope. These are usually new products projects, but it could also be major changes to existing products at Volvo Buses. The case study within this research is following projects in this classification. Consequently, the knowledge of the

gates and phases concerning class 3 project is vital for analysing the results from these projects and are therefore presented below.

The six phases in the GDP is presented below including the major gates for each phase (Corporate GDP, 2010):

- Pre-study

The first phase in the GDP is aiming to define the project scope. This will be achieved through establishing the project conditions, requirements and solution concepts. The project conditions consist of goals, directives and target descriptions. The prerequisites should also be established in this phase, containing a high level "wish list" from all the stakeholders.

- Concept Study

In the concept study phase the alternative concepts should be analysed and one of these should be selected for development. Important to notice is that the project should freeze the project prerequisites in this phase. Hence, the project should not accept new needs after freezing the project prerequisites. In the end of this phase, at the development gate a pre-contract should be signed to commit all the parties to the selected concept.

- Detailed Development

During the detailed development phase the solutions that have to be implemented should be defined and approved, including identifying the project´s delivery from all areas. At the Final development contract gate the project should freeze and sign the project description to establish the contract agreement.

- Final Development

During the final development the work with finalising the product solution starts. This includes both to build the product but also activities like verifying and validating. Soft products as improving for example assembly, market and aftermarket solutions are also taking place during this phase. Before leaving this phase the project has to confirm that the product is ready for industrialisation. This confirmation is done at the industrialisation gate.

- Industrialisation and Commercialisation

The product that has been developed has to be prepared for industrialisation. The main objective of this phase is therefore to install, prepare and verify the industrialisation system. During this phase the project should also commercialise the product and the aftermarket products.

- Follow-up

The fallow-up phase is the last phase in the GDP. The project should in this phase be handed over to the line organisation. Finally, the project should follow up how well it fulfilled the project target and summarise the experience gained.

3 Theoretical frame of references

This chapter presents relevant theories within the research area. This will provide the research with knowledge that is necessary to investigate and explore the research aims.

3.1 The project life cycle

Even if every project is unique, the literature agrees that the typical project life cycle could be described on a high level. The APM BoK (2006) describes that the project life consist of four phases;

- *Concept*

  This phase contains the pre-project activity that tries to captures the new needs, problems and opportunities through a business case that are aligned with the organisations strategy. Decision if this new idea will be taken further into development of a new project will be taken. Also included in this is phase is to secure resources and setting the project requirements in co-operation with the stakeholders.

- *Definition*

  In the definition phase the project management plan (PMP) is being developed. It contains all the plans that are needed for executing the project. The PMP has to be agreed by the sponsor, stakeholders and the organisation. This plan should be based on the preferred solution that should be able to meet the high-level requirements that comes from the concept phase. Finally a decision is taken if the project should continue into the implementation phase, or being terminated.

- *Implementation*

  The implementation phase is the phase in the project life cycle in which most of the resources will be used and activities will be done. The plans stated in the PMP will be executed and monitored in order to deliver the deliverables. Monitoring of all activities is typical under the project managers' responsibility to ensure that the activities carried out are aligned with the agreed project scope.

- *Handover and closeout*

  The final phase in the project life cycle is the handover and closeout phase. The project deliverables are handed over to the user or the project sponsor and these are tested to assure that they are meeting the acceptance criteria. This phase could also include a formal transfer of the ownership of the project outcomes. Finally the project is being reviewed and project information stored.

Maylor (2010) describes the project life cycle in a similar way and is also describing four major phases. These are the *Define*, *Design*, *Deliver* and *Develop* phase. However, Maylor (2010) points out that there are usually several stages within each of these phases depending on what type of project there is but the generic project life cycle could be explained like this. These phases are very similar to the one that the APM BoK (2006) mentions, but there are some small differences. The 4-D structure explained by Maylor (2010) does not include the pre-study. However, it is worth mentioning that it is stated diversity in the literature if this should be included in the project life cycle or not, as in the concept phase (APM BoK, 2006) where it is included.

3.1.1 Project life cycle characteristics

There are also some typical characteristics for the generic project life cycle more than just common phases. How the level of activity and expenditure varies with time, are for most types of projects also sharing some generic characteristics. The amount of activities is very low in the beginning of the project life cycle and increases rapidly first in the implementation/deliver phase. The expenditures follow this pattern, and most projects will spend most of their budget during this phase (Maylor, 2006). According to the PMBoK (2008) this pattern is described similar but instead describes how the cost and activity level varies with time (Figure 3.1).

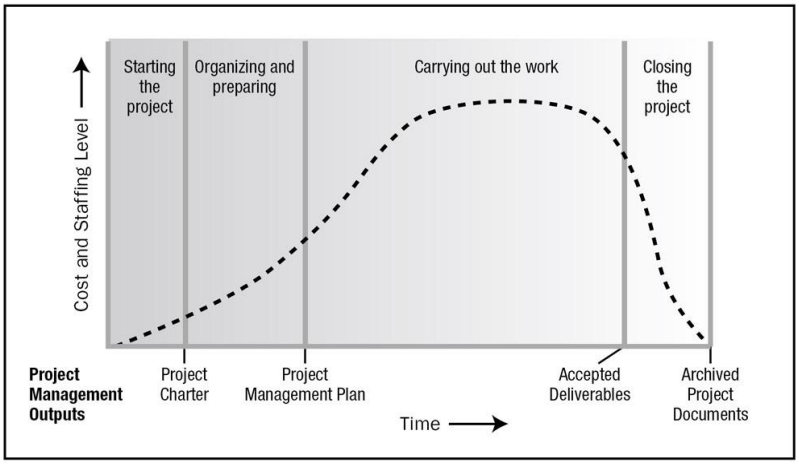

Figure 3-1 - *Generic project cost and staffing level (PMBoK, 2008)*

3.1.2 Product development projects

Product development projects have their unique characteristic compared to other types of projects. The planning phase does usually contain input of different possible ideas that are growing exponential. Input from different stakeholders such as customers, suppliers and staff are likely to give the project a wide range of possible concepts. Trough different types of methods the ideas are filtered down to a level that is aligned with the project scope. This screening could be carried out through marketing and financial, strategic and technical appraisal to see whether or not the product is feasible to deliver and its potential value (Maylor, 2006). Hence, the level of activity (Figure 3-1) could be argued to be more extensive in the beginning of product development projects than the generic project life cycle.

3.1.3 Project constrains

The PMBoK (2008) describes six different constraints that have to be balanced in when managing projects. These are Scope, Quality, Schedule, Budget, Resources and Risk. However, it is also stated that the typical project is not limited to these. In other words there could be more constraints a project could face and needs to balance. Yet, some theories or models represent only four different constrains. Wideman (2011b) presents a four square model to illustrate these, presented below in figure 3-1.

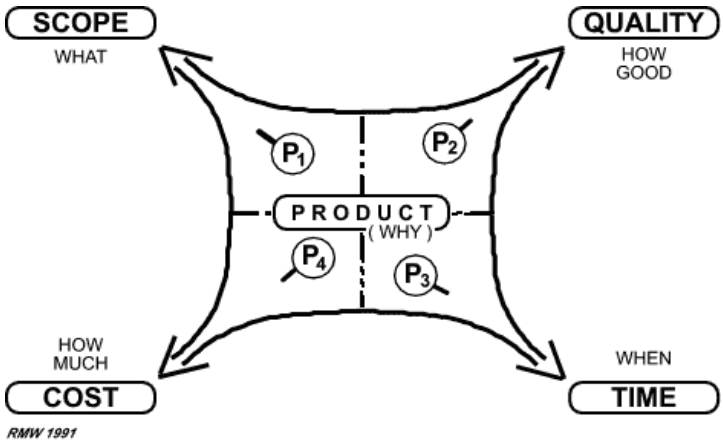

Figure 3-2 – *Scope, Quality, Cost and Time constraints (Wideman, 2010b)*

Wideman (2011b) describes that managing the trade-off between scope, quality, cost and time is very important when managing projects. The trade-offs between the constraints should not only be recognized in the beginning of the project life cycle. Project managers should also understand that the focus of a project could change throughout its life cycle. The basis is to understand that projects usually are not equally focused on all the constraints, often one constraint is more prioritized. Wideman (2011b) states that research and development projects for example have scope as its priority, and that the three other constraints are more uncertain. However, if a change occur in one of the constraints it is essential to realize how the other ones will be affected.

3.2 Scope Management

The importance of good scope management practise is according to the literature vital for delivering successful projects (e.g. Khan, 2006; PMBoK, 2004). This statement should be enough for describing the importance of scope management. However, other literature are more focusing on the scope issues that occurs in projects when there is a lack of good scope management practise (Mathur, 2007). So the importance of scope management is not only a function for delivering a successful project, it is also about avoiding problems that otherwise could arise. The elements included in scope management are slightly different described in the literature, but there are some typical descriptions of its purpose. Scope management involves the work to specify the process scope and the product scope that the project are intent to deliver. This includes not only the understanding of what should be included in the project but also what should be excluded (Maylor, 2010). The APM BoK (2006) gives a similar view:

> 'Scope management is the process by which the deliverables and work to produce them are *identified* and *defined*. Identification and definition of the scope must describe what the project will include and what is will not include, i.e. what is in and out of scope' (APM BoK, 2006, p.34, my italics).

This description illustrates that scope management is about stating what the project is intended to deliver. Moreover, these descriptions focus on identification and definition, the input and the output. So it answers the question "what", but it doesn't mention anything about "how" and "when" they should be identified and defined. The next section will therefore clarify the typical process behind scope management.

3.2.1 The scope management process

The PMBoK (2004) states that "Project Scope Management includes the process required to ensure that the project includes all the work required, and only the work required, to complete the project successfully" (PMBoK, 2004, p.103). This definition is similar to the view that the APM BoK (2006) and Maylor (2010) gives. This work is according to the PMBoK (2004) is not only about defining the project scope but also how it will be controlled troughout the project. The work involved with defining and controlling the project scope are described as five process areas:

- Scope Planning

The first step for developing the project scope is to create a plan that defines how the project scope will managed. This plan should include both how the scope will be defined but also a plan for how it should be verified and controlled. This process also involves creating a plan for how the work breakdown structure will be created and defined. The detail level of the planning depends upon the complexity of the project and balanced consideration is needed depending on every unique project.
The output of this process, the project scope management plan, includes the components described above. However, this output will be generated through expert judgments from previous projects but also through standards and templates that are available as a support. Moreover, these tools and techniques depending on input from e.g. the project charter and the preliminary project scope statement (PMBoK, 2004).

- Scope Definition

From the preliminary project scope statement a detailed project scope statement is developed. This is possible since more and more information becomes available throughout the planning phase. Needs and wants from the project stakeholders should be concerned and stated as requirements (PMBoK, 2004). The main output for this process is the project scope statement.

- Create WBS

From the project scope statement and other relevant inputs such as the project scope management plan, a work breakdown structure could be developed. This could be developed through identifying all deliverables and work that the project will undertake, and decomposing these into more manageable components. This WBS will together with the detailed project scope statement form the project scope baseline (PMBoK, 2004).

- Scope Verification

The scope verification is the formal acceptance of the project scope from all stakeholders in the project. This process includes documenting all deliverables that have been accepted but also the one that have been rejected. Corrective actions should be introduced in order to adjust these (PMBoK, 2004).

- Scope Control

The scope control process is used in projects in order to control scope changes. It concerns both how requested changes should be handled but also how this should be managed (PMBoK, 2004). This process is the heart for project managers to keep the scope under control, and could be one of the key sources for managing the project scope. However, the above mentioned description is not enough detailed and will be further explained (Chapter 3.4)

3.2.2 Product and project scope

The PMBOK (2008) describes the term ‘scope’ and refers to both project scope and product scope or just one of them. Project scope is stated as “The features and functions that characterize a product, service, or result.” and project scope as “The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions”.

3.3 Scope changes

The typical project life cycle described in Chapter 3.1 shows how the project life cycle is described from the theoretical perspective. The theory illustrates a linear progress, with a start and finish. Compared with the theory the reality on the other hand does not follow this patter. This gap between the theory and the reality are described by Read (2000):

> "Most literature on project work shows charts of linear progress, in which the percent completed is proportional to the effort or time spent …. In reality, most projects are experience some sort of change during their life cycle and some tremendous change. This could be represented by a progress graph that has several loops in it…. " (Read, 2000, p.31)

Read (2000) describes these loops as a step backward in the progress towards completion of the project. Moreover, the additional impact in cost and time that these loops create are usually not in the budget. Unfortunately, this description could be interpreted as that all project changes have impact on projects when it comes to cost and time when this is probably not the reality. Dvir and Lechler (2004) distinguish project changes into two different types; plan changes and goal changes. The first one is changes that affects the project plan but have no direct impact on the customer requirements or the project goal. Goal changes on the other hand affect the project goal and/or requirements and will affect the schedule first when they have been implemented. This is necessary so that the project could meet the new requirements or project goals. Since this report is focusing on scope changes the last mentioned change is in the frame of the study for this report. Yet, design changes could also be classified as scope changes according to Joan (2001) since they alter the work content for the project.

3.3.1 Types of Scope Changes

Ibbs *et al* (2001) distinguish project changes into two different types. The first type is *elective changes* which could be seen as an opportunity for the project team or management to change the original budget, schedule or project goals. *Required changes* are the opposite and are mandatory. Changes like these could be necessary for complete the project. Milosevic (2003) has a similar view and do also distinguish project changes into two different types. These are described as *want changes* and *must changes*. Were a must change needs to be implemented to avoid project failure and a want change typical is intended to bring benefit to the project product. However, a quotation from Sun *et al* (2004) clarifies the difference:

> "Project changes can be classified as "elective changes" and "required changes". An elective change is where one may choose whether or not to implement and a required change is where there is no option but to make the change" (Sun *et al*, 2004, p.7)

The distinction between these two types could then be seen as its necessity. It is important to understand the different between these types since they should be managed differently (e.g. Milosevic, 2004 and Ibbs *et al*, 2001).

3.3.2 The Impact of scope changes

Wallace (2007) separates scope changes from other types of project changes. Changing the scope after the project has been executed has consequences. This impact is usually increased project cost and longer duration of the project. Greater risks are also a consequence of changing the scope in the middle of a project. The impact in cost, risk and duration is illustrated as exponential throughout the project life cycle (Figure 3-3).

Making late changes in product development projects is no difference from any other types of project. Late changes cause delays and increase the project cost for various reasons. The main reason for this is the amount of activities that have been carried out in the project. Late changes will for this reason have more impact since the amount of activities that have to be redone will be much greater. However, also related activities to the one affected could be impacted. For product development projects a late change could cause more than just redesign of work. Repurchasing tooling, fixtures and materials and creating new prototypes is usually related to late changes in product development project (Milosevic, 2003).

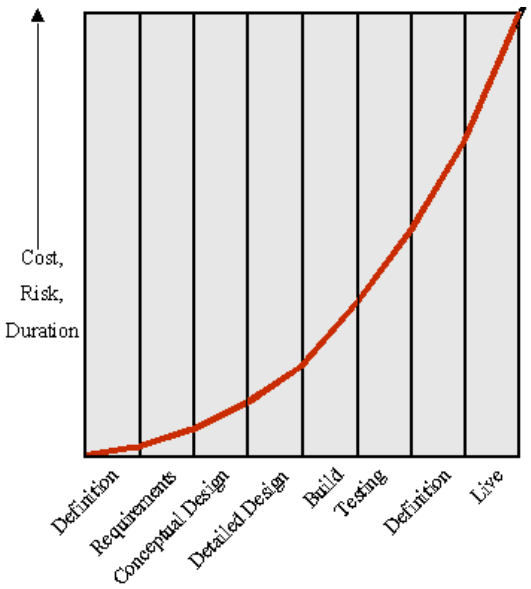

Figure 3-3 - *Cost, Risk and Duration of a project change varies with time (Wallace, 2007)*

Ibbs *et al* (1998) does mention the effect of reducing the scope in a project. It will not necessary reduce the total project cost since it could create disruptions and other indirect impacts that instead could increase the total project cost. These disruptions and indirect impacts are related to rework of the project planning and effects on the productivity. According Sun *et al* (2004) rework and revision of work is the major additional cost for project change, where rework is the unnecessary consequence of redoing the processes and activities that already have been carried out.

Sun *et al* (2004) describe that project changes have both *direct* and *indirect* effects the project cost and schedule. Addition of work, deletion of work that already has been done and re-doing work are some examples of direct effects of project changes. Other direct impacts are; time to revision project reports, rearrange schedule and activities but also the time wasted in stopping and restarting current activities.

Indirect effect on the other hand is the impact that the change eventually will have on the project in both cost and schedule. This could for example be due to the need for communicating the change and its effect of lower moral and conflicts that could arise among the project partners. Finally, the risk will also be affected indirect since the project will lose float and co-ordinate failures will increase.

3.3.3 Benefits of scope changes

The PMBoK (2008) also illustrates how project changes vary exponential with time. At the same time the stakeholder influence, risk and uncertainty in a project are decreasing (Figure 3-4). So while the cost of making a change is less costly the uncertainty surrounding the project is high. These factors could be argued to be one of the reasons for changing the scope later in the project, when the project is phasing less uncertainty. Furthermore, Wallace (2007) argues the difference between a successful and a world-class project manager, where a successful project manager aims to deliver a project on cost and budget. The world-class manager on the other hand should be "… to optimise the benefit that is generated by the project. If that means allowing the scope to change then that scope change is a good thing, not a bad thing. It is wrong to resist all scope change.".

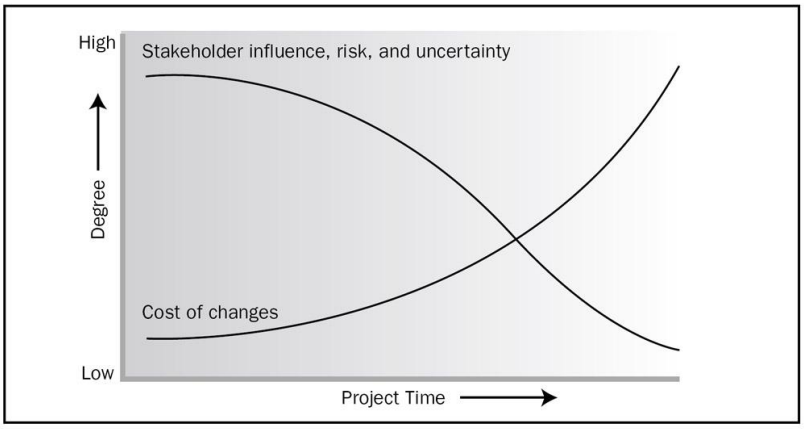

Figure 3-4 - *Stakeholder influence, risk and uncertainty vs. Cost of change - PMBoK (2008)*

Wideman (2011a) describes this implication for managers to make a decision whether or not to change the project scope. In all projects a change in the project scope could be a constructive opportunity if the opportunity to add value is higher than the cost of change. However, this opportunity will instead become harmful at a certain point when the cost of change is higher than the value the scope change brings. Since both the opportunity to add value and cost to change is exponentially decreasing and increasing an addition in the early stages will give much more benefits to the project. Yet, each project is unique, for that reason the point where the destructive intervention starts is also unique which is illustrated in Figure 3-5.

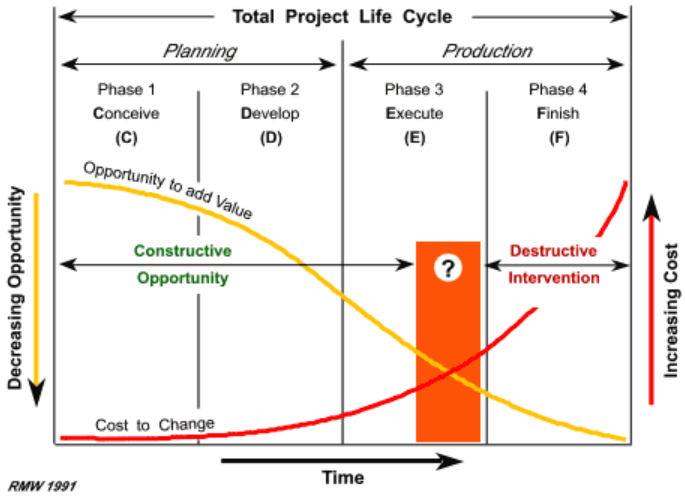

Figure 3-5 - *Adding value vs. Cost to change (Wideman, 2011a)*

3.3.4 Reasons for scope change

The need for changing the project scope during the project life cycle could be caused for various reasons. Joan (2001) states five major reasons for a need to change the project scope which is cited below:

- Lack of sufficient information during the early stages of planning.
- Increase of customers´ ability to specify their requirements, resulting from a better understanding of their real needs.
- Change in environmental conditions.
- Improper orginal planning.
- New technology that may improve the project´s performance.

However, Sun *et al* (2004) distinguish the reasons for project changes into external causes and internal causes. External causes could be economic, environmental, technical and regulatory issues. Internal causes could on the other hand be uncertainty in the project scope, changes of client brief, design improvements and ineffective decision making for just mention some of the examples. Unfortunately, the examples presented by Sun *et al* (2004) are from the construction industry. This should be considered since they all may not be causes for project changes in product development projects. However, Wallace (2007) points several similar change drivers as new legislation and regulations and also that available technology improves constantly during the project. But also organisational changes and business changes could trigger the need for change. New business leaders, new products and competitors are some of these examples.

3.4 Managing scope changes

Scope changes could have a huge impact on project in for example cost, time and quality as described in previously chapter. However, this impact could be minimized trough an effective response from the project management team (Ibbs *et al*, 2001). The literature presents several different methods, systems and processes within this area, how to prepare and respond to changes. The one that is most relevant for project development projects will be presented below.

3.4.1 Change Control

The PMBoK (2008) presents a generic process for managing changes, titled 'Perform Integrated Change Control'. This processed is described on a high level and is suitable for all types of projects and is considering three main areas:

- Reviewing all change requests
- Approving changes
- Managing changes

This process should be available from project start to finish since this ensures that all changes have to be approved or rejected so only the ones that have been approved are aligned with the project. Wallace (2007) points out that change control is often used after the first version of the deliverables have been completed and agreed. So a good practise is to have the change control system in place after the project scope has been accepted until project finish. Figure 3-2 below is illustrating the process presented in the PMBoK (2008) on a high level from the input to the outputs.

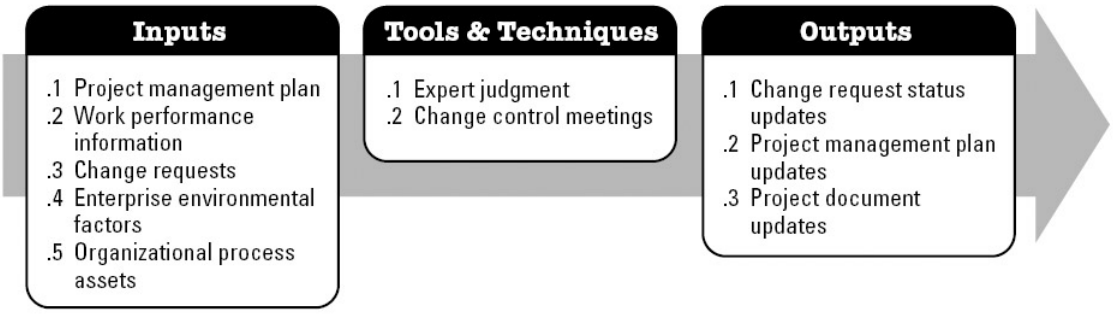

Figure 3-6 - *Illustration of the 'Perform Integrated Change Control' process (PMBOK, 2008)*

All change requests that are issued should be recorded in written form before implemented into the change management system. These requests could be issued by any stakeholder involved with the project. If essential, information regarding estimation on cost and time impacts should be included in the request. Each request must then be approved or rejected. This should be done by either the project management team or someone external in the organisation. However, the PMBoK (2008) points out that this decision should be taken by the one having authority for making the decision. These roles should be predefined in change control system before project execution and should be approved by appropriate stakeholders. Project manager could have the authority for approving some types of changes if stated in their role description, in other cases a change control board (CCB) should be included in the change control process and responsible for the rejecting or approving change requests. If the change request is approved it could require updates on the project estimates. This could include new cost, activity sequences, risk calculations etc. (PMBoK, 2008).

3.4.2 Project change management systems

The idea of change control presented above has in other literature been even more developed. Ibbs *et al* (2001) presents an *change management system* (CMS) that has been developed for the construction industry in order to manage project changes effectivly. Eventhough it is developed for the construction industri it is designed to be adopted for other types of projects like new product development projects. The CMS contains five principles that will presented below. However, other systems and teories such as the *Change Coordination Matrix* (Milosevic, 2003) are also included in each section to provide an more comprehensive understanding how to deal with project changes. These two systems could be found in Appendix A and B.

Promote a balanced change culture

The first principle described Ibbs *et al* (2001) is to promote a balanced change culture. The project management team should inform team members that beneficial changes will be supported and encouraged. Still, it is also important to discourage detrimental changes that have a negative impact on the project or the owner value. Beneficial changes on the other hand could reduce project cost and schedule. Perhaps even more important is that these changes could reduce the project complexity. Project success factors should also be communicated among team members. This is essential since the likelihood of conflicts arising during the project will be kept to a minimum. However, the overall aim for this principle is to promote the project team to have a proactive approach so potential changes could be identified early. This could be done through identifying areas within the project where changes are most likely to occur so that beneficial changes could be identified early. Wallace (2007) describes that it is important that all participants in a project understands that the later a change is addressed in a project the impact on schedule, cost and risk will increase. This view is similar to the one that Ibbs *et al* (2001) describes as the first principle.

Recognize the change

Communication should also be encouraged during project execution. Having frequent discussions among the project team should be encouraged so potential could be identified early. The reason for this is that the change then could be managed in a more effective manner. Whether the change has positive or negative impact on the project it should be identified and the impact should be appraised by the project team. Determining if the change is required or elective should also be clarified since they should be managed different in a CMS. When the change has been described and justified the potential change should be logged before the evaluation could start (Ibbs *et al*, 2007). This second principle does only describe that required or elective changes could be proposed from the project management team. The PMBoK (2008) and Milosevic (2003) do, however, describe that a project change could be initiated by any stakeholder.

Processes and systems for managing changes like the CMS (Ibbs *et al*, 2011) or perform integrated change control (PMBoK, 2008) do not mention a deadline when to start and to stop allowing change requests. Milosevic (2003) does however describe that project change requests should first be considered at the later stage in the progress of scope definition. In product development projects for example it could be after the first design has been specified. The deadline for stop using project change request is harder to specify. But after the scope freeze only overriding reasons should be considered. Yet, each organisation is recommended to have its own policies when to start and stop allowing project change requests.

Evaluating the change

Change control process or systems should contain at least one step where the proposed change request should be evaluated (e.g. PMBOK, 2008; APM BoK, 2006; Ibbs *et al* 2001). The effectiveness of the review is however crucial since the decision whether the change request should be approved, rejected or deferred has to be taken as quickly as possible in order to minimize the impact. Since a slow decision could generate more impact on cost, time and feasibility of the change (PMBOK, 2008). The APM BoK (2006) points out that evaluating change requests is time consuming which also creates deviation from the project plan. For this reason they suggest that the evaluation should be divided into two steps:

- Initial evaluation

When a change is requested a first brief judgment call should be taken. This evaluation aims to investigate if the proposed change is worthwhile to evaluate more in detail. If not, the proposed change could already in this step be rejected.

- Detailed evaluation

If the proposed change request is worth to investigate more in detail it should be forwarded to the detailed evaluation. In this step the impact of the requested change should be analysed containing the impact on e.g. the projects baseline scope, time, cost and other relevant areas.

Ibbs *et al* (2001) CMS do also have a similar first step of evaluating proposed changes. However, during the first evaluation the proposed change could be accepted directly as a slow decision could add extra cost. In such case an interim approval is necessary. If the proposed change is not that time sensitive a more detailed evaluation in cost, schedule and quality should be analysed. If the change is elective a benefit-to-cost ratio could be used as a guideline for approving or rejecting changes (Figure 3-7). Where the decision ratio is exponential with time since late changes brings unexpected consequences.

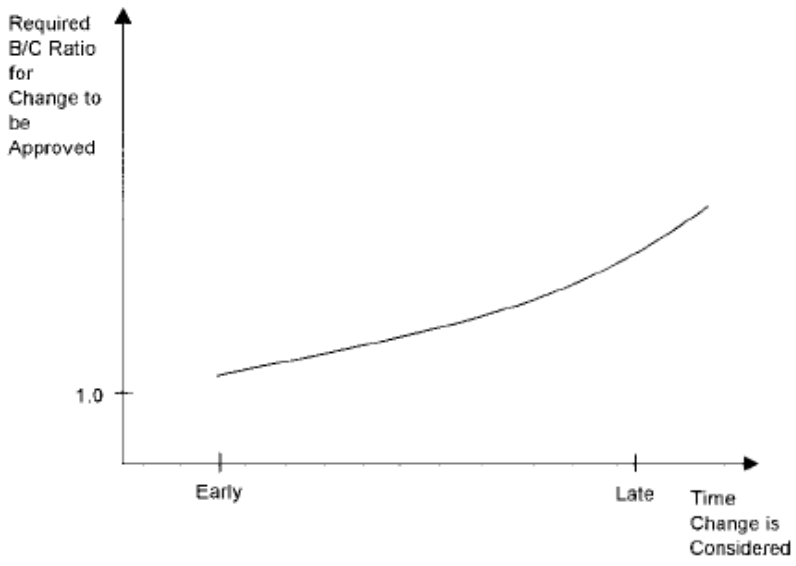

Figure 3-7 - *Benefit/Cost ratio for Elective Change (Ibbs et al, 2001)*

Steffens *et al* (2007) present findings from a multiple-case study within one product development organisation showed that several different decision criteria were used when project changes were evaluated by the project managers:

- *Project efficiency*

Evaluate how the change will have impact on scope, schedule, budget and product quality.

- *Impact on the customer*

This criterion includes both positive and/or negative impact on product performance and specifications to reach the customers' needs and to solve their problems.

- *Business success*

The business success criteria should evaluate how the requested change would affect sales volume and potential profit. Included in this criterion is also time-to-market which was pointed out in Steffens *et al* (2007) research as the criterion most frequently used.

- *Preparing for the future*

How the requested change could impact future opportunities in the market and technology.

- *Project portfolio*

Important to point out in this criteria are the resource dependencies; how the suggested change would impact resources in other projects.

- *Risks*

The last criterion to that has to be evaluated is whether or not the proposed change will generate new risks to the project.

Implement change

Ibbs *et al* (2001) mentions that the most important step in a change management system is the implementation phase. Even though a change has been evaluated and accepted it is important to communicate the project change and document all relevant information so there is no misunderstanding whether or not the change have been implemented or not. This should be done so that the project could avoid mistakes that are caused due to lack of communicating the change. Finally, monitoring an approved change is also important during the implementation phase. Ibbs *et al* (2001) argues that this could help the project to follow up the expected and disputed impact caused by the change.

Lesson learned

Learning from the projects´ mistakes is the last principle in the change management system. Root causes for each change should be identified so that the mistakes could be evaluated. This is important since the project team could prevent similar mistakes from happening again. Discussion among the project team should be encouraged so that the project team could identify and understand these root causes. The lesson learned enables the project team to have a more proactive approach to avoid similar mistakes again (Ibbs *et al*, 2001).

4 Research Method

This chapter describes the research methodology used in this thesis and the rationale for choosing this method. This will be done through a reminder of the focus for the study and how the problem was investigated and finally to justify the chosen research method. Since this research was carried out at Volvo Buses a clarification of the feasibility and limitations of materials and participants will also be presented.

4.1 Research design

The research methodology chosen in this thesis has been a qualitative research design through performing a case study at VBC. Since the main aim for this thesis was to evaluate scope changes in product development projects two projects at VBC was purposefully selected. These projects have been the baseline for the case study and the investigation. Yin (2009) recommends that a case study should preferable be at least a "two-case" design. One case could be enough but the likelihood of performing a good case study increases when using a multiple-case design. Yin (2009) points out that a single-case design could be vulnerable since the researcher risking to not find all answers within one case. However, the advantage of using two cases is the analytical benefits. Making analytical conclusions will be much stronger since it is possible to show both direct replication and contrasting situations from the cases. For this reason two different product development projects at Volvo Buses were selected as described above. The first case representing project 'new seat' and the second case represents project 'hybrid'.

It could be argued that a two case study is not enough for finding enough patterns to answer the research aims. However, the rationale for choosing a case study approach was to find clear examples that could be related and discussed. Due to the time limit, this was seen as the best research design within the given time to really understand the situation at VBC.

4.2 Data collection

In order to investigate the research topic two types of data was gathered. Secondary data was gathered through an extensive literature review. Primary data was gathered primary through interviews and data collection from both white books and other relevant data such as processes that were described within VBC local network. Since the research was carried out within a limited time between February and April 2011 the time was a major constrain for the collecting all data.

Kvale and Brinkmann (2009) describe that 'why' and 'what' have to be answered before the question 'how' could be answered in a research. Defining *why* the research was carried out was not a problem since the research aims already were predefined. Knowledge about the *what*-question could but are not limited to reviewing literature and theory. It is also recommended that the researcher gains knowledge and familiarity with the environment where the research will be carried out. This could be achieved through physical being in the researched environment to understand e.g. the daily routines, authorities and procedures. The researcher will then be more prepared for carrying out the research since it will become easier to understand for example what the interviewees are reflecting upon (Kvale and Brinkmann, 2009).

The approach used for this thesis was quite similar since the knowledge and familiarity with VBC was limited in the beginning of the study. For this reason data that not necessarily was directly related to the main topic was also gathered. This procedure

included e.g. to attend at meetings and investigating VBC Global Development Process and organisation. Even though an approach like this is time consuming it was essential for this research, since this knowledge was a great benefit to understand for example local VBC abbreviations and processes that were mentioned during the interviews and in other data.

4.2.1 Selection of participants

To get as accurate information as possible the interviewees were selected based on their role and experience in the project. Through recommendations from the author´s supervisor at VBC some main persons in each project were selected. This included the CPM for each project and the responsible PAM and project managers from some of the project organisations such as finance, manufacturing, purchasing and quality. Totally five persons were selected for the new seat project and eight persons in the hybrid project. To get validity of the findings also two CPM not associated with the cases were selected.

4.2.2 Interviews

To investigate what scope changes that were implemented in the two cases a semi-structured questionnaire was used, containing questions regarding the causes, types and impacts of each scope change. Also how the changes were managed was asked as showed in Appendix E were the questionnaire could be found.

The purpose of having the same questionnaire for all the interviewees was to get a broader picture of the investigated area from all involved organisations, but also to fill in gaps from each interview. However, the knowledge did vary a lot between each interviewee mostly depending on their duration in the project. For this reason the focus was concentrated on the areas where each interviewee had most knowledge. Typical the answers were related from their point of view and role which had to be taken in consideration when evaluating the findings from the interviews. To be able to compare the findings with a broader perspective at VBC a second part was included in the questionnaire, containing questions outside the two cases to validate the findings.

Since the interviews were carried out by one person it was vital to record the conversations. Yin (2009) states that the best option is to record all interviews in most cases. An exception is when the author does not have the time to go through the audiotapes. For this research it was needed, so that the results could be typed down afterwards. This made it possible to fully concentrate on the questions during the interviews.

4.2.3 Validity

To provide validity of the study several approaches were used. Firstly, the results found during the interviews were appraised depending on the interviewee’s duration and role in the project. For examples scope changes that were implemented before a person’s involvement in the project was considered less valid. Secondly, whitebooks and other sources such as project descriptions were used to validate the findings. But also two additional interviews were carried out with open-ended questions to fill in the gap and giving the study a wider perspective.
Finally, when all data was collected a matrix sheet was used to provide a clear structure over the findings. This made it possible to allocate the data into different rows in order to find similarities and diversities.

4.2.4 Limitation

The chosen research design has some limitations to be considered. Using a qualitative research design is to some extent limited answer why and how (Yin, 2009). So quantifying for example the impact is not feasible when using a research approach like this. However, since the preliminary focus for the report is to understand the investigated area the 'why' and 'how' is more of interest.
Another limitation for this study is that is limited to only the projects´ point of view since product planning and the market organisation is not represented.

4.2.5 Ethics

Since this thesis was conducted at VBC some ethical consideration was taken. Firstly, the report is limited from confidential information. With support from the supervisor at VBC decisions about which information that could be published were taken. So the thesis does only consist of information about VBC and their projects that has been agreed between the author and VBC.

Secondly, before any interviews was executed information regarding the interview and the thesis was shared to the interviewee. This was vital so that the interviewee could decide to participate or not. Finally, the names for each interviewee are not mentioned in the report and all recorded audio tapes were deleted after the data was written down.

5 Results

The results presented are divided into three major areas. The first two subchapters are presenting the scope changes that were identified in project P9310 and P8800. Lastly, the findings from a more general perspective are presented.

5.1 Project P9310 – New seats

N.B., since this project was running during the case study the results following below is limited to only the current status.

The first case is representing project 'New seat' that was carried out to develop a new seat for the coaches within the European market to replace the existing seats that are currently used. The most important targets for this project were to lower both cost and weight compared with the existing targets together with a new improved design. VBC was in this project responsible for designing all visual parts since the project was developed together with a supplier that had the basic construction.

5.1.1 Redesign of design concept

In project P9310 one major scope change was identified during the interviews, including several minor changes to the existing concept design that the project was working towards. Since the design already was frozen at the Development Gate (DG) these design changes resulted in a scope change. Even though it was several minor changes to the existing design the Project Management Group (PMG) saw and managed it as one scope change consisting of all the additions and changes stated below:

- Increase headrest width by 30mm.
- Create new integrated handles in addition to intercity handles
- Redesign the control panel with separate decoration piece
- New designed table version with a cup-holder
- New designed cloth hook
- New seat belt installation
- Volvo logo in all seat backs

There was a common perspective from all the interviewees that this was an elective change since the project and product would have delivered its intended purpose anyway. One person described that it was an elective change since the PMG did calculate the profitability for both options.

The idea of changing the design that already was stated in the project scope was identified after the first customer clinic. This clinic presented the first prototype of the new seat design that the project was working towards. Since the idea was to confirm that the design was accepted by the marketing representatives and customer from vital clusters was invited to the clinic. One of the interviews described that the major reason for having a clinic in this project was that another project at VBC had low customer acceptance of the product. For this reason the new seat project was more or less forced to have a clinic. However, this clinic resulted in poor customer acceptance from some core markets. For this reason the market organisation suggested a change of the design that already was signed at the DG.

During the interviews several persons stated that the design already was accepted from all organisations within VBC including the market organisation and the top management. They had been involved in the development of the design concept and approving it. However, one interviewee stated that it was new persons in the marketing organisation when the clinic was executed compared to the one involved when it was accepted. Another interviewee had a similar explanation and described that this change was proposed because of different personal opinions. Table 5-1 summarize the scope change identified.

5.1.2 The Impact

Mainly all of the interviewees had a common opinion of the impact for changing the design concept. Additional project cost and project time was described as the main impact. The project cost was increased with almost 40 per cent, from 11 MSEK to 15 MSEK. Also the project time schedule was affected with a delayed production start with a couple of weeks. Since the supplier almost was ready with the release of the drawings and ready to order tools the new proposed design forced them to rework. This was stated as the main reason for the increased project cost among most of the interviewees. However, another interesting finding was described during one of the interviews. It was stated that P9310 had to pay an extra charge for all the additions and not only for the rework for the supplier. These additions could to some extent been integrated in the original order that was negotiated with the supplier. Instead the supplier now charged them as additions to the origin start cost.

Except the direct impact in cost and schedule overrun mentioned above an interviewee described an indirect impact of this scope change. This project was scheduled to meet a bus exhibition in end of 2011. However, since the production start was delayed the project will not be able to present more than just a prototype at this exhibition, which could affect the sale for the product.

Project P9310 – New Seat				
Scope change:	**Cause:**	**Type:**	**Time:**	**Proposal:**
Redesign	Increase of customer acceptance.	Elective	After DG	Market organisation

Table 5-1 – *Results from the New seat project*

5.2 Project P8800 – Hybrid

The second case is representing project 'Hybrid' which was an installation project to introduce a hybrid driveline on two bus types including single decker (SD) and double-decker (DD). This project did also contain two subprojects, P3610 and P3615 responsible for the engine and hybrid technology. Time to market was one the main priority for P8800 and the technology complexity was high and unique. However, during the interviews eight scope changes were identified which are presented in chronological order below and are summarized in table 5-2.

Start and Stop

The feature 'start and stop' was decided to be kept in the project scope just after the project had passed the development gate which did result in some new technical solutions that the P8800 project became responsible for. Most of the interviewees saw this as an elective change since the product did not really need this function. During the interviews it was not a clear opinion why this feature was decided to be kept in the project scope. Some interviewees did mention this additional feature would give and more "hybrid feeling". However, it was pointed out that the top management did request to keep this feature even though the PMG did question it. It was questioned since the PMG did forecast several consequences if it would be kept in the scope. This late decision was one of the reasons why it was seen as a scope change despite it was already included from the beginning.

New design

In the beginning of the detailed development phase a new design for the SD bus was added to the project scope. The need for a new design was not mentioned from the start since it was a driveline installation project. Adding the design was seen as an elective scope change from all the interviewees. It was a common agreement that they saw a potential to add value to the product and distinguish it from the rest of the product program.

Remove DPF

The feature Diesel Particulate Filter (DPF) was removed from the project scope just in front of the Final Development Contract Gate (FDCG). Volvo Power Train (VPT) who was responsible for the development of this feature was already behind in the main time plan. They requested for this reason the PMG to remove this feature from the project since they could not guarantee to be ready before the production start.

AC DD

Just before FDCG the body builder for the DD buses requested the project to add an electrical drive pulley so they could install air condition on their buses. Misunderstanding or lack of communication was frequently mentioned as the main reason why this feature was added late in the project. Among the interviewees there were different opinions if VBC was responsible for developing this feature or not. The majority stated that the body builder had committed to developing this feature and then suddenly changed their mind. It was however also pointed out that this commitment was only for the first test vehicle and not for the final product.

ESS heating

After FDCG, when the final contract was signed Volvo, VPT requested to change the original project scope by adding a heating function for the battery. From the beginning it was only stated a need for the battery to be cooled. The interviewees had a common

opinion that VPT had during one field test noticed that the battery performance was much lower than expected. This addition to the scope was seen as required since the project would not have delivered the expected quality of the product.

Limp Home
Due to the new technology of installing a first version of a hybrid driveline the top management was questioning the reliability. They requested late in the final development phase that the feature 'limp to side' had to be changed to 'limp home' to increase the reliability. One of the interviewees clarified that it was because of the PMG ability to communicate the problems to the top management during the project. Changing this feature did result in an additional slave air system that the project team became responsible for developing late in the project. There was a common opinion among the interviewees that changing this feature was elective. However, as it was requested from the top management it was a required change from the projects´ point of view.

Electrical motor
In the middle of the final development phase a decision was taken to replace the electric motor that was used for the air compressor. The project team had worked with this solution parallel with the original concept before the decision was taken to change the concept. One interview stated that the project had not carried out a supplier quality assurance due to lack of resources which was one of the reasons why the required change was identified so late. Among the interviewees this was the most risky decision taken of all the changed scope in the project. It was seen as required for various reasons but mainly because the PMG was questioning both quality and the technical solution that the supplier was offering. But also benefits in lower product cost and weight was pointed out as reasons for taking this decision.

PM Level
Finally, a last required addition to the scope was requested very late in the detailed development phase. One customer had unique requirements for measuring the Particulate Matter (PM) which were tougher than the legal requirements that were specified in the project scope. The interviewees had a common opinion that this added scope was required since this was one of the major customers for the project. One of the interviewees mentioned that the project more or less got forced to undertake this requirement in order to pass the next gate, even though this requirement was not specified in the project scope. However, this requirement resulted in additional work for the project team to fulfil these demands.

5.2.1 The impact

The added and changed scope resulted in several consequences for the hybrid project. The project cost increased in several steps during the project and one of the main reasons for this was the added and changed scope according to the whitebook. According to the interviewees all the scope changes presented above did bring additional project cost for various reasons except when removing the DPF from the scope. This was the only scope change that decreased the project cost for the hybrid project. However, specifying an exact amount of additional project cost for each scope change for this case was not possible according to the interviewees. It was clarified that most of the funding realised during the project included more than just the added or changed scope. Besides the increased project cost the project and product quality were

also affected and the reason for this was well argued among the interviewees. As a result for this the project still has some problems. To clarify the impact and reasons for this in a more detailed manner they will be presented below with examples from the scope changes and additions presented above.

The project cost was mostly affected of the increased workload that each additional scope change brought, which also was pointed out that this specific extra workload would have been the same even if the requirement or feature had been included from the beginning. However, the rework or waste of activities that already had been started was pointed out as direct effects in increased project cost caused by the scope changes. Mainly the features as PM Level, Electrical motor and removing the DPF did result in rework and waste of work. For the additional customer requirement to fulfil the PM Level the project team had to re-measure and reprogram the hybrid parameters that already were done to fulfil the legal demands. It was clarified during the interviews that these extra activities could have been avoided if this requirement had been included from the beginning. Except the additional project cost in man-hours also tools that had been available for the project had to be rented once again. The project cost for changing the electrical motor was also well argued among the interviewees. This was mainly because the project team had worked parallel with both the new and the old solution before a decision was taken. One of the interviewees clarified that it took almost one year from that the idea was discussed until it was implemented. Lastly, some of the additions and changed scope resulted also in quality issues which indirectly resulted in unexpected project cost. The reason for this was mainly pointed out for the additional work to secure the quality issues that the late changes brought.

Similar to the results in project cost the quality issues identified during the interviewees were not only connected with the late changes. One interviewee clarified that most requirements that results in new features will affect product quality whether or not they are included from the beginning, since the probability for quality issues will increase for each additional feature. However, product quality issues directly related to the late scope changes were also identified, especially for the later changes. The main reason for this was that the project quality for these activities suffered for various reasons. Shortcuts, late verification and late answers were frequently used by the interviewees to explain the quality issues that were identified very late in the project. For the ESS heating function the lack of follow-up resulted in quality issues that were notified late in the project. This did result in two campaigns for the project to solve the quality issues on the already released vehicles which also increased the project cost.
Even though most scope changes did result in some kind of quality issue, changing the electrical motor was described to be the worst. Since this change was implemented so late it did not synchronize with the main time plan. One of the interviewees clarified that the production had already started before the test results came back to the project. Also the lack of time to do a proper supplier quality assurance control was one of the main reasons for to the quality issues according to the interviewees. Finally, the project quality for carrying out this activity would have been better if there had been more time and a decision had been taken earlier.

Project P8800 – Hybrid				
Scope change:	**Cause:**	**Type:**	**Time:**	**Proposal:**
Start and Stop	Late decision.	Elective	Detailed development	Top management
New design	Potential to add value/distinguish.	Elective	Detailed development	PMG
Remove DPF	VPT behind in main time plan.	Required	In front of FDCG	VPT
AC DD	Misunderstanding/communication.	Required	In front of FDCG	Body builder
ESS heating	Low battery performance during winter test.	Required	Final development	PMG
Limp home	Increase the reliability.	Elective	Final development	Top management
Electrical motor	PMG did question both the quality and solution that the supplier was offering.	Required	Final development	PMG
PM Level	New unique customer requirements	Required	Final development	PMG

Table 5-2 – *Results from the Hybrid project*

5.3 General view at VBC

In a broader perspective outside the two projects represented above some typical scope changes at VBC were identified. Firstly, additions of product variants to satisfy different markets were seemed to be common among the interviewees. New or changed market demands were frequently described as a reason for this. One interviewee clarified that VBC products should serve so many different markets, and since they all have different demands it results in a lot of market input for each project. Also tenders from potential customers could affect projects at VBC. The market organisation could then ask if they managed to undertake additional variants.
However, also missed or insufficient requirements were commonly mentioned as reason for late addition of variants. One interviewee clarified that the knowledge about each unique market requirement varies and that this results in different quality of the input to the projects, which result in that new requirements are noticed later.

Secondly, decreasing the project scope and removing variants were also seemed to be common among the interviewees. Mainly because the project realises that it cannot deliver the intended scope within the given budget and schedule. The project is then forced to remove variants that will have as little impact as possible on the intended project benefits. Also scope changes of technical solutions were mentioned to be common. For the same reason as with the variants, the knowledge about all markets varies which results in missed requirements. As a result the technical solution is not sufficient in some markets. One interviewee clarified that an example for this could be the cooling system for the engine. Which works in most markets, but due to insufficient market input it could be notified late in a project that some markets need their own solutions.

5.3.1 The impact of scope changes at VBC

The GDP process is structured in a way that the projects at VBC do not have any room for manoeuvre. Both time and schedule are planned in a way that expects everything to follow the original plan. So projects cannot manage additional workload, instead it becomes a deviation from the original plan. One interviewee clarified that this is the reason why almost every project is increasing the budget and schedule. In a broader view among the interviewees' mainly four types of impact were mentioned. Despite increased project cost and schedule also decreased project quality and lack of resources were mentioned as direct consequences of changed or added scope.

The impact on project cost for late changes at VBC was not only mentioned in direct waste of development work in time and cost. Also indirect impact in project cost was mentioned among the interviewees. Material to production start could be affected of late changes which forces the production to use prototype material which is way more expensive and could cause problem for the aftermarket. However, also the approach for projects to undertake late added or changed scope could be affected. One interviewee mentioned that the project team do not have the ability to manage the work in the same effective way when it comes late in a project. The reason for this is that additional features have to be tested separately in new vehicles which indirectly add even more project cost. Other example of this was also mentioned such as the time limitation to really choose the best possible solution. Instead the time restriction could force the project team to stick with what they got.

Despite the project cost also the project quality seemed as a problem related to late changes at VBC. Similar to the hybrid project that is presented above late changes could cause product quality issues. However, one interviewee clarified this problem could be avoided if the production start is delayed. If not, proper quality verification is hard to accomplish since the project team have to verify the new solution separately in a more isolated environment. Another interviewee mentioned that it also could force the project team to carry out the verification to fast due to the lack of time.

5.3.2 VBC approach to deal with scope changes

Even though that amount of scope changes at VBC is seemed as a problem many of the interviewees mentioned that the start cost projects has to be flexible to some extent. The reason for this is that separate PMR and customer adaptations otherwise will be more expensive for VBC than if they are included in start cost projects. One interviewee clarified that shared cost such as the resources for the project management team could be used for these additions as well. Likewise, the opportunity to negotiate with for example suppliers will also benefit VBC since start cost projects have a better opportunity to negotiate due to higher volumes. But also the possibility to evaluate internal issues was stated to be important so that the project is not going in the 'wrong direction'. However, the interval for being flexible did vary among the interviewees so there was no clarity when projects should stop allowing changes. Since some mentioned that it should be acceptable as far as possible meanwhile the others view was to stop allowing changes after FDCG or even DG, depending on interviewee.

Even though VBC have a process for evaluating change requests projects tends to get questions directly to the project. One of the chief project manager clarified that it is important to say no directly to these requests. This will avoid misunderstandings and give time for evaluating requests separately before deciding upon them. Yet, some interviewees mentioned that in the hybrid project changes actually were implemented before they were decided or implemented without their awareness. Firstly, the supplier for the ESS heating were contacted and decided without purchasing organisations awareness, which otherwise should confirm and agree all suppliers. Secondly, the electrical motor was also an example where the change was implemented before a decision was taken.

If a decision is taken by the decision body to change the project scope, information about the change is distributed both through the project group meetings and at the internal project web portal. However, there is no formal change log used containing the scope changes that have been approved after the scope freeze. One interviewee clarified that he had never seen a change log, but that the project description is updated. Yet, a CPM described that he use to update the project description if still in the detailed development phase. After that he uses to add an extra chapter in the project description with the addition or changes to project scope.

6 Discussion and recommendations

This chapter analyses and discusses the findings presented in the result. This is done together with an evaluation of the theoretical frame of reference as a support to answer the investigated research questions.

6.1 Causes and types of scope changes

The situation for the project at VBC could be argued to be quite unique since their customers have so unique demands. One product should serve so many different markets which unfortunately has consequences. As the findings showed from a more general view at VBC many scope changes are caused by new, changed or late market inputs which change the requirements that each project should fulfil. However, the two cases presented in this paper do also show another view of the situation at VBC.

In the new seat project the trigger for changing the scope was the low customer acceptance that was notified during the clinics. This is directly linked one of Joan's (2001) major reasons for the customer´s ability to better specifying their requirements first when they realise their actual needs. Since the seat only had been showed digital before the clinic the customer could actually specify what they really wanted first when they saw the physical prototype.

The reason for the scope changes in the hybrid project did vary. However, some distinctions between the late and early scope changes could be argued. It shows that required changes were more frequently implemented towards the end of the project as illustrated in table 5-1. Only the limp home function was elective but since it was a directive from the top management some of the project members saw this as a required change for this reason. While the start and stop and the new design were the only obvious elective changes that also were implement earliest in the project. The reasons for these changes were mainly influenced by the opportunity to still add value to the project which will be further discussed in the next subchapter. However, the late changes were instead caused by missed customer requirements, quality issues and time restrictions that forced the project team to react through a change in the project scope. Therefore the main reason for these changes were not to bring benefits to the product but instead necessary to secure the intended benefits of the project.

Comparing the situation in the two cases with a broader view at VBC they are not fully representable. Insufficient market input during the early stages of planning and or new market input could to some extent be related to some of the scope changes in the hybrid project. But new tenders and changed market input that result in new variants or design changes is not represented in the two cases. Also decreasing the scope that seems to be common at VBC to keep the project budget is not represented. Removing the DPF was the only decreased scope identified but were caused by time and not budget restrictions.

To sum up, changes of the scope in projects at VBC could vary for many reasons. The limitation of two cases is not enough to clarify a common cause for scope changes. Not at VBC or in other product development projects. It is instead essential to understand that they most likely will be the reality for most projects whether they are beneficial or not. Also to classify a list of types of changes is not possible since it would be too extensive since just the examples shown in this paper contain many different types.

Instead the types of scope changes could be distinguished in *elective* and *required* or *want* or *must changes* as already clarified by previously authors (e.g. Milosevic, 2004 and Ibbs *et al*, 2001). First then a relationship could be argued between what type of change and the reason for them. The elective scope changes in this paper have all been implemented to bring additional benefits to the end product. Maybe to most clear examples are the design changes in both projects. But also the start and stop and the limp home feature did bring more value to the end product. The main cause for implementing the required changes was not to increase the value. Instead they were necessary for delivering the intended benefits of the project which not directly means a higher value of the end product. So a scope change does not have to be trigged only from a new need. For this reason the definition of a scope change used in the introduction by Wallace (2007) does not cover all the scope changes presented in this paper. Instead Read´s (2000) definition of scope changes is more representable for the wider findings.

6.2 Impact and benefits of scope changes

Scope changes in projects at VBC have showed to have significant impact in cost, quality and time. As clarified during the interviews the project has no room for manoeuvre in cost and time. The cases represented in this paper showed two different scenarios how scope changes could affect projects. Since the prioritisation of the two projects was different also impact followed the same pattern. This could be illustrated by consider the constraints (figure 3-2). Since a scope change will add work a project compromise in some or all of the remaining constraints in quality, time and cost must be made.

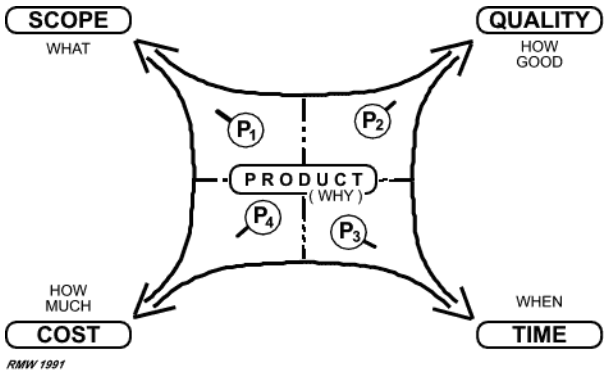

Figure 6-1 – *Scope, Quality, Cost and Time constraints (Wideman, 2010b)*

Time to market was the main focus in the hybrid project which was a directive from the top management. For this reason the project team only had the opportunity to make compromises in cost and quality when adding or changing the scope since the ability to delay the project was limited. The product quality problems that did occur in the hybrid project were for this reason mainly depending on the project quality that the project team had to make compromises in. Especially the really late changes such as adding the ESS heating and changing the electrical motor are clear examples of this, where the time constraint becomes more critical further into the project life cycle and compromises had to be done somewhere else.

The new seat project had different priorities which also showed another view of the effects that caused the project. Product weight, cost and design which could be translated to the quality targets that the project was aiming for. Since compromising around the quality was out of the question, the only option was add to cost and time. In other words deferring the production start and increasing the budget.

The impact in quality, cost and time for the projects at VBC will for this reason vary depending on its prioritisations for each added or changed scope. Allowing the schedule to be deferred could be a solution to be able to deliver the intended quality even if extra work is added to the project. However, the situation for the project at VBC today is depending on the time to market. As mentioned during the interviews buses could already be sold or promised to customers before the release gate. This causes even more focus for the project to deliver in time and limits their opportunity to be flexible in the time constraint.

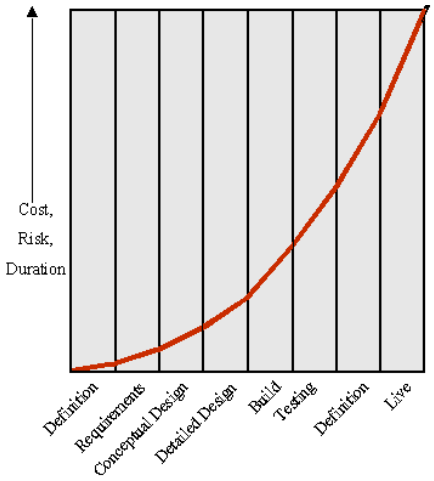

Figure 6-2 - *Cost, Risk and Duration of a project change varies with time (Wallace, 2007)*

In order to understand why cost, risk and duration vary with time as explained by Wallace (2007) also at projects at VBC examples from the two cases could illustrate this. The late request for changing the design in the new seat project illustrates how the cost increased with almost 40 per cent compared with the original start cost and delayed the project with several weeks. The addition in cost was mainly depending of the rework that the supplier did charge the project. For this reason the cost to make the change was sufficiently higher than making the same changes before signing the contract with the supplier. Likewise, if the change had been requested even later when the tooling process had started, the cost for change had been significantly higher due to repurchasing of tooling.
Comparing this situation with the changed scope in the hybrid project gives also another view of how cost of change varies with time. Available resources in both manpower and tools for fulfilling demands in PM Level were not available for the project team when this requirement was added to the scope. Hiring the same resources once again did affect the project with unnecessary cost that otherwise could partly been included when fulfilling the legal demands which were stated from the beginning. Similar, as described in a more general view at VBC that late changes could force the project team to test additional features and functions separately on a new test vehicle. These examples show how the probability for increased project cost varies with time the later the change is introduced.

In the hybrid project not only the changed scope was identified as presented in the results but also additions. However, interesting to notice is that also added scope could be argued to have similar cost impact that varies with time as changed scope. This could be explained trough evaluating for example the addition of the ESS heating feature and the new requirements in PM Level. Both these additions did affect previous work that already had been carried out. For the ESS heating one of the interviewee clarified that the intended delivery without the heating had to be slightly adopted. Similar, adding the requirements for the PM level did not only require additional work, it did also result in waste of work that the project had carried out to fulfil the original legal demands. This is similar to Milosevic (2003) description that the probability for late changes to affect related activities will increase further into a project. For this reason also additions to the scope could result in change of previous work and not only changed scope which is more obvious.
However, the exponential curve that shows how the impact varies with time like Wallace (2007) and PMBoK (2008) do not illustrate how the project quality is affected.

It could however be argued that project quality is included in risk in figure 3-3. Yet, the quality issues that arose in the hybrid project were more than just the risks that the project team had expected. Looking at the results from both the hybrid project and a more general view at VBC some examples why also the project quality varies with time could be noticed. The shortcuts and late verification that are unavoidable when a late change is requested is mainly depended on the lack of time to manage the additional work with the same quality as the original work. But also for example technical solutions that have to be verified in an isolated environment could affect the previously verified solutions and the effect on these may not be notified. Perhaps the worst example of this was the really late changes in the hybrid project such as changing the electrical motor where the production had started before all test results were reported. These examples are directly linked to what one of the interviewee explained as the projects inability to follow the original process.
However, deferring the production start would minimize the product quality related with late changes since the project quality could be kept to some extent. This could be argued to be not realistic since the project cost and other factors will increase sufficient. And carrying out the same field tests again is not realistic due to the high costs as explained during the interviews. For this reason also project quality will vary with time and should be concerned when evaluating the impact of late scope changes.

In order to justify the consequences caused by scope changes also the opportunity to add value has to be considered. It is vital to understand that all scope changes are not always destructive. For early changes the opportunity to add value is much higher than the actually cost to change as explained an illustrated by Wideman (2011b). Adding a new design to the single-decker in the hybrid project shows how a change actually could benefit the project. The small project cost that the change brought was well compensated by the value added to the end product.

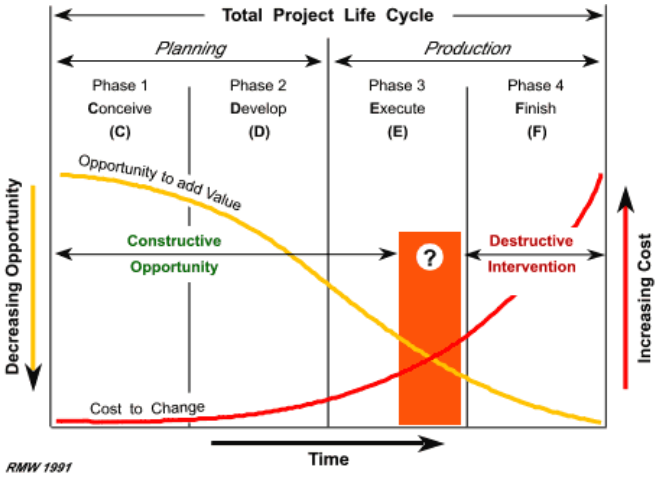

Figure 6-3 - *Adding value vs. Cost to change (Wideman, 2011a)*

However, it is essential to understand that also destructive scope changes are necessary. New and missed customer requirements and quality issues are just some of examples that triggered the project team in the hybrid project to actually change the scope really late in the project. This shows that destructive changes could be forced and actually necessary even though they might not bring value to the project or product. This is related to the distinction between elective and required changes as discussed above. Elective changes should obviously not be implemented during the destructive intervention. For this reason it is vital for project managers to determine whether the

scope change is required or elective. Since requested or identified changes could be rejected if they are elective.
Clarifying exactly where the destructive intervention starts is not possible since it depends on several factors. For example which product development process that is used and other characteristics that are unique for each project, also how much work that are needed and the added value are unique for each change. However, after clarifying with one of the PAM´s a more general view of when the destructive intervention starts in project at VBC. Somewhere around FDCG is the breakpoint for the constructive opportunity to add value to the project. After this gate the production of tooling starts and the cost for making changes increases rapidly. The scope changes in the hybrid project show also problems in quality of the one that where implemented after FDCG, that later indirect did increase the project cost.

To summarize, scope changes will have impact in project cost, time and quality. The later they are addressed the more impact they will have. Allowing the production start to be deferred could minimize the consequences in project quality that otherwise could suffer when more work is put to the project. However, scope changes will have different impact depending on the project prioritisation, so to some extent the impact in project cost, time and quality could be chosen.

6.3 Managing and evaluating scope changes

The situation at VBC today demands that scope changes could be managed. Rejecting all possible scope change is not realistic since required changes must been concerned and managed whether or not they are appreciated. Also elective changes should be concerned for two reasons. They could bring additional value for the project and some of the elective changes will otherwise be carried out separately as customer adaptations or a PMR which will be more expensive for VBC. However, when allowing scope changes after DG it gives contradictory messages to the organization. Since the pre-requisites should freeze at this gate the message of allowing scope changes later will give less respect for the GDP process. This gives in return a vicious circle where adding new needs to the project is seen as okay since 'it was that last time'.

The distinction between elective and required changes should for this reason be clear. Allowing required scope changes is a must and should be considered at all times during the project life cycle. Rejecting these will not only adventure the intended benefits of but could in worst case cause project failure. However, elective changes could be rejected and are not necessary required for delivering the intended benefits even though some of them could actually add value to the project. For this reason it should be a clear deadline when to stop allowing elective changes. It is not possible to have this deadline strict at DG as shown in the new seat project where the customers' ability to actually understand their real need was at the first clinic. Since the prototype build starts in the detailed development phase the feedback should be considered even though it is after the development gate.
Instead at VBC an idea could be to allowing elective changes until FDCG if there is an overriding reason. A similar model as figure 3-7 for deciding upon elective changes could be used to determine what cost-benefit-ratio that is needed for allowing changes until this gate. More uncertain elective changes should instead be rejected even though they might bring a small value to the project since the unforeseeable additional cost is difficult to predict.
Having this clear, not only in the project but also in the organization, is necessary to manage and evaluate requested scope changes not only at VBC but in all product development projects. This could clarify and simplify the decision whether or not the change has to be evaluated. Also the amount of late requested needs could be minimized if everyone respects the deadline and since it actually forces everyone to give their input in time. This is similar to Ibbs *et al* (2001) first principle 'promote a balance change culture' where beneficial changes should be encouraged by the project team if they are addressed in time.

Whether or not the change is required or elective it will have impact on the project and should therefore be managed in the same way. Since scope changes bring additional work it is essential to understand that the project conditions will change as discussed in Chapter 6.2. The constraints in project quality, cost and time are not enough when evaluating the actually impact. Also risks and resources most be considered as they also will influence how well the change will be managed. Understanding the risks associated with the scope change will give the project team a more proactive approach and will insure that also the decision body agrees upon them. Finally, ensuring that the project have enough and right resources for undertaking additional work must be considered. If not, the implementation will be further delayed even if the change actually is approved by the decision body.

Figure 6-4 – *The six project constraints – Based on the PMBoK (2008)*

The most important factors to be evaluated and that have to be approved are for this reasons are the six constraints that the PMBoK (2008) recommends as the basis in all projects. Understanding what actually happens with the five other constraints when adding work through changing the scope is essential. This should not only be considered by the project manager but also cross functional so that all project organization involved could appreciate the impact from their point of view.
Taking fast decision is important since time is the major restriction for projects at VBC. This was pointed out as a key factor by one interviewee when changing the scope. However, equally important is to actually evaluate the impact before taking any decision. Keeping the balance between evaluating and taking a fast decision is therefore important.

As explained in the results some changes actually were implemented before decision was taken. The example with the electrical motor was well argued among the interviewees as they had worked with two solutions parallel for a long time before they got a decision. However, one interviewee clarified that neither the old or new solution was fully prioritized before the decision was taken. The situation was similar with the ESS heating where it was implemented without purchasing´s awareness.
Having a CMS as shown in Appendix A or any other similar process or system will allow that all scope changes will to the right way. VBC has a process for managing larger requests such as new PMR. However, smaller requests such as a change of a supplier could be more clarified if a processes like *change control* or CMS is used. Mainly the CPM was aware how change requests should be handled while some other PM was actually questioning how changes are managed. Even though the aim of this report was excluding to create a new process for VBC, a recommendation is to clarify the process used today. The recommendation is that all scope changes whether they are initiated internal or external have to be documented in a project change request, an example is showed in Appendix C. This forces all requested scope changes to be decided before they could be implemented. Still, evaluating the request is of course essential, and could still be appraised with the same process that is used today. Yet, the central idea of having a project change request available is to ensure that changes are not “slipping between the chairs”.

Keeping a change log of all scope change requests is also a recommendation that projects at VBC could benefit from. Scope changes that are initiated whether or not approved should be documented in a project change log. An example could be found in Appendix D but have to be adapted for VBC. This could be an advantage both during and after the project has been closed. Keeping a log like this could help to clarify which changes that have been requested and their approval status. This suggestion is also based on my data research carried out at VBC where the scope changes were difficult to identify without interviews.

Finally, keeping a clear log for all scope changes after DG and monitoring their progress will also have benefits after projects have been carried out. The log could help both the project team but also VBC as whole to improve in future projects. Evaluating the actually root causes for all scope changes could then be discussed among the project team so that mistakes could be learned and avoided next time. The cause for changing the electrical motor is an example of this. One interviewee explained that the mistakes that caused the change are now used as a lesson learned in the following project to avoid the same mistake again. Having this approach will avoid mistakes from being repeated which could benefit VBC in the long run.

Also learning from the estimated impact compared to the actually impact could result in better knowledge to evaluate a requested change to next time.

7 Conclusion

The finding in this research has showed that scope changes in product development projects could be caused for various reasons. Exploring even more projects at VBC would most likely end up with even more causes. Not only missed requirements during the scope definition did cause the scope changes that are presented in this paper. Time restrictions, quality issues and misunderstandings for just mentioning some could also cause the need for changing the project scope. For this reason it is essential for all project managers not only at VBC but in all product development projects understands that scope changes might be necessary.

Equally important is to understand that whether the scope change is required or elective it will have consequences. The impact depends to some extent upon a projects prioritisation and should therefore be concerned differently. Mainly the constraint in time restricted projects at VBC to undertake scope changes properly. Tight planning and short time to market demands limit the opportunities to absorb scope changes in an effective way. Instead, trade-offs in project quality could be forced to be taken in a typical project at VBC when adding or changing the project scope since it is not possible to only increase the project cost. Also how the impact varies with time is important to understand as a late scope change will have much more impact than if it is addressed earlier.

Realizing this should be concerned by all parties at VBC so that an even more proactive approach could be established. Giving projects more and better input before the scope has been defined will at least avoid some scope changes. However, as some information could be unpredictable a proactive approach is also to encourage beneficial changes if they are address in time. Yet, a clear deadline should been set and could as suggested be to stop allowing elective changes first at FDCG if an overriding reason exist. Required changes should on the other hand be considered during the entire project life cycle. Even though they might not bring additional value to the project they must be considered to fulfil the intended project benefits or to avoid project failure. Having a clear structure how these actually are managed could benefit VBC as it will avoid that they are implemented before decided. This will ensure that all parties are well aware of the change and how it affects them. Fast decision and considering delaying the production is one way to actually minimize their impact. Whether the change is required or elective it has to be carefully evaluated. Evaluating the consequences in the six project constraints should be a basis before taking decision to implement the change.

It is important for all persons that are involved in project at VBC to realize that mistakes and lack of input during the pre-study and concept study did cause some of scope changes presented in this paper. But also mistakes during the project did cause some of the scope changes. For this reason a recommendation is to keep a log with both reason and their actually impact so that each change could be discussed and evaluated after project end. Having this approach could avoid similar unnecessary scope changes from happening again.

Finally, as a last recommendation for all project managers not only at VBC is to be aware that scope changes actually could be a good thing. If there is an opportunity to actually add value to the project without jeopardizing the other intended benefits it should be considered. The new design for the hybrid bus is one good example of this where the project team actually saw an opportunity to add value without risking the outcome of the project. For this reason the suggestion mentioned by Wallace (2001) that

project managers should optimize the benefits generated by the project at all times is worth to consider. In the end it is actually not only about delivering the project within cost and time, it is also to deliver a product that generates most benefits for VBC as whole.

7.1 Further research areas

There are several areas to explorer that surrounds the topic presented in this paper. Systems engineering and product portfolio management were highlighted during some of the interviews as areas where project at VBC could benefit from. Firstly to minimize the frequencies of scope changes that is caused of insufficient requirements. Secondly, that requested changes could be deferred until next product generation.

However, an even more interesting further research is to explorer how VBC or other product development organisations could benefit from having a more flexible product development process. Having a process that actually allows and is adopted for scope changes is perhaps the key for product development projects. Today there are several different flexible processes available that are frequently used in software development project. Agile and Scrum is well explored in those areas but less used for product development project. So, exploring if processes like this could benefits organisations as VBC is an interesting further research area.

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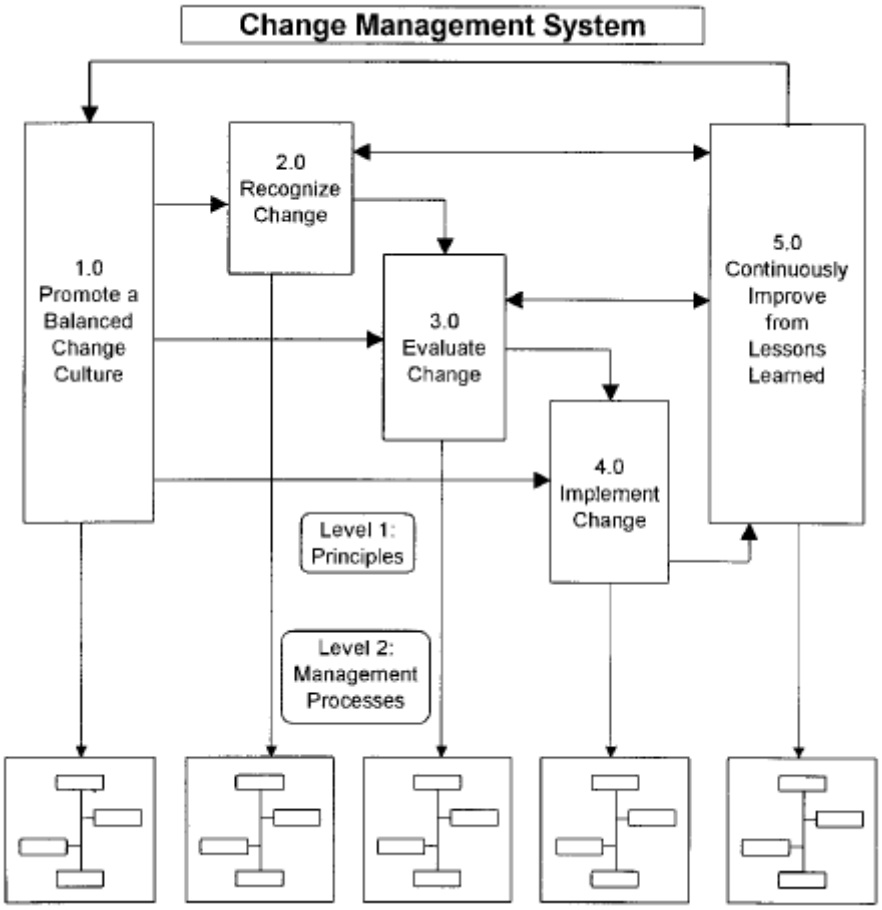
8.2 Internal sources

VBC Presentation (2011) Volvo Buses Corporate Presentation [PDF]

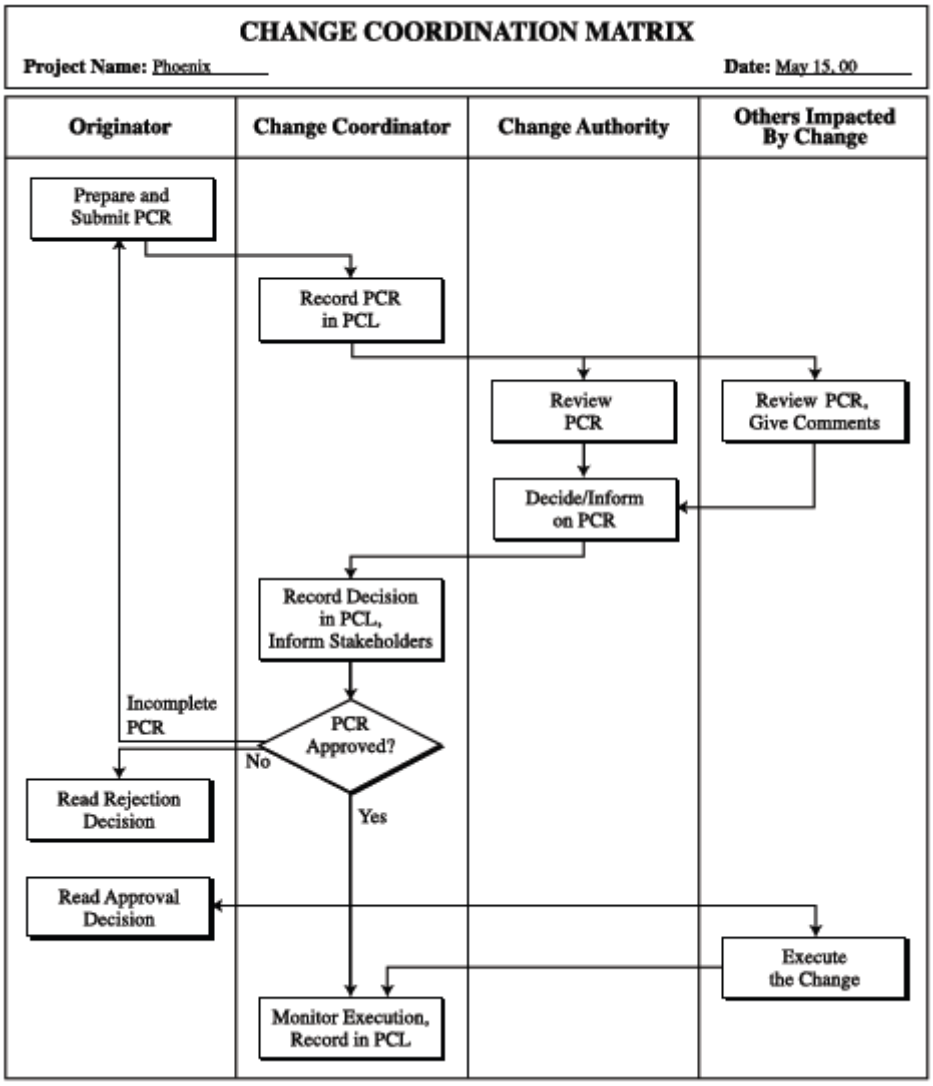
Corporate GDP (2011) 'Global Development Process' [Handbook]

Appendix A



Appendix A - *Change Management System (Ibbs et al, 2001)*

Appendix B



Appendix B – *Change Coordination Matrix (Milosevic, 2003)*

Appendix C

Project Change Request - Template		
Project Name: _____	**Request #: _____**	
PCR originator: _____	**Date: _____**	
Details of change request and their impact or scope/quality:		
Reason for request:		
Type of change:	**Required [ ]**	**Elective** [ ]
Impact on project schedule:		
Impact on project cost:		

Change review boards:	**Approval**	**Date:**
CPM		
GPSC		
GPB		

Appendix C – *Project change request – Based on Milosevic (2003)*

Appendix D

Project Change Log - Template								
Project Name:					**Sheet Number:**			
Project Change Request No.	Submitted By:	Brief description of the change request:	Date of submission	Status	Issue date	Complete?	Change´s Cost/Delay	Project Cost/Completion
# 1								
# 2								
…								
…								
…								
…								
…								
# n								

Appendix D – *Project change log – Based on Milosevic (2003)*

Appendix E

Questions

Date: ……..

Name: …….

Project role: ……..

Duration in project: …….

Part 1 – Project _____

1. Brief overview

- What have been the major milestones in the P9XXX project so far?
- Was there any ‘change management system’ in place before project execution?

2. Project scope changes

- Which scope changes have been implemented in the P9XXX project?
- Were they required or elective?
    - Why?
- When was the need for these scope changes identified?
- When were they decided?
- When were they implemented?

NB. The questions 3, 4 and 5 should be answered per identified scope change in question 2.

3. Impact of project scope changes

- What were the expected consequences of each listed scope change? – Give examples
    - Time
    - Project cost
    - Product cost
    - Quality
    - Risks
    - Other
-

- Which unexpected have you faced so far?

- How did the project team react to the change?

- Knowing the output, could you have done something different in order to minimize the impact of the change?
    - What? Why not?

4. Causes of project scope changes

- Where did the proposal for each listed change come from?

- What was the major cause for implementing this change?

- Did the team make a root analysis in order to find out the causes for each listed scope change?

- Knowing the output, could you have done something different in the project to avoid the change?

5. Implementation of the decided scope change

- Who took the decision to implement the change in the project?

- How did you implement the decided scope changes?
    - Explain the process (Volvo?)
    - What were the major challenges when implementing the scope?

- How did you inform the project team? (CPM)

- How did you get informed? (PM, PAM etc.)

- Were all involved persons well informed about the scope change?

- Were they all informed about the root cause for the change?

Part2 – General project questions

- In general, what are the most common project scope changes at Volvo Bus?

- Are they usually required or elective?

- Is it usually the same cause for implementing these scope changes?

- Do you see any differences of the consequences depending on when they occur in the different phases in the GDP?
    - Give some examples

- How do you evaluate new possible scope changes?
    - Who should be responsible for this?

- What is your perspective of late scope changes is it necessary to be flexible or not?