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Project management:

Case study: Heat treatment test cycle in CLIC

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Project management:
Case study: Heat treatment test cycle in CLIC

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Projektijohtaminen:
Case: Heat treatment test cycle in CLIC

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Tämä opinnäytetyö tutkii Heat treatment test cycle- projektin toteutusta kriittisesti projektinhallinnan näkökulmasta. Projektin toteutettiin CERN:n CLIC-study:n osaprojektina, jossa tutkija työskenteli elokuusta 2010 tammikuuhun 2011.

Heat treatment test cycle on tutkimusprojekti, jossa selvitetään, miten erilaiset muuttujat vaikuttavat kuparikiekkojen ominaisuuksiin lämpökäsittelyn jälkeen. Muuttujina tässä tutkimuksessa on lämpökäsittelytyyppi, paine, lämpötila, lämpökäsittelyn tuottaja ja ennen lämpökäsittelyä tapahtuva kuparikiekkojen puhdistus.

Projektinhallinnan näkökulmasta projektista nousi useita kehittämiskohteita. Näitä kehittämiskohteita analysoitiin opinnäytetyössä ja pyritään tarjoamaan ratkaisuja paremman projektinhallinnan, ja -suunnittelun kehittämiseksi. Osaprojektit toimivat usein väliaikaisen työvoiman turvin ja niitä vetävät ihmiset, jotka ovat töissä jopa alle vuoden. Tämä johtaa siihen, että projektin suunnittelija, alkuvaiheen toteuttaja, loppuvaiheen toteuttaja ja päättäjät voivat kaikki olla eri henkilöitä, jotka tapaavat toisensa vain hetken aikaa, jos ollenkaan. CLIC on myös hyvin kansainvälinen organisaatio, ja kulttuurierot asettavat omia haasteita projektien onnistumiselle.

Asiasanat: kehittäminen, projektijohtaminen, projektinhallinta, projektisuunnittelu

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Abstract

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Project management:
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The purpose of this thesis is to study the Heat treatment test cycle-project, how it was conducted, and to analyse its phases. The project is part of the CLIC -study, which is conducted in CERN where the researcher was employed from beginning of August 2010 to end of January 2011. The heat treatment test cycle -project is a study for finding out how copper plates react to different kinds of heat treatments. Variables for these heat treatments included type of heat treatment, pressure, temperature and producer of heat treatment. The study also included three different types of cleaning methods that were used before heat treatment was done for the disks. This thesis will take a critical view on the project from the perspective of project management.

Several aspects requiring further development arose during the project. These aspects are analysed and tools for better management and better project planning are provided. Subprojects are often planned and conducted by temporary workforce such as students, fellows etc. Therefore it is not uncommon that a project is planned, started, conducted and finished by different people. This highlights the importance of good project management skills. CLIC is also an international organization so cultural differences might play an important role for the success of the project.

Keywords: developing, project management, project planning

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List of Concepts

Milestone

Milestones are statements phrased around a specific outcome. They should be phrased 'The milestone is complete when' <state of achievement> and <measure of quality>

Risk assessment

Risk assessment is the determination of quantitative or qualitative value of risk.

Risk management

Risk management is the identification, assessment and prioritization of risks.

Risk mitigation

Risk mitigation is a systematic reduction of severity and likelihood of exposure to a risk.

Risk register

A risk register is central database for identified risks.

Work breakdown structure (WBS)

A work breakdown structure is a tool for organizing and defining the total work of project.

Work package

A work package is the lowest level of WBS.

1 Understanding projects

There are some characters that are the same for all projects. Richard Jones defines these characters as follows. A project is always temporary. This means that the group undertaking the project does not exist as a whole after the project has been finished, even if completing project would take year. A project is unique activity. If the project is repeated it becomes a process and should therefore be handled as one. (Jones 2007, 5 - 6)

The theory for this section has been chosen from project manager's point of view. It includes information on basic project management, project structure and some helpful tools for managing project.

A project should also have well-defined objectives so that people can understand what the project will deliver, how it is integrated with other projects, and how to prioritize the project against other options and resource uses. The project should also have a defined budget, resourcing and timescale constraints. (Jones 2007, 6)

The project manager takes care of managing the project. Good management is important since this is the only way to get critical information about the project such as how it is progressing as well as receiving information to support making decisions. The project manager gives information about the progress of the project as compared to the initial plan. This includes information such as estimated completion dates for key milestones, estimated overall completion, resource requirements etc. This helps to manage risks and uncertainty linked to the project. (Jones 2007, 8-9)

Project management can be broken down to four key elements: Planning, Organizing, Implementing and Controlling. Within the project there are only four factors that the project manager can alter to achieve desired outcome: Specifications, Quality, Timescale and Resources. These are interlinked and changing one will have effect on the others. (Jones 2007, 7) Adding more staff to the project does not necessarily increase the efficiency of the team. This is due to an increased amount of time needed for communication and coordination and the time a new employee needs to familiarize themselves with the work. (Jones 2007, 120-121)

There are several ways how project can go wrong. If the team is incompetent they do not even know that the project is not feasible or it is going wrong. In the worst case they can even believe that the project is going well. Sometimes the team is scared. This can arise from

the improper handling of bad news. In this case the team has a perception that they will face hostility from the management when telling bad news. If the team has experienced unattainable deadlines or bad communication they might just ignore the goals of the project. A similar situation occurs when the team loses faith in the project. (Jones 2007, 9-11)

A project manager should, according to Pelin (2009, 276), be:

- Skilled in motivating people
- See the big picture
- Willing to take responsibility
- Able to handle stress and solve crisis and problems
- Have excellent negotiation skills
- Able to see risks beforehand and mitigate them
- Determined
- Have excellent co-operation and social skills

Typical vices include:

- Micro management
- Working alone and not sharing information
- Lack of decisions
- Unable to manage own workload
- Technically orientated and forgetting people

(Pelin 2009, 276)

1.1 Taking over a project

If the project has been started but the project manager changes, the new project manager should check if the project is going well or not. The first thing to do is to talk with the old project manager to hear her/his opinion about the project. After that, the new manager needs to talk with team members to figure out how they feel about the project. Following is a chart that should be used while interviewing team members and previous management. (Jones 2007, 20-21)

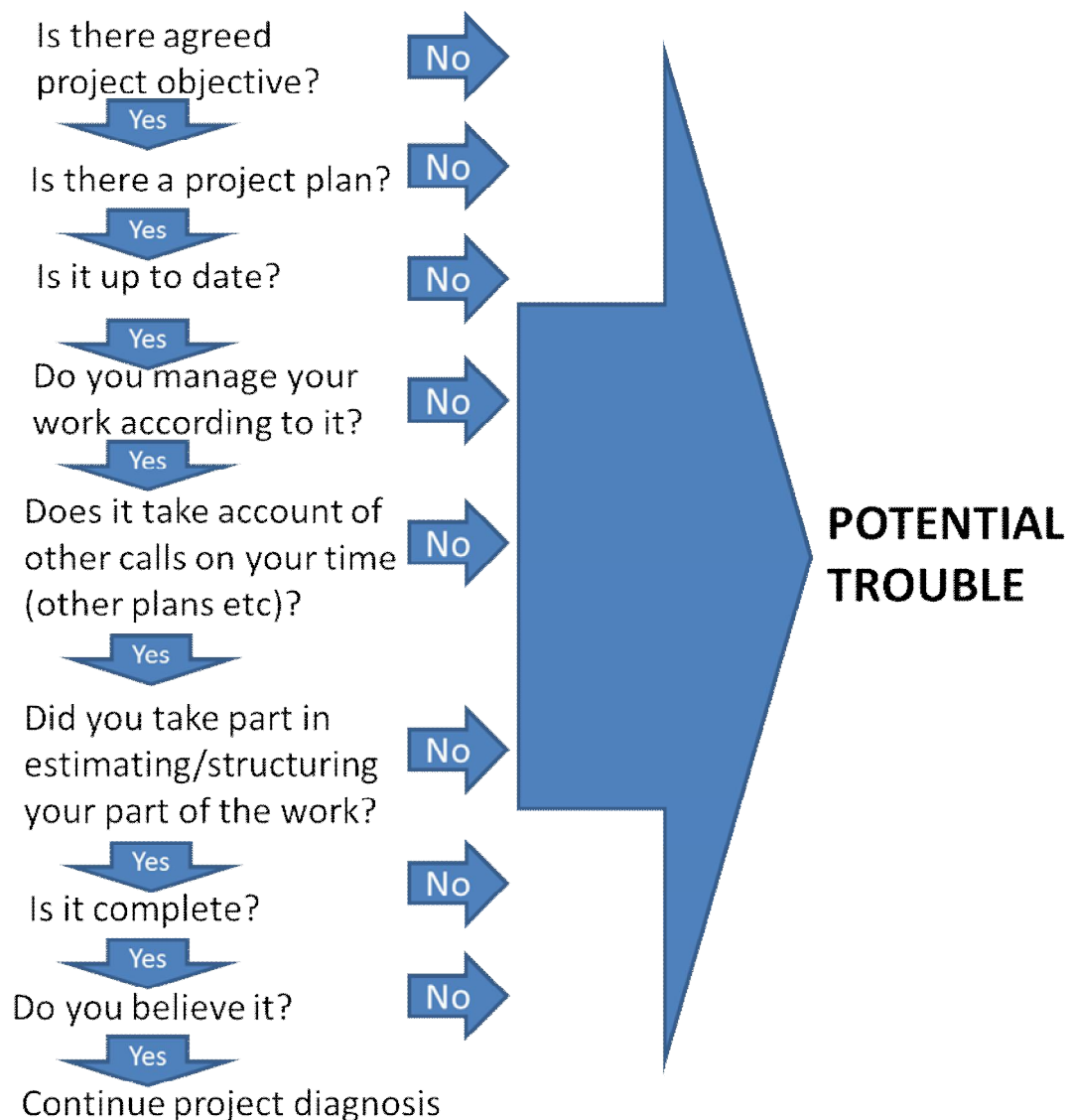


Figure 1: Talking to the project team (Jones 2007, 21)

1.2 Milestones

Milestones are used to create precision and a shared understanding in the project. They are, or should be a specific, measurable, state of achievements rather than actions. Milestones are not about how to achieve, but where to be. There should be around 10-15 milestones per project but if necessary they can have their own sub milestones. (Jones 2007, 66, 68, 74)

For writing a good milestone Richard Jones gives the following structure:

"The milestone is completed when <state of achievement> and <measure of quality>. The state of achievement - this is where you define where the project should be when the

milestone is complete. The measure of quality - this is how you will know the milestone has been met to the appropriate quality." (Jones 2007, 70)

Cooper has developed a so called stage gate process. It reduces the need for senior management to make decisions in the everyday life of projects. This is done by creating criteria that capture the intentions of senior management. This way other people can review the project and understands both the process and the criteria in advance. (Jones 2007, 71-72)

Milestones should be illustrated in a diagram. This helps to spot points when special attention is required such as handovers. Creating a result path also helps evaluate the usefulness of chosen milestones. (Jones 2007, 76-77)

PROJECT NAME			DATE	
DATE	Research R	Development D	Engineering E	Milestone Statements
	R1			R1 is completed when <state of achievement> and <measure of quality>
		D1		D1 is completed when <state of achievement> and <measure of quality>
		D2		D2 is completed when <state of achievement> and <measure of quality>
	R2			R2 is completed when <state of achievement> and <measure of quality>
		D3		D3 is completed when <state of achievement> and <measure of quality>
			E1	E1 is completed when <state of achievement> and <measure of quality>
			E2	E2 is completed when <state of achievement> and <measure of quality>
		D4		D4 is completed when <state of achievement> and <measure of quality>
			E3	E3 is completed when <state of achievement> and <measure of quality>

Figure 2: Result path with milestone statements (Jones 2007, 80)

1.3 Work breakdown structure

The purpose of the work breakdown structure is to divide the project in to smaller pieces. This helps in allocating resources and it is easy to see what work contributes to which milestone (Jones 2007, 86). Milestones are divided in work packages and each work package is divided in more detailed tasks. In a technically difficult project there can be an added

alternative work package that can deliver the same results for the milestone. The smallest tasks should take no less than half a day to complete. (Jones 2007, 87-89)

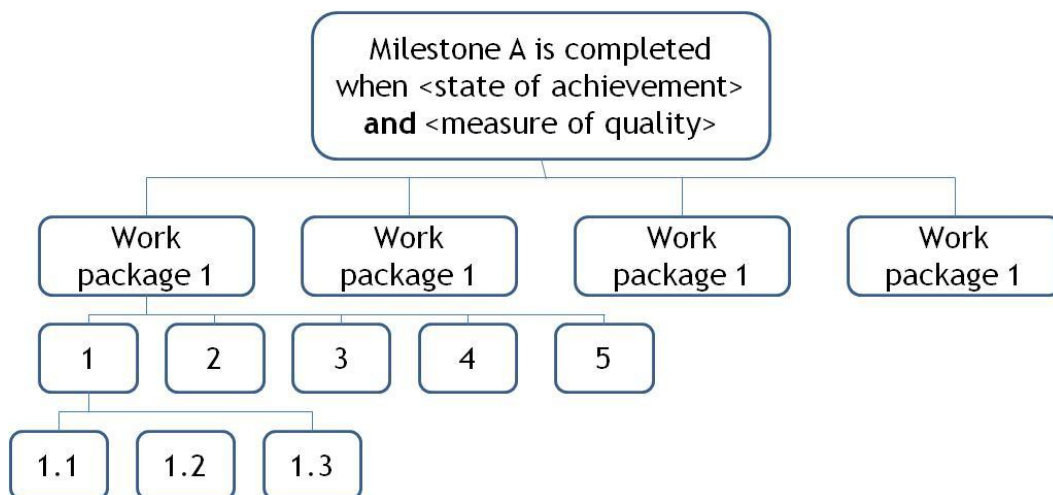


Figure 3: How the work packages are completed to deliver the milestone (Jones 2007, 88)

Creating a work breakdown structure supports the planning process. The benefits according to Richard Jones for the project team are the following:

- “Assign responsibilities within the team
- Allocate tasks to specific resources
- Estimate time against each task to help understand the overall timing within the project
- Create a budget for the project
- Provide a structure for monitoring and reporting progress against budgets
- Predict spend to the end of the project/milestone
- Recognize and understand problems within the plan” (Jones 2007, 89)

1.4 Assigning resources by role

It is useful to create a chart showing the roles of people working with individual tasks. Jones provides the following example:

A is available for Advice

C must be Consulted

D makes decisions with others

D makes a Decision alone

I should be Informed
 P manages Progress
 T provides Tuition
 X eXecutes the work

	Project manager	Systems Manager	Client	Test Team	A. Mutrib	G. Murad
Create high level specification	A	I	C	X		
Develop unit test strategy				X	C	
Define systems test strategy			I	X	C	A

Figure 4: Example assignment of resources by role (Jones 2007, 97)

1.5 Time estimation

Time estimation should be done with the people involved in the project. Time estimates should be revised during the project and therefore the whole team must be committed to it (Jones 2007, 101-102). It is important that the estimates, assumptions and methods used are recorded. This way it is easier to make more accurate estimations next time. (Jones 2007, 111)

Time estimations should be based on the work content. That is how long it would take to complete the task if working uninterrupted from 8am to 4pm. There are several techniques to produce better estimates. Inexperienced team members should find help from senior team members. You can also assess the results of previous projects. (Jones 2007, 107)

More complex estimations can be done as follows:

$$\text{Estimate} = (\text{opt. events} \times \text{opt. dur.}) + (\text{pess. events} \times \text{pess. dur.}) +$$

$$\underline{(\text{most prob. Events} \times \text{most prob. Dur.})}$$

Total number of events (opt. + pess, + most propable)

Figure 5: Using historical information for estimating work content (Jones 2007, 111)

1.6 Resource availability

When the work content is defined the project manager needs to define how long it takes to perform the given tasks. For a quick and rough calculation in larger teams you can assume that 70% of the working hours of team members are actually productive (Jones 2007, 115). The rest of the time goes to holidays and interruptions such as coffee breaks, meetings, chatting etc. This naturally applies only to those cases where the team members are committed to only one project. Therefore the duration of completing the task would be:

$$\text{Duration for task} = \frac{\text{Work content (days)}}{0.7(\text{availability}) \times \text{Full Time equivalents committed}}$$

(Jones 2007, 115)

For more accurate estimations the project manager needs to look more closely into holidays, compulsory meetings etc. In making estimations the project Manager cannot count on people working beyond contracted hours even though it would be common practise. (Jones 2007, 114-116)

1.7 Roles and responsibilities

The project manager is the centre of the project. The project manager should have all the same skills as a regular manager and more depending on the type of project at hand. The project manager needs to organize the project and choose the right people for the team. Project manager is also responsible for motivating the team, distributing and supervising tasks. (Pelin 2009, 273)

The project manager's responsibilities according to Jones are:

- "Assigning work directly to the project team member or to work package managers.
- Maintaining the top level plans by:
 - Ensuring the team is providing regular progress updates;
 - Integrate updates from the team at the work package and task level as appropriate
- Taking a global view on the project to:
 - Solve problems as they arise
 - Ensure risks are identified and managed within the team

- Negotiating with the resource managers (people, funding, equipment, facilities) to secure resources for the project
 - Providing update and sufficiently detailed project plans and responsibilities to the team
 - Providing regular management report summaries:
 - Progress against the milestone plan
 - Cost versus budget (actual and predicted to end of project)
 - Significant risks and mitigation actions
 - Potential 'show stopping' problems
 - Progress against gates (where the company has a 'stage-gate' process)
 - Providing feedback on team members' performance for their evaluations
 - Maintaining the motivation and belief within the team
 - Keeping the project sponsor involved, informed and hopefully supportive of the project"
- (Jones 2007, 167-168)

Work package or module managers are used especially in larger projects or with outsourced parts etc. They update their parts of the plan and provide key dates and key information on progress, new milestones etc. to the overall project manager. They identify and mitigate risks and ensure that their team members have understood their given tasks and executed them.

(Jones 2007, 169)

Project team members are usually assigned to execute some specific work. Team members are vital for keeping the project realistic. They should find errors or gaps in the project plan and inform the project manager about them, identify the risks and update the work plan as they complete their tasks.

(Jones 2007, 169-170)

1.8 Risks and mitigation

"Risk management is the process of identifying and categorizing potential risks and then defining actions to mitigate these risks." (Jones Jones 2007, 136)

Thorough planning can eliminate many of the risks caused by confusion or poor estimation. However during the project unexpected changes will happen sooner or later. Therefore it is useful to identify risks and to determine which ones need to be managed and how. (Jones 2007, 136)

Risk management starts with four simple steps:

1. Identifying potential risk.
2. Recording risk
3. Classifying risks against probability and impact
4. Mitigating potential impact

(Jones 2007, 138; Pelin 2009, 227-230)

There are two types of risks. Certain risks are ones that will happen during a project and uncertain ones may, or may not, occur at some point (Jones 2007, 138).

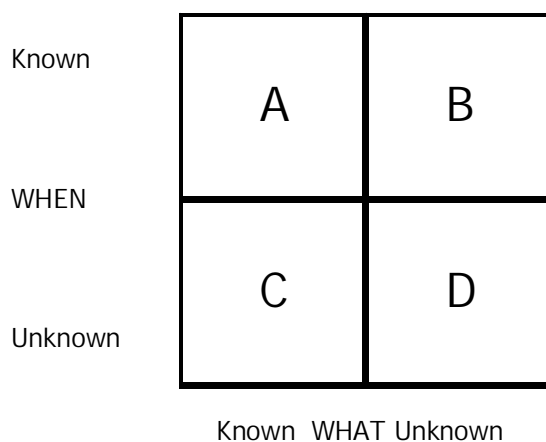


Figure 6: Types of risks (Jones 2007, 138)

Identifying risks should happen throughout the project. Risk should be recorded in the risk register, shared with the team and managed. (Jones 2007, 139)

1.9 Risk assessment

Risk assessment should be done on the impact and the probability of risk. (Jones 2007, 139)

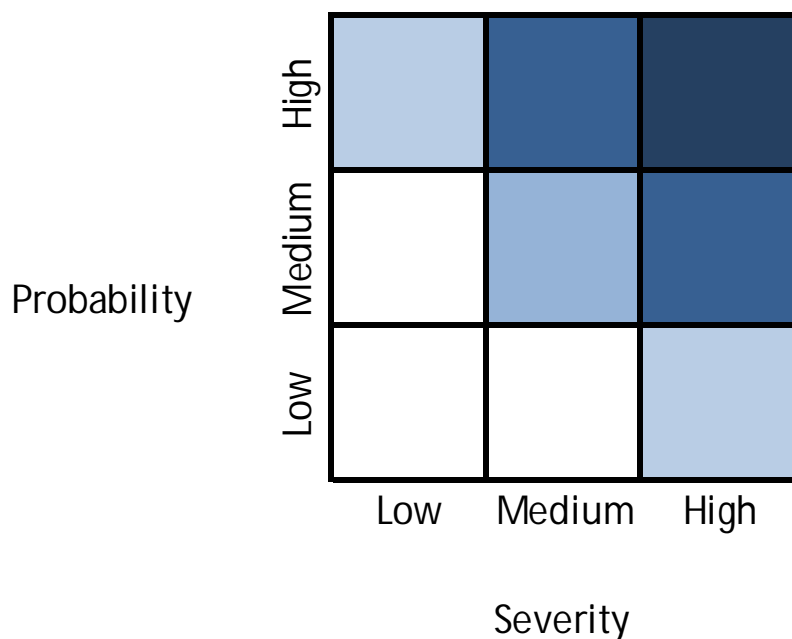


Figure 7: Severity of risks displayed against impact and probability (Jones 2007, 141)

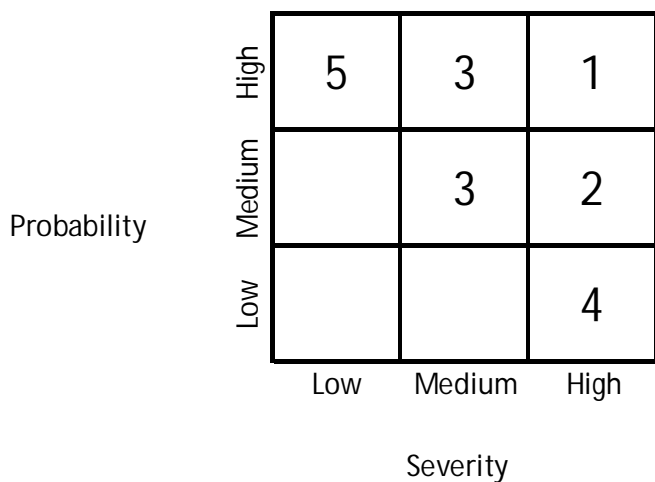


Figure 8: Order of tackling risks sorted by probability and impact (Jones 2007, 141)

A risk that is both probable and can have a severe impact should be dealt with first. After that risks should be recorded on risk register. The risk register is composition of ratings for risk, probability and time. Each factor is rated from 1-5 and the overall score is used to define the order for risk management. Rating for time is calculated by dividing the project in to five parts and the first "time slot" is rated highest and so on. (Jones 2007, 140-142) The risk register should be reviewed at weekly meetings and be part of the status update. (page 147)

		A	B	C	= A.B.C		
		Time					
Rank	Problem Description	Impact 1-5	Probability 1-5	urgency 1-3	Score 1-75	Resp.	Action
1	Failure to secure WiMAX mast site contract	4	5	3	48	HAJ	Seek second source of mast sites from international broker or local GSM companies
2	In building penetration below 'calculated' levels	5	4	3	40	KGS	Carry out field trials with three potential vendors in 'real world' conditions
3							
4							
5							

Figure 9: Example risk register (Jones 2007, 142)

1.10 Risk reduction

Risks can be reduced by trying to find ways to completely avoid them. When this is not possible one can build contingency by starting parallel work that delivers the same result, apply more resources to work or carry out more planning to improve the accuracy of estimates. (Jones 2007, 147)

1.11 Reporting

Reporting should happen on a regular basis e.g. monthly or weekly. Reporting should also be done also to the team members so that they can see the effect of their work and how it fits to the wider context. Report updates should include:

- Current status and reached milestones
- Significant events
- Updated timetable
- Performance against the budget
- Risks and mitigating factors
- Quality of work
- Suggestions for further actions

(Jones 2007, 201; Pelin 2009, 308)

It is not always a good idea to provide a full detailed report to the upper management for the simple reason that they will not have the time to read and fully understand the report.

Therefore it is important to provide them with meaningful information. According to the size and complexity of the project the following information should be included. (Jones 2007, 202)

- "Project name
- Project objectives
- Project milestones
- Achievements in month
- Last tollgate passed
- Predicted date of next tollgate
- Last milestone passed
- Predicted date of next milestone
- Important upcoming activities
- Initial project budget
- EVA summary
- Budget spent
- Budget predicted to end of budget period
- Budget predicted to end of project
- Risk list
- Progress on previous risks - management actions
- Key problems
- Decisions required by the project team
- Next team meeting
- File location of key documents"

(Jones 2007, 202)

1.12 Project plan

Every project should have a well defined project plan. The project plan is a tool for managing projects but it is mainly defined for the projects' own sake. If a project plan is well defined, it can be used as a contract between parties included in the project. (Silfverberg 2007, 74)

Silfverberg (2007, 74) lists three questions that should be answered in a project plan:

- 1) Why is this project set up? What are the goals of the project? How to evaluate the goals and the progress of the project?
- 2) What is the purpose of the project? What kind of results are expected and how can the goals be achieved?
- 3) How is the project carried through?

Long and demanding projects can be broken down in to smaller projects. Sometimes it is reasonable to divide different parts to different projects e.g. developing software and training people how to use it. (Silfverberg 2007, 75)

The most essential goals of the project should be defined both quantitatively and qualitatively. The implementation model, work plan and executive organisation should be derived from the goals and results. When the resources are well described in the budget and financing plan can be made based on that. (Silfverberg 2007, 75-76)

Below is an index for a project plan. Some of the headlines can be emerged especially if the project is short.

Summary

A project plan should always be accompanied by a summary. The summary should include basis of study, objectives, the key points of implementation and the roles and responsibilities of parties. (Silfverberg 2007, 78)

Background

“At the beginning of project plan there should always be background and purpose of project. A development project should also contain the purpose of the project: what is the underlying problem or what is the new innovation project is based on. A research project should also have the research problem attached. This is also the section where the project is linked to other programs, wherewithal etc.” (Silfverberg 2007, 78)

Stakeholders

Beneficiaries are divided to immediate and definitive beneficiaries. Definitive beneficiaries are usually people that the project is aimed for and/or end users. Immediate beneficiaries are usually other stakeholders, who also benefit from the project even though the project is not aimed for them e.g. team benefits from improved methods on tackling the problem. (Silfverberg 2007, 78-79)

Other stakeholders can include e.g. institutes that benefit from the knowledge transfer or companies that develop their processes.

Beneficiaries should be well defined so that goals, needs and evaluation methods can be set the best way. Sometimes in scientific research projects beneficiaries are unclear and the project is performed only to produce new information. (Silfverberg 2007, 78-79)

Objectives and Indicators

Objectives should be clear and concrete. Stakeholders should be devoted to the objectives. Goals should be ambitious but realistic. Follow up of progress and evaluation of objectives should be possible. Reaching of targets should not depend too much on external factors. (Silfverberg 2007, 80-81)

Each objective should be accompanied by quantitative and qualitative indicators. These indicators are the most important tools for the project manager. Using these indicators enable the study and verification of the impact of the project. Good indicators are responsive to changes, reliable and practical to use. (Silfverberg 2007, 82-83)

Usually objectives can be divided in two categories. The first one is called a development objective and second one immediate objective. (Silfverberg 2007, 76)

Milestones

Milestones are statements phrased around a specific outcome. They should be phrased 'The milestone is complete when' <state of achievement> and <measure of quality> (Jones 2007, 74)

Outputs/Results/Deliverables

Expected results should be loosely defined. Defining them too strictly can cause damage to the implementation of the project. (Silfverberg 2007, 86)

Implementation Strategy

Due to its importance implementation strategy should have its own chapter. Implementation strategy includes: project steps, main stages and how they are linked to another. Usually it is presented as a project chart. (Silfverberg 2007, 87)

Work Plan/ Action Plan / Operation Plan

The action plan describes the concrete steps that the project requires, how much time is required to complete each step and how the steps are linked together. (Silfverberg 2007, 88)

Inputs/Resources

Resources needed for the project can include personnel, material, machinery, travelling, services, managing, rents etc. This chapter should also describe how the needed resources are acquired and who is responsible for them. A listing of the resources is used for creating the budget and convincing financiers.

(Silfverberg 2007, 89)

Budget and Financing Plan

The budget and financing plan is done according to chapter resources. Each sub projects can be set as individual cost pools. Of course each cost pool should be coherent with another. (Silfverberg 2007, 90)

Institutional Framework, Project Organisation and Management

Roles and responsibilities of different interest groups should be well defined at an early stage of project. This helps to prevent problems that may emerge later on in the project. (Silfverberg 2007, 90)

Risks and Assumptions

The success of the project is not linked only to the project itself but also to external factors. The risks of these external factors can be minimized by closely studying the risks. Risk analysis includes estimation of likelihoods and the effects of risks. Assumptions are those external factors that the success of the project is based on. (Silfverberg 2007, 93)

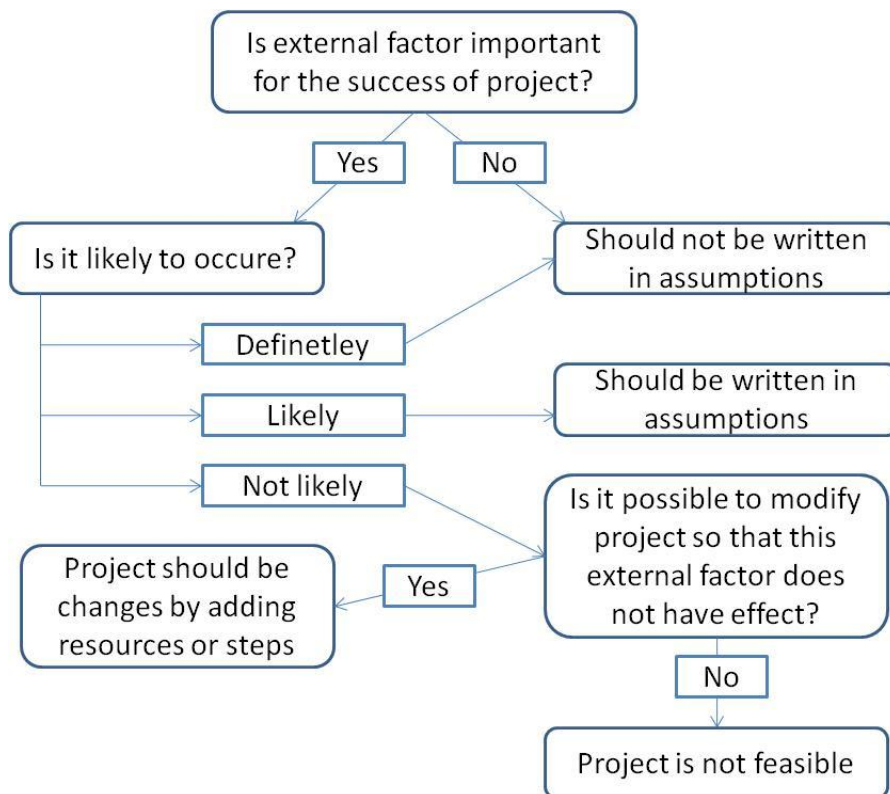


Figure 10: Defining assumptions (Silfverberg 2007, 94)

Monitoring, Evaluation and Reporting

The project plan should also include information about how monitoring, evaluation and reporting will be done. At least it should have a schedule of reporting and their content. (Silfverberg 2007, 95)

Communication Plan

Every project should have a plan on how results are published and how other gained information is distributed. There should also be a timeframe and course of action. (Silfverberg 2007, 95)

Appendixes

Appendixes can include distinct documents such as:

Summaries

Job description of key employees

List of reports

Large budgets and action plans

(Silfverberg 2007, 96)

1.13 Ending the project

The project has a temporary organization and when the project is finished it should be closed down. Projects might be closed down before the project finishes because it fails to meet milestones, there are technical failures, the project is no longer profitable etc. Whatever the reason, it is important to close the project down properly. (Pelin 2009, 355 ; Jones 2007, 203).

All the documents should be filed in the project folder. Documents can be divided to management documents and technical result documents. These should be separated if possible. Contracts, juridical documents and accounting should be saved in a fire-resistant vault. Documents that are to be filed should be chosen so that they are useful for the implementation of the project results and for learning from the project (Pelin 2009, 360)

The project manager writes a closing report, which is presented to the project steering group. At this point all the work such as documentation and filing should be completed. The closing report includes a review of meeting milestones, how the work was done, success in following schedule and budget, problems encountered during project and solution to them. If there are actions that need to be taken they should also be included in the report, along with who is going to take these actions and how. It is also useful to have a list of all the people that have worked within the project and their contact information. (Pelin 2009, 364-365)

During the lifecycle of the project the project team members might have become a closely knit team. Some people might have difficulties coping with changes or they might have angst for the future. The project manager can help the team members to deal with these problems by finding a new project for the team members. Jones suggests that the project manager would take time to write about project to, for example, a newsletter and point out the lessons learnt and contributions from team members. (Jones 2007, 204)

2 Introduction to case environment

2.1 CERN

CERN is the European Organization for Nuclear Research and is one of world's leading centres of scientific research. CERN was founded in 1954 and is located at the Franco-Swiss border near Geneva. (CERN 2011)

CERN is run and financed by 20 European member states. These member states are: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom. Other states are also involved in CERN activities and scientists come from all around the world. Member states are represented in the CERN Council. Some states and international organizations are Observers and they can attend Council meetings but cannot take part in the decision-making. (CERN 2011)

The highest authority is at the CERN Council. It controls CERN's activities, approves budgets and reviews expenditures. The Director-General is also appointed by the Council and he manages the Laboratory. The council is assisted by the Scientific Committee that is composed of people elected by their scientific eminence and the Finance Committee that has representatives from national administrations. The current Director-General is Rolf Heuer. (CERN 2011)

CERN employs around 2400 people and receives some 10 000 visiting scientists that represent over 600 universities and 113 nationalities. (CERN 2011)

CERN hosts also the world's largest and most powerful particle accelerator Large Hadron Collider (LHC). It consists of a 27 km ring buried in the ground. In the accelerator two beams of particles are accelerated close to the speed of light and collided with one another. The beams travel in an ultra-high vacuum in order to avoid colliding with gas molecules. The beams are guided using magnetic fields that are generated using superconductive magnets (CERN 2011)

2.2 CLIC

CLIC stands for Compact Linear Collider. CLIC is a study for a future linear electron-positron collider within a new energy range unreachable with current particle accelerators. Unlike the LHC, CLIC will run in room temperature. This is due to the fact that superconducting technology is fundamentally limited to lower gradients than the ones CLIC will require. To optimize the production of components and to lower the costs, CLIC has a unique two-beam-acceleration concept. The two-beam-module consists of a drive beam that runs parallel to the main beam. RF-energy from the drive beam is extracted and transferred to the main beam using special power extraction structures (PETS). (CLIC study 2011)

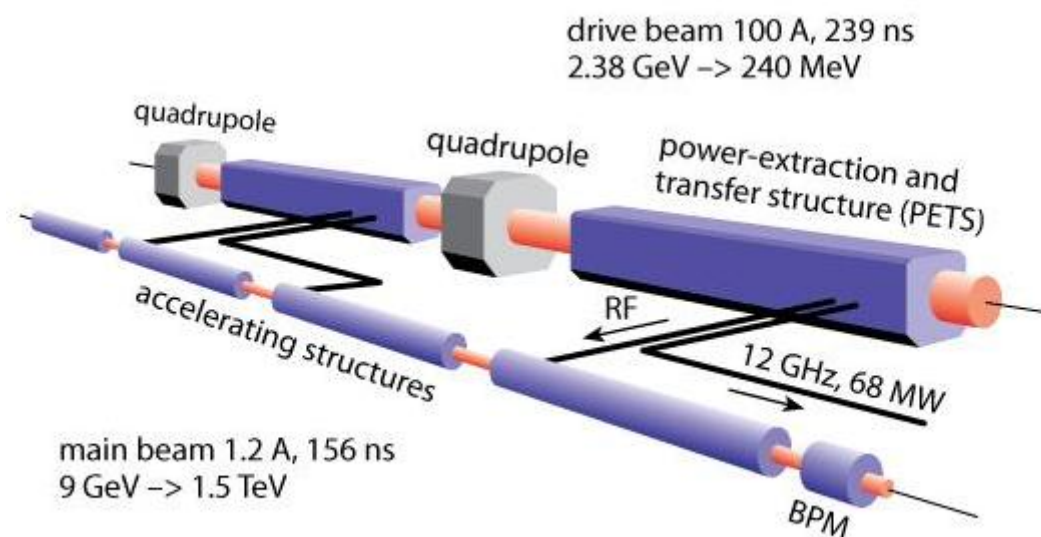


Figure 11: CLIC module layout (CLIC 2011)

Several technical difficulties need to be solved before CLIC can be built. The CLIC study webpage lists the following technical challenges:

- the efficient generation of the high-intensity drive beam
- the Power Extraction Structures generating the required power
- the 12 GHz accelerating structures capable of producing the requires gradient at a low rf breakdown rate
- the generation and preservation of a small emittance main beam
- the focusing of the beam to nanometre beam size
- the precise alignment of the different components



Figure 12: CLIC&CTF3 collaboration (CLIC study 2011)

There are 41 institutes from 21 different countries involved in developing and testing theory and technology. (CLIC Study 2011)

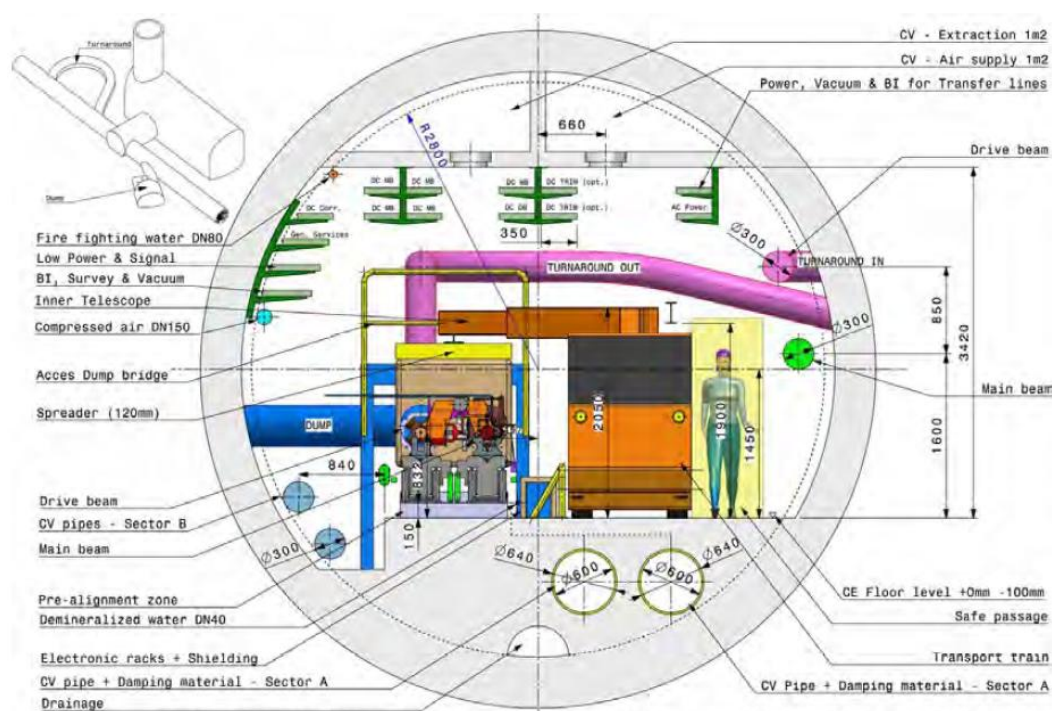


Figure 13: CLIC tunnel typical cross section (Aicheler 2010, 5)CLIC tunnel typical cross section (Aicheler 2010 p.5)

3 Heat treatment test cycle study

In my thesis I will look into the Heat treatment test cycle study conducted in CLIC and analyze the planning and implementation from the point of view of project management. I will also present the current state of the project as well as the outlines of technical content. I will also compare the study and how it is conducted to available project management literature.

The purpose of the Heat treatments test cycle study is to study and investigate changes that different cleaning methods and heat treatment procedures have on copper disks. The study is performed in CERN under the CLIC study and it is performed on disks that are made out of 99.9% copper. All the disks were ordered from the same producer (Institute A) to standardize possible variation to company, heat treatment method and cleaning method. For the same reason all the cleaning procedures were performed at CERN.

The study can be divided roughly to four separate phases. The first phase was included in the the background investigations where different cleaning methods, heat treatment types and collaborative institutes and companies were chosen. This phase included actions such as call for bids, charting useful experiments and creating naming standard for the disks. The second phase involved executing the first phase. This included making and receiving orders, performing cleaning, sending and receiving orders from/to companies and institutes for heat treatments. The third phase started when the disks arrived for the second time to CERN. Now the disks were divided between different tests and testing was carried out. The final fourth step is presenting results, taking necessary actions and making conclusions. The final step partially overlaps with the third one since not all the tests concluded at the same time. This is due to differences in scale, depth and complexity of tests. There has also been a mismatch of resources and unforeseeable changes in the project.

There are 7 different firms, institutes and universities involved and they will be hereafter referred as Institute A, Institute B etc.

When I started working with the study it had already been launched. Outlines of the project had been defined but several details were undefined and the project structure had been poorly established. In this section I will try to define what the project was about, how it was done and what are things that should have been done better. An early estimate for project completion was October 2010, but since then the project has been prolonged and when I left the project at the end of January 2011 the testing phase was still unfinished.

3.1 Planning of the project

The planning of technical details was done somewhat properly. The tests to be executed had been chosen and the people responsible for doing them had been informed if not committed for tests. However some of the tests were cut short and some even 'postponed'. The reason for this was that the people responsible for certain tests saw that no new information could be extracted if the tests were carried out at full scale. In other cases people could not commit their resources for performing the tests at full scale. It seemed like no thorough discussion of the tests had been done and the decision to carry out tests was done only for the sake of performing tests.

For Scanning Electron Microscope (SEM) inspections we had 128 disks and when the tests started the researcher was asked to do it only for the "representative" part of the disks. With some extra resources it could have been done to all of the disks. Detailed plan of how to conduct the tests, what features to look for and what kind of methodology to use had not been done before tests begun.

Assessing the resources was done so that most of the people conducting the tests did acknowledge that the tests were coming up. If there were plans for allocating resources such as time, they failed due to the delays on heat treatment of disks. The general assumption seemed to be that the study was to be conducted when one had time off from other duties. This shows a lack of general planning of the workforce and lead to an insufficient use of workforce.

The work breakdown structure was done at a general level. This means that outlines of the project had been defined and the project had been approved. However the project had been started before detailed planning of the project. This factor combined with the change of the project manager lead to a situation where no one had a clear view of the project, where it was heading or how it could be reached. Roles were badly defined and they had not been clearly set out or written down. The project group did not hold regular meetings nor did they have the feeling of working together. Also many of the group members were burdened with other work of a more pressing nature.

The project lacked risk register. Many risks did occur and there was no prior plan on how to deal with new situations. These situations included at least: change of personnel, delay of delivery, lack of skilled workforce, breakdown of machinery, delays on calibrating new machinery, personal chemistry, cultural differences, lack of resources at one end and splurge of resources at other, language barriers.

By composing a mitigation plan many of these risks could have been prevented or at least made less severe.

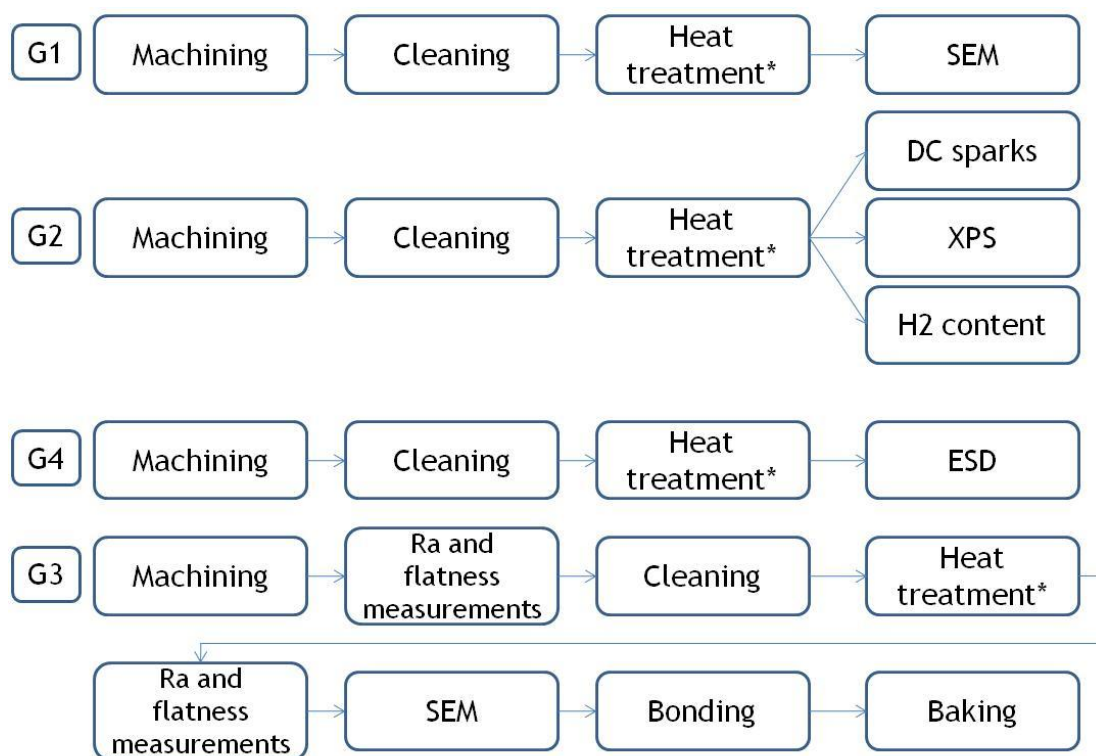
Reporting was done once a week at a weekly meeting. This meeting was also used to somewhat plan ahead the project. The problem was that during these meetings the whole group was not present and there was only little time for project planning. There was little or no time for face to face informal discussions with group members.

As said before the project plan was more an overview of the project instead of a detailed project plan.

3.2 Work breakdown structure

The work breakdown structure is based on milestones. Milestones were not defined as <state of achievement> and <measure of quality> but there are steps that could have been defined as milestones. These milestones could have been;

- Approved plan
- Call for bids
- Receiving disks and approving them
- Cleaning finished
- Heat treatment finished (each seven institutes separated)/ Distribution of disks to tests
- Concluding tests
- Analyzing results



*7 different institutes conducted 8 different types of heat treatments for disks

Figure 14: Manufacturing steps for each group

3.3 Naming of the disks

Separating the disks from one another is necessary since the disks have individual or close to individual treatment. The disks are distinguished in two ways. Each disk has an etched serial number on the backside of the disk. The disks also have a code or name that tells what kind of treatment they have gone through. This code is written on the plastic bag covering each disk. If for some reason the code is lost, the treatment can be traced back using serial number.

Serial number	Cleaning method	Institute	Heat treatment	Temperature	Size					
123	S W P	Etching Solvent Passivation	P T C B S L	Institute B Institute C Institute D Institute E Institute F Institute G	H V A h	Hydrogen at 1 bar Vacuum Argon at 10 mbar Hydrogen at 10 mbar	104 82	1040 °C 820 °C	B C	Diameter 80/85 mm Elliptical disk Diameter 12 mm

Figure 15: Naming of disks

The names are constructed using information of how the disks are treated. The information includes the serial number of the disk, the cleaning method, the institute where the heat treatment is done, the type of heat treatment performed, the temperature of heat treatment and the size of the disk. The serial number is separated from the rest of the code with an underscore.

Disk 66_SLH104B is disk number 66, it is etched, heat treatment is done in Institute G, Heat treatment was performed in hydrogen at 1 bar in 1040 °C and the diameter of disk is 80/85mm.

3.4 Information management systems

The main information management system in CERN and in CLIC is the Engineering and Data Management System (EDMS). It is used to store information from tests, results, meetings etc. EDMS also has a folder for the Heat treatment test cycle study. This folder is used to store information of the tests conducted, results and concerning presentations. Access to EDMS folder is open for all employees of CLIC, but it can also be granted for outside stakeholders, such as companies providing heat treatments for disks.

Raw data from the tests are saved to an online hard drive of the section that conducted the test. This information is accessible only to the specific employees of the section. This way only processed information is spread for wider public.

The EDMS folder would be the place to save management information such as roles and responsibilities, budget, project plan, risk register, mitigation plan etc. if this kind of information would be something that is required to share with rest of the group or with wider audience. EDMS includes the possibility to choose who can access the information and if they can change it.

3.5 Reporting

Reporting was done on a weekly basis in production meetings. There had not been any communication plan made at the very beginning of project. This was not a source of problems as long as this weekly meeting included all the people working at that time with the project. However, not all the people conducting the tests were among those people. Through the project manager the test results were added to the EDMS under the right folder.

The technical plan for the project was presented at the RF-design meeting. This meeting is more "high level" than the normal weekly production meeting. If the tests give any interesting results, these results will also be presented at this meeting. This presentation is done by the project manager and/or person responsible for test.

3.6 Ending project

The project was still going on when I left my position at the organization. Therefore it is quite hard to say how the finalising is being taken care of. However if some valid information can be extracted from research it is sure to be published at the weekly RF-meeting. All presentations from the meeting are saved to EDMS-database where they are open for all employees.

Initial finishing time for the project was at the end of October 2010. After this ending was postponed and no strict time limit was introduced.

3.7 Conclusions and suggestions

CLIC hosts enormous amounts of top quality talent. Unfortunately the talent concentrates on technical "engineering" fields rather than in management. This is understandable due the nature of CLIC being a world class technical institute. Due to the same research concentrated nature it is quite natural that not all business models and business orientated working methods can be implemented successfully. However it is this researcher's strong opinion that with more efficient project management better results could be achieved with smaller resources.

It is clear that project management and project culture should be improved in CLIC. Project planning could be improved by offering better support at the planning phase. Also reserving more resources for developing team spirit would be helpful at those situations when employees are changing ghastly.

Communication should take to account the vast diversity of cultures working at projects. Not merely technical but also social skills should be considered while recruiting upper manage-

ment. Support material, such as risk register templates (figure 9) and or to-do-lists (appendix 1), for project managers could be added in EDMS. This would also help to create standards for the way projects are executed and mitigate risks from different work cultures.

Courses on project management could also prove helpful.

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Appendix 1: Project Managers weekly checklist

“Is the plan up to date?”	Ensure that you have feedback from individual/teams working on elements of the project. This should be given to you on time and in the format you need.
Is the plan still realistic?	Take some time to think about whether the plan still represents what you are doing and what you should be doing!
Update the project status	The project may be part of a larger programme of activities; do you need to provide a weekly summary?
Are new risks being handled correctly?	Are new risks being identified and escalated by the project team? Have they been captured in the risk list and assessed for their seriousness within the project?
Have team members had up-to-date feedback on progress of the project?	Tell them about milestones passed, progress against targets, major changes, feedback from the project sponsor, customers, steering group, etc.
Do the project team know what to do?	Are they aware of the tasks they should be working on? Have they been told clearly about any changes in task priorities or objectives?
Is the team happy?	If everyone’s happy you probably need to wake up and get to work because it’s bound to be a dream. Human nature means there will always be some level of tension and unhappiness within a project. You need to look for, and resolve: <ul style="list-style-type: none">• Serious tensions within the team;

- Individuals who are over-stressed;

- Individuals who are working too hard and/or risking burn out.

Remember - your team's well-being is *your* responsibility.

Are regular team review meetings happening?

Are you keeping the team (or team leaders in larger projects) up to date with progress and allowing them to raise issues?

Are team leaders and people managing work packages keeping their respective teams informed?

Have you got the right team?

Does team have the right set of skills for the project?

Have any gaps appeared?

Is anyone not able to pull their weight?

Who need support in some way (help, training, praise)?

Is the team learning?

Are mistakes being repeated?

Are new team members getting up to speed on the project quickly enough? If not, what can be changed to enable them to contribute more quickly?

Are you being consistent?

Remember consistency is vital to your credibility with the team. Are you keeping your promises and commitments?" (Jones 2007, 176-177)