



**TAMPEREEN AMMATTIKORKEAKOULU**  
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**FINAL THESIS REPORT**

**DEVELOPING MASTER SCHEDULE TEMPLATE  
FOR CAPITAL PROJECTS**

**Case Metso Power Finland**



**Susanna Koivisto**

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Kai Hintsanen

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**Author:** Susanna Koivisto

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## Abstract

The purpose of this Final Thesis was to develop the scheduling template used in creating executive project schedules in the case company. The objection of the development work was to create a functional and coherent schedule template based on the case company's Work Breakdown Structure. This way also the schedule will be connected to the global management system implemented in the case company.

Scheduling is linked to other project management areas tightly. To really get a deeper understanding of scheduling also the other areas were considered and therefore project management has been dealt as a whole and scheduling as a part of it. Project management areas such as project life cycle, planning and scheduling, risk and opportunity management, cost management, project control and closeout were investigated further.

Based on the theory current working methods in the case company were introduced. The final chapters concentrate on the development work itself. The current schedule template was investigated and features of the new schedule template were introduced. Also the flow of the development work is described and suggestions for future developments were listed. The working methods of the case company and the development work itself are confidential and therefore not included in the public version of the Final Thesis.

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**Keywords:** Project Management      Schedule Management      Schedule Development  
Schedule Template      Work Breakdown Structure

# Table of Contents

<b>Abstract.....</b>	<b>2</b>
<b>Table of Contents .....</b>	<b>3</b>
<b>Abbreviations .....</b>	<b>4</b>
<b>1. Introduction.....</b>	<b>5</b>
1.1 Background .....	5
1.2 Research Objectives .....	5
1.3 Research Methods .....	6
1.4 Structure of the Research .....	6
<b>2. Project Management.....</b>	<b>7</b>
2.1 Project Organisation .....	7
2.2 Project Phases .....	9
2.3 Planning.....	10
2.3.1 Project Scope .....	10
2.3.2 Work Breakdown Structure (WBS).....	11
2.3.3 Activity Definition.....	15
2.3.4 Developing Networks .....	15
2.4 Scheduling .....	18
2.4.1 Activity Duration Estimation.....	18
2.4.2 Activity Resource Estimation .....	19
2.4.3 Gantt Chart.....	20
2.4.4 Computer Software Programmes.....	21
2.5 Risk and Opportunity Management .....	24
2.6 Cost Management.....	25
2.7 Project Evaluation and Control .....	27
2.7.1 Reviews.....	27
2.7.2 Tracking Gantt .....	28
2.7.3 Milestone Analysis .....	28
2.7.4 S-curve Analysis .....	28
2.8 Project Closeout and Termination .....	29
<b>3. Company Overview.....</b>	<b>31</b>
3.1 Metso Corporation.....	31
3.2 Metso Power.....	32
<b>4. Conclusions .....</b>	<b>34</b>
<b>Bibliography .....</b>	<b>35</b>

## Abbreviations

WBS	<p>Work Breakdown Structure</p> <p>A tool to breaking down the project scope into smaller more manageable pieces of work to meet the project objectives. Also a graphic description of the project scope.</p>
ERP	<p>Enterprise Resource Planning</p> <p>A compute-based system to manage resources, finances, materials and human resources.</p>
DOR	<p>Division of Responsibility</p> <p>A document for dividing project responsibilities by person or organisation used by the case company.</p>
PEM	<p>Project Execution Model</p> <p>A tool for monitoring project progress in the case company.</p>
R&O Register	<p>Risk and Opportunity Register</p> <p>A document for controlling risks and opportunities during projects in the case company.</p>

# **1. Introduction**

The main focus of this thesis is to develop the project schedule template for the case company. Scheduling is only one piece of a bigger picture which is project management. To really get a deeper understanding of scheduling also the other parts involved in project management have to be looked at and taken into consideration. Therefore in this thesis project management has been dealt as a whole and scheduling as a part of it.

Scheduling improvement is now one of the top priority development issues in the case company, Metso's Power business line. This includes developing the scheduling tool Master Schedule Template for Capital Projects and the scheduling methods. Metso Power is an international company with locations in Finland, Sweden, Brazil and USA. The Master Schedule Template is currently implemented in Finland but the development work was performed with the Metso global management system in mind. The development ideas and the Master Schedule Template have been introduced to the all the company locations.

## **1.1 Background**

In 2009 a Master of Science Thesis on Scheduling in Multiproject Environment was written for Metso Power. The thesis analysed the current scheduling methods in all the Metso Power global locations to find a global framework for scheduling and suggestions for best practices. As a result the scheduling process was developed to a more detailed level where roles and responsibilities were defined. Suggestions for the schedule tool functionality and framework were made. The structure recommendation for the scheduling tool was based on the Metso Power global WBS. This thesis continues from these suggestions to conduct the development work of the scheduling tool Master Schedule Template.

## **1.2 Research Objectives**

The purpose of this final thesis is to develop the Master Schedule Template for Capital Projects business unit in case company Metso Power Finland. The aim is to develop the Master Schedule Template into a functional and coherent scheduling tool for projects. The schedule is developed away from the separate departmental discipline schedules towards a schedule where the chain of activities can be cross-checked based on the company WBS

logic. In this way the project schedule can follow the same logic as risk and opportunity, cost and scope management.

### **1.3 Research Methods**

The research was mainly conducted based on the qualitative research method. Theoretical data and ideas are gathered from secondary literary resources dealing with project management. The current situation in the case company Metso was established with internal material and observation of daily routines and ongoing projects.

In the actual case study development work action research method was used. The input from departmental disciplines in the Capital Projects business unit was vital. Based on their knowledge and experience the information was gathered through discussions and put together to find the best solutions. The reason to collect input from the departmental disciplines was that people from these different disciplines form the project team. It was momentous to have their input and knowledge since the team members are the end users of project schedules created from the Master Schedule Template.

### **1.4 Structure of the Research**

The final thesis consists of four entities. The first part deals with the theoretical literature discussing project management. The development work in the thesis focus on schedule development but since it is only one part of the project also other important parts are studied as these different parts together form the project as a whole and affect each other greatly.

The second and third entities cover an overview of the case company and how project management is executed currently. The last entity goes deeper into the development work behind the Master Schedule Template. Problems with the current scheduling tool are introduced and solutions to these problems are presented. The development process is introduced as well as the methods of implementation. In the end the findings are analysed, conclusions drawn up and suggestions listed for the future.

## 2. Project Management

Lewis (2002) defines the word project in his book as a “multitask job that has performance, time, cost, and scope requirements and that is done only one time”. He continues that a project has a definite starting as well as an ending point and a temporary team that will be disbanded after the project ends. The PMBOK Guide (2004, 5) further defines that a project is “undertaken to create a unique product, service, or result.”

There are four project constraints: time, budget, scope and performance requirements. All of these constraints are dependent on each other and have to be in balance for the project to succeed. Only three of the constraints can have values assigned and one of them has to be determined by the project team. For example the customer or project sponsor can define a certain timeframe, scope and performance level for the project. From here the project manager or the project team can determine the costs. Being realistic at this stage is very important since committing to a too tight schedule or budget might result in a disaster later on. (Lewis 2002, 7-8)

There are two types of organizations in the macro level, project-based or non-project-based. In project-based organizations everything is focused around projects. Each project has its profit and loss statement and the organization profit is a sum of the profits of all the projects. (Kerzner 2006, 20) There are two categories of project-based organisations. Organisations that get their revenue primarily from performing projects under contract for other organisations and organisations that have adopted their management style by projects. In the latter the organisation’s management systems are designed to specially facilitate project management. (PMI 2004, 27) In non-project-based organisations projects are performed to support the product or functional lines. (Kerzner 2006, 20) Often non-project-based organisations may be lacking management systems that facilitate project management effectively and efficiently. (PMI 2004, 27)

### 2.1 Project Organisation

A project organisation is an organisation that is created for the purpose of executing a project. The amount of people in the project organisation may vary along the different phases of the project. Projects often vary in size and character and therefore also project organisation composition and emphasis vary between projects. (Pelin 2008, 65)

In project organisations with multiple projects a management team is created to make the essential project decisions, define the project and decide on the project manager. The management team consists of senior managers that regularly review the current situation of all the ongoing projects. At the reviews any conflicts between projects such as for example with resources or finances are seen and resolved objectively. (Pelin 2008, 66)

The project manager holds the main responsibility for planning, execution and control of the project. In smaller projects the project manager is the main resource for the project. In multi-year projects the best solution is to create a project organisation where the essential resources are found in the subordination of the project manager. The key for the success of the project manager is creating the project team for the project. (Pelin 2008, 66-69)

To create an effective project team a great deal of effort goes to finding the right people and developing this team into a functional and collectively performing project team. The ideal situations in creating a project team is where people themselves express an interest to take part and are awarded a place in the team. Unfortunately, in reality, in many organisations people are often chosen simply because they are available. However the team is built, it is a challenge for the project manager to build these different individuals into an effective and united project team. (Pinto 2007, 183)

The project manager needs to approach the people he or she would like to have in the project team. Sometimes personnel have authority to assign their time to projects but most of the time these people are under the authority of the departmental head. The latter situation can lead to situations where the project manager will have to negotiate with the departmental manager over the use of their staff. The final step is to assemble the project team and check that all necessary skills have been acquired. (Pinto 2007, 183)

One of the key factors in a successful project is a mutually understood and clear project mission. All project members need to understand the project objectives and how they can contribute in achieving these objectives. Enthusiasm and positive attitude are strengthened

when the project team is encouraged to believe that by working together towards certain goals they are attainable. (Pinto 2007, 186-187)

All project team members need a reason for their contribution in the project. Often projects may compete with team member's other duties and managers need to make all resources and sources of organisational reward available in order for the team members to devote time and energy to further the project's goals. A sense of interdependency is vital among team members. It is not only important to know how team members own contributions affect the project but also how this work fits into the overall scheme and to the work of other team members in other departments. (Pinto 2007, 186-187)

Participation from the project team in the planning process is extremely important, especially for the people who will be involved in performing the detailed activities. They usually have the best knowledge about these activities. Commitment comes through participation and taking part in the planning stage is of consequence. (Gido & Clements 2003, 102)

## **2.2 Project Phases**

Projects are divided into phases from the beginning of the project to the end to gain better management control. Many organisations set specific phases which together form the project's life cycle and use this life cycle on all of their projects. Project phase descriptions can be extremely detailed or on the opposite very general. Detailed descriptions can include charts, forms and checklists to create control and structure. (PMI 2004, 19-20)

There is no one way of defining project life cycle. Different project phases generally define what work is to be performed and when the deliverables are generated. Phases are usually sequential and the amount of work and resources required are low at the initial phase, peak during the intermediate phase and drop dramatically at the final phase. Level of uncertainty is also at the highest in the beginning as the risk of failing to achieve the project objectives is high. (PMI 2004, 20-21)

In large projects in particular the project phases are often divided into subphases for reasons of complexity, level of risk and financial constraints. Each of these subphases consists of deliverables related to the primary phase deliverable. Deliverables for phases are measurable, verifiable work such as detailed design document, specification or working prototype. The deliverables can match to the project management process or the end product or a component of it. (PMI 2004, 22)

Throughout the project the project manager needs to demonstrate to the executive management that the project has clear objectives and the work is carried out as planned. A system of phase gates between different phases of a project offer review points to evaluate project status and progress. Each of the phase gates, if opened, allow the work to be continued into the next phase. The decision to open a phase gate is made after revising the current progress and possible slippages, current risks, the budget and available resources. Occasionally it is necessary to make recommendations or revisions to current plans before proceeding to the next phase or even cancel the work. (Young 2007, 26-28)

## **2.3 Planning**

“Failing to plan is planning to fail.” (Kerzner 2006, 396) Planning a project is to establish a predefined plan of action in an environment that is characterized by estimation and uncertainty. Project planning must be systematic, flexible, disciplined and a continuous process throughout the duration of the entire project. Good planning reduces uncertainty, improves efficiency and gives tools to control and monitor the project. Planning will give answers to questions what and how. (Kerzner 2006, 396-398)

### **2.3.1 Project Scope**

The project scope includes the work that is required to complete the project successfully to meet the requirements for deliverables set at the onset of the project. (Gido & Clements 2007, 6) Scope so to speak sets the boundaries for the project, what is included and what is not included in the project. (PMI 2004, 103) Project scope contains also constraints and limitations as well as project goals. (Pinto 2007, 147)

### 2.3.2 Work Breakdown Structure (WBS)

It is a graphic description of the project scope (Lewis 2002, 27) and a tool to breaking down the project scope hierarchically into smaller more manageable pieces of work to meet the project objectives. (PMI 2004, 112) The PMI goes on defining the lowest level WBS components as work packages. The WBS answers the question “What has to be accomplished in the project?” (Haugan, 2002, 13)

The WBS can be broken down into different levels. According to Lewis (2002, 47) typically there are three to five levels in a WBS. The amount of levels can vary greatly depending on the size and complexity of the project. The WBS tree does not have to be symmetrical and not all of the paths have to end up on the same level. Sometimes breaking down the work into three levels is sufficient, while another work may take up to five levels to break it down into the accuracy desired. (Lewis 2002, 50) Finding the right level can prove to be a difficult task. Breaking the work down to too many levels and too much detail may lead to non-productive management and inefficient use of resources. The project team needs to find the appropriate balance between too little and too much. (PMI 2004, 114)

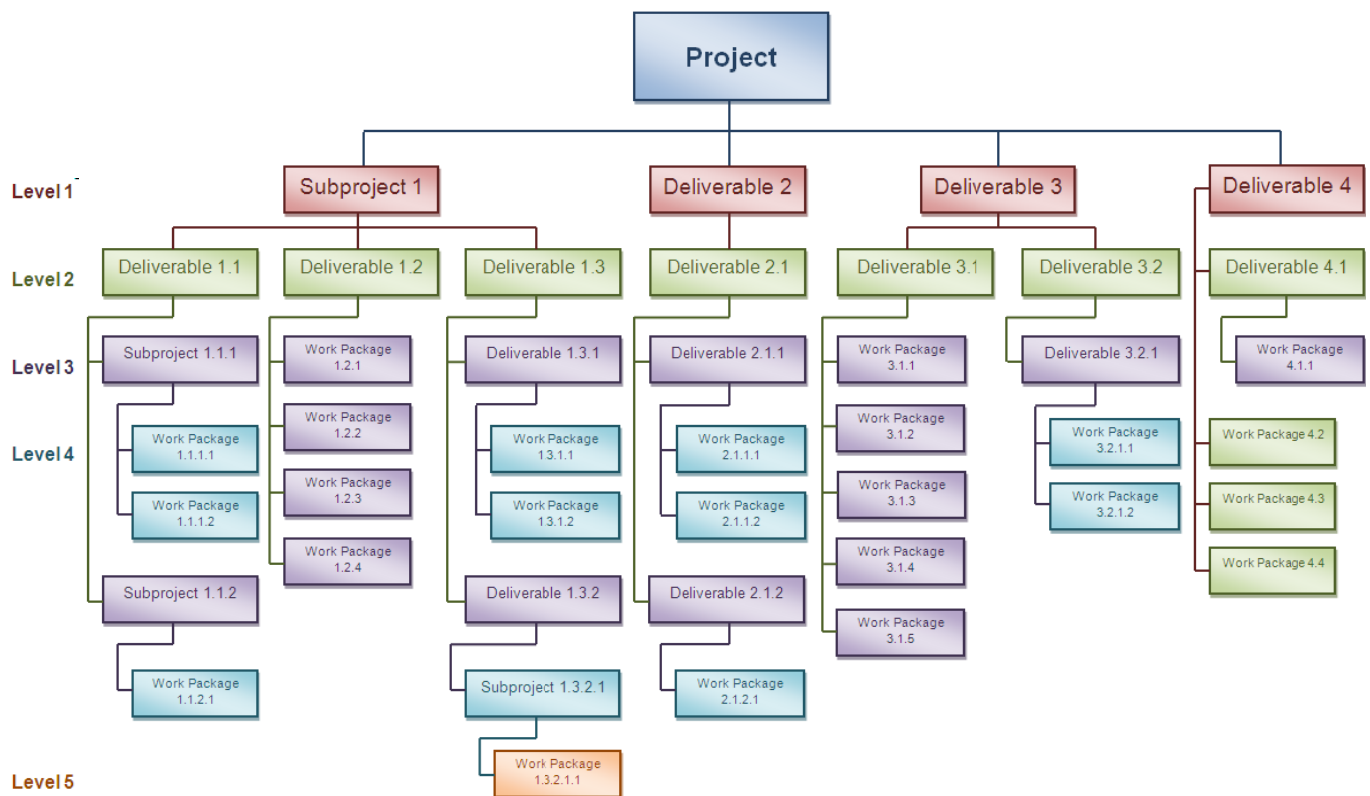


Figure 1: Sample Work Breakdown Structure (Modified from PMI 2004, 114)

The deliverables and subprojects are summed up from the work of work packages supporting them. When deliverables or subprojects are divided into work packages, the deliverables or subprojects do not have duration of their own, have assigned costs or spend any resources. All the resources and costs to a deliverable or subproject are from the work packages supporting it. (Pinto 2007, 157-158)

The main reason for the WBS structure is to identify and ensure that all relevant work packages are included in order to successfully carry out the project. “The 100 percent rule” states that the sum of work in the next WBS level must be 100 percent of the work represented in the previous level. This means that the work represented by the work packages in each deliverable or subproject must add up to 100 percent of the work it takes to complete the deliverable or subproject. The purpose of this rule is to arouse the question whether any work is missing from the WBS. (Haugan 2002, 18)

WBS is important to create before the schedule. A WBS does not contain the sequence of the work packages and this is done later on in the scheduling process. WBS shows the scope of the project in a graphic form allowing resource allocation as well as time and cost estimates. (Lewis 2002, 49) Lewis writes that it is misleading to develop a schedule before all work packages have been identified and agreed on by the project team.

Projects are often unique but a previous WBS can be used as a template for a new resembling project. Many large organizations have similar project life cycles with similar deliverables required from different phases of the project and thus have a standard WBS template which is used in new projects. (PMI 2004, 113)

All the different components in the WBS are assigned a unique identifying numeric code. (Pinto 2007, 157) The numbering can follow any desired method or logic but it has to be consistent throughout the entire WBS. This numeric code shows where each activity fits in the project overall hierarchy and identify them from each other. The WBS code helps with scheduling, tracking, assigning and communicating throughout the project. (Haugan 2002,

42) Also the company's accounting function can allocate costs more precisely and compare the activities to their budget costs. (Pinto 2007, 157)

The WBS can have a number of different structures or categorisations due to different situations and cultures of the stakeholders. Commonly the following basic structures or a combination of several of these structures are used:

- Projects

Where the project consists of several different subprojects the WBS can be broken down into these subprojects on level 2. The project is divided into Project A, Project B, Project C, etc. (Haugan 2002, 47)

- Project phases

The WBS is divided into successive phases of the project. The project phases can be for example preliminary planning, execution and implementation. (Pelin 2008, 95)

- Systems

The WBS is itemised into different systems delivered in the project. The systems typically affect the project organisation horizontally. (Pelin 2008, 95) A power plant consists of an entity of different systems such as for example air system, water system and fuel system.

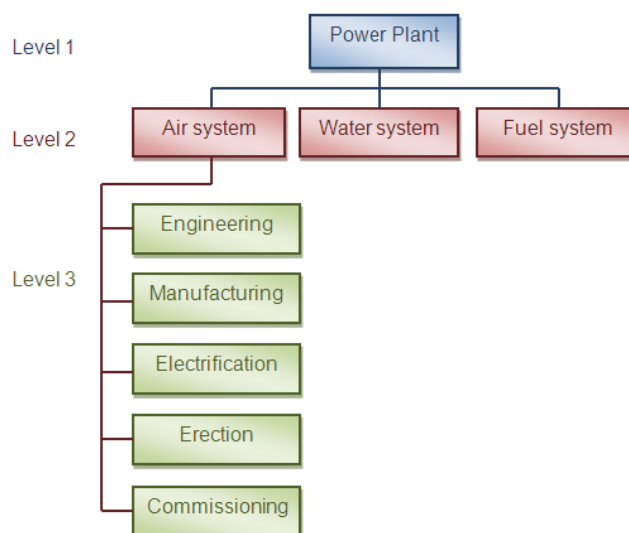


Figure 2: Example of system WBS structure

- Product components

The WBS is broken down to different physical parts of the project. In a large project the WBS can be first broken down into geographically separate parts such as buildings. It is then further divided into different parts of the building, equipment and so on. (Pelin 2008, 95) A power plant for example consists of different products such as boiler, fuel handling and flue gas cleaning.

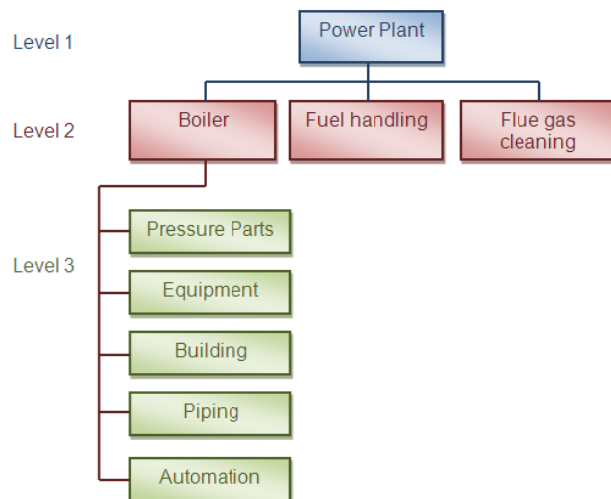


Figure 3: Example of product component WBS structure

- **Organisational Units**

The WBS is divided into organisational units in the project such as engineering, manufacturing, erection, commissioning etc. (Pelin 2008, 95)

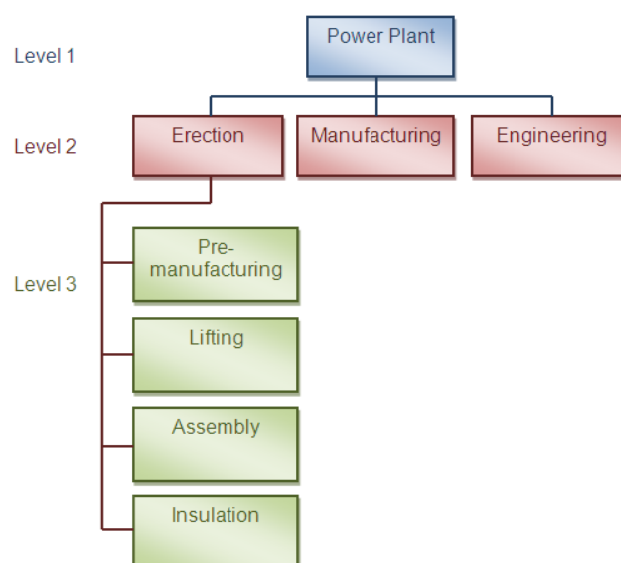


Figure 4: An example of organisational units WBS structure

### **2.3.3 Activity Definition**

In the activity definition process the WBS work package deliverables are further broken down into smaller schedule activities that can be scheduled and monitored during the project duration. (PMI 2004, 127-128) In large multiyear projects with thousands of people working on the initial planning the top-level activities are usually created by a core group. Other team members will then further develop these levels and break them into lower-level activities. (Lewis 2002, 49) The activity definition process answers the question “How will the project be accomplished?” (Haugan 2002, 13)

The short-duration activities have a definite start and finish time, have costs assigned and spend resources. (Pinto 2007, 156) A single person or a discipline within the organization is responsible for the work described in the activity. (Haugan 2002, 36) These activities are not a part of the actual WBS structure but the structure offers a framework for defining these activities for the project. (Haugan 2002, 4)

Activity lists from similar projects in the past or a standard list can be used as template for new projects. The template can also include further information on resource skills and the requisite hours of effort, reference to risks and possible other characteristic information needed in activity definition. (PMI 2004, 128)

Rolling Wave Planning is a form of gradual planning where the work that is performed in the near future is planned on a detailed low level of the WBS and work far in the future is planned on a more general WBS level higher up. As the project progresses, work is planned in more detail for the next one or two reporting periods. This means that schedule activities can appear in different detail levels throughout the life cycle of the project. (PMI 2004, 128)

### **2.3.4 Developing Networks**

As the WBS does not show the sequence of activities and a network diagram can be prepared once all the activities are known. The two most commonly used methods for creating activity networks are the Activity-on-Node (AON) and the Activity-on-Arrow (AOA) logic. (Pinto 2007, 284) The AOA logic was commonly used a several decades ago

but nowadays because of the computer-based scheduling programs the AON logic has become the preferred method. (Pinto 2007, 285)

With these two methods the activities can be placed in their logical precedential order. According to Gido & Clements in order to find the precedential order for each individual activity you should ask the following questions:

1. Which activities have to be finished immediately before the start of this activity?
2. Which activities can be performed at the same time with this activity?
3. Which activities can not start before this activity has finished?

By answering these questions you are able to place each activity in their right place in the network diagram portraying the interrelationship and sequence between the activities needed to accomplish the project. (Gido & Clements 2003, 116) If a WBS has been developed for the project, there should be activities in the network diagram for each work package. (Gido & Clements 2003, 116)

In the Activity-on-Node (AON) logic each activity is written within a box. In each activity node contains a unique activity number. The node can also include the following information, activity descriptor, activity duration, early start time, early finish time, late start time, late finish time and activity float. (Pinto 2007, 285) Activity float or slack is the time that an activity can be delayed from its early start without delaying the finish of the whole project. (Pinto 2007, 284) The more information included in the node makes calculations easier such as identifying critical path, activity float, total project duration and so on. (Pinto 2007, 286)

Activities have relationships and they are linked in a precedential order to display which activities are to be finished before starting another activity. Arrows linking the boxes show the direction of the precedential order. (Gido & Clements 2003, 110-111)

Some of the activities are to be done in a serial order where a preceding activity has to be finished before starting on the consequential activity. For example when designing a product the activity “Detail Engineering” can start only after activity “Basic Engineering” is finished. (Gido & Clements 2003, 111)

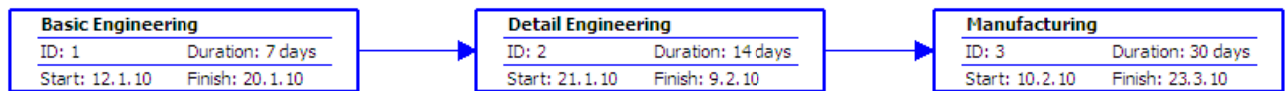


Figure 5: Activity-on-Arrow logic, activities performed consequentially.

Some activities can be done at the same time. (Gido & Clements 2003, 111) For example, after the activity “Basic Engineering” has been finished both activities “Detail Engineering” and “Layout Design” can be done concurrently. When they are both done, activity “Manufacturing” can start. When performing activities concurrently there must be sufficient resources to perform all simultaneous activities. (Pinto 2007, 287)

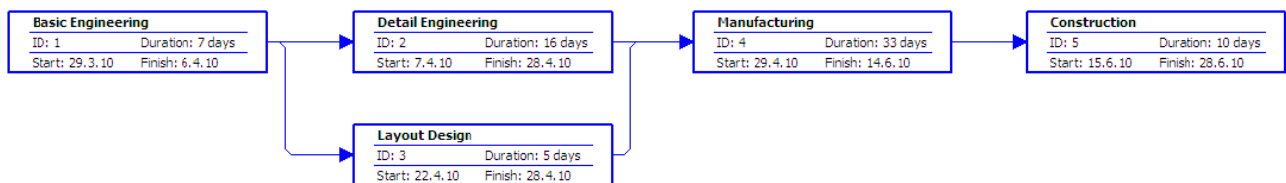


Figure 6: Activity-on-Arrow logic, activities performed concurrently.

In the Activity-on-Arrow (AOA) logic activities are written on the arrow instead of a box. Activities are each represented by an arrow where the tail of the arrow signifies the start of the activity and the arrowhead represents the end of the activity. The length of the arrow does not indicate the duration of the activity nor implicates anything about its importance. (Gido & Clements 2003, 111)

All activities are linked by events. Activities finish in these circles and start from them. Unlike in the activity in a box format, here the events have a unique number. (Gido & Clements 2003, 112) Activities “Basic Engineering” and “Detail Engineering” are linked together with event number 2. Event 2 signifies the end of activity “Basic Engineering” and the beginning of activity “Detail Engineering”.

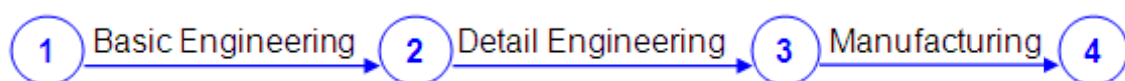


Figure 7: Activity-on-Arrow logic, tasks performed consequentially.

Activities going into an event must be finished before activities going out can start.

Activities can be performed simultaneously and when they are both finished can the next activity start. (Gido & Clements 2003, 112) For example, activities “Layout Design” and “Detail Engineering” have to be both finished before activity “Manufacturing” can start.

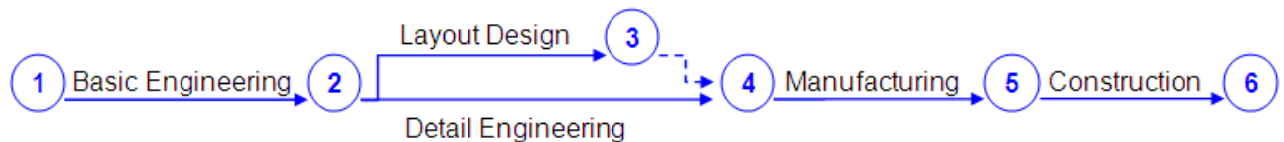


Figure 8: Activity-on-Arrow logic, tasks performed concurrently.

## 2.4 Scheduling

In the planning section activities have been decided and sequencing formed to reach the project objectives. This plan was then portrayed in graphical form by the network diagram to visualise the project scope. Now the scheduling process for the project can begin by scheduling the plan. Scheduling can answer the questions when and by whom.

### 2.4.1 Activity Duration Estimation

The scheduling process starts with estimating how long each activity will take to complete (Gido & Clements 2003, 144) and respond to the question “When will it be accomplished?” (Haugan 2002, 13) Activity duration signify the total elapsed time which means the time for the work plus any additional waiting time. (Gido & Clements 2003, 144) Activity duration estimates are based on the assumption that they will be completed with normal working methods, during normal working hours and normal business days. (Pinto 2007, 292)

The ideal situation would be to have the person performing the job estimating the duration. This creates commitment to the work and avoids bias. However, in large multiyear projects in particular involving hundreds of people, this would not be possible. Here each organisation or subcontractor designates a responsible person to make the duration estimations for all the activities the organisation or subcontractor is responsible for. (Gido & Clements 2003, 144)

The activity duration estimation is always directly linked to the available resources in the project and estimation must always be based on the resources that will be expected to be used on the performance of the activity. This should be as realistic as possible, not too pessimistic or positive. People sometimes perform to expectation, hence if the duration estimation is too pessimistic and set to 10 days, the activity may take the whole 10 days even if it could have been done in a shorter time. The activity estimation should not include a lot of extra time for things that could go wrong. (Gido & Clements 2003, 144-145)

Duration estimation is always somewhat uncertain. Past work and experience can be used as a guide and history to estimation. What worked in the past might not work right now due to for example different external factors. (Pinto 2007, 292) Duration estimations for some tasks will be spot on, some will be delayed for one reason or another and some activities are performed faster than expected. Over the duration of the whole project these delays and accelerations sometimes tend to cancel each other out. For example, one activity can take two weeks longer to complete but two activities preceding it took each one week less to complete than expected and this way cancelling each other out. (Gido & Clements 2003, 145)

The entire project also requires a start and completion time. These times can also be dates, usually the completion time is a date that is stated in the contract. (Gido & Clements 2003, 146) Creating the project schedule can begin from the completion date when the project is due to end and worked from there until the start date can be defined. Alternatively the project schedule creation can begin from the start date and be built from there until the completion date is defined. Often in practice both the completion date and the start date are defined in the contract and the project schedule is created either from the beginning or the end but is restrained by both the start and completion dates.

#### **2.4.2 Activity Resource Estimation**

Activity resource estimation is to define the appropriate resources whether it is material, equipment, facilities or personnel to perform the activities in a work package. The budget of the project often dictates how much resources are at disposal. (PMI 2004, 135) Resource estimation is closely knitted with cost estimation and budgeting process. (PMI 2004, 135)

Available resources for the use of a project are often limited. Several different activities may require the use of same resources at the same time span and therefore are competing for the use of these resources. If there are not enough resources for all the activities some of them may have to be rescheduled until the necessary resources are available. (Gido & Clements 2004, 230)

### 2.4.3 Gantt Chart

The Gantt chart was developed in 1917 by Henry Gantt to create a network linking individual activities into the schedule baseline. It is also a very handy tracking tool, the difference between planned and actual performance is easy to see. (Pinto 2007, 319) The Gantt chart combines both the planning and scheduling functions of a project. (Gido & Clements 2003, 109)

In the Gantt chart activities with an estimated start and finish dates are listed on the left-hand side and time scale with a bar displaying the duration of each task horizontally on the right-hand side. Estimated start and finish dates are ordered by baseline calendar dates allowing review of the status of the project at any given date during the project. (Pinto 2007, 319)

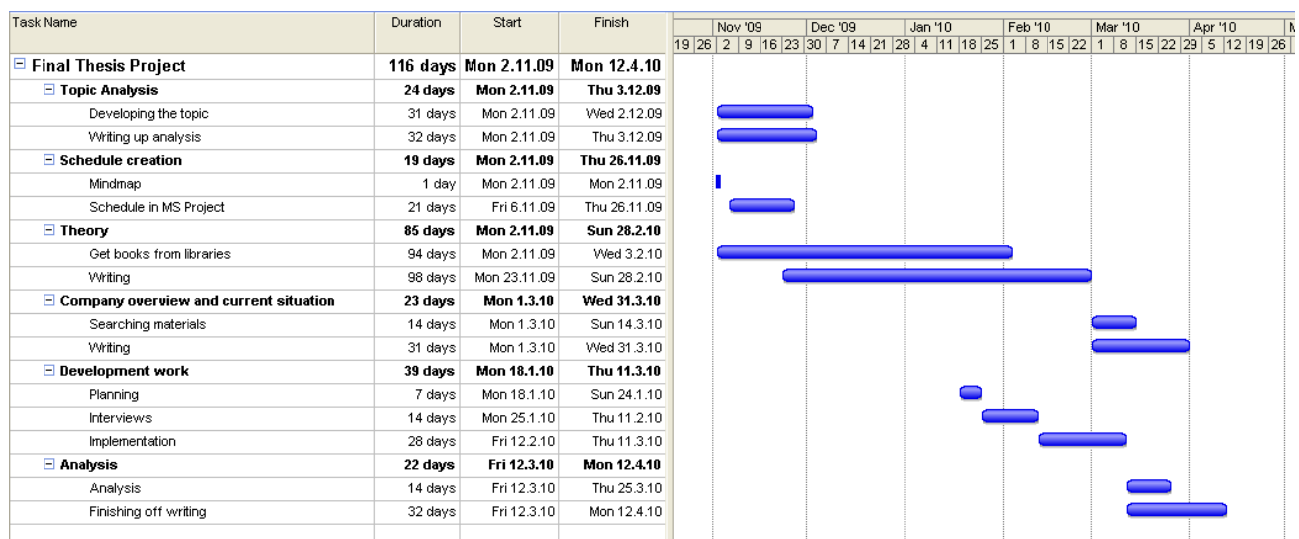


Figure 9: Example of a basic Gantt chart

Besides benefits the Gantt chart also has limitations. The chart does not show interdependencies between the activities. (Kerzner 2006, 525) Without these relationships it is difficult to see how a change in one activity will affect the rest of the activities. It is clear that a change in the beginning can affect the rest of the project but it is not clear which individual activities this change may affect.

#### **2.4.4 Computer Software Programmes**

Today there are many available computer software programmes to plan and control projects. The programs vary slightly as to how they function and what features they offer. Gido & Clements (2003, 409-413) list the following features among the most important:

##### **Planning**

The feature allows the definition of all the activities to be performed during the project. For each activity the user can specify the basic functions; a name or description, start date, finish date and duration. In addition the precedential relationships between activities can be established and resources assigned.

##### **Graphics**

For large projects consisting of several thousands of activities it would be difficult and prone to errors to manually draw up and update Gantt charts and network diagrams. The software can generate a variety of charts and networks quickly and easily based on the given data. Modifications to the plan can easily be entered to the data and the software will automatically adjust these changes into the graphics.

##### **Scheduling**

The feature provides support for scheduling based on planning. The software can create Gantt Charts and network diagrams from the planned activities and the precedential relationships. After the relationships have been entered, any changes to the activities will be reflected to the entire schedule automatically. Users can also schedule recurring activities, perform scheduling from the project start or finish date, schedule lag, set priorities to activities and give constraints to activities such as schedule activities to start as late or soon

as possible, specify must-start-by or must-finish-by dates, no-earlier-than or no-later-than dates.

#### Project monitoring and tracking

For the project manager it is important to know during the project how activities are actually being performed compared to the baseline plan. The software allows the user to set a baseline from the planned schedule and compare actual progress or cost to the baseline schedule. Most available software allow tracking of progress, start and finish date, completed tasks, actual cost spent and used resources. There are several different report formats provided for these monitoring and tracking features.

#### Handling multiple projects and subprojects

The feature allows to handle at the same time multiple projects in separate files with connecting links between these files or to divide large projects into smaller subprojects. It is possible to store multiple projects in the same file and handle several projects simultaneously. Gantt Charts and network diagrams can be created from several projects.

#### Importing and exporting data

Software allows the user to import information from other applications such as spreadsheets, word processing or database applications. This feature saves time and possibility of errors from retyping the information into the project management software. Data transferring also works in reverse where data can be exported from project management software into other applications.

#### Calendars

This function offers the possibility to define different working days and hours to different resources or groups of resources. The project has a set base calendar with standard working hours and holidays. This calendar can be changed for each resource or resource group. Working hours, working days, nonworking days, vacation days, different shifts such as part-time or night time can be entered.

### Budgeting and cost control

Costs can be assigned to each activity and resource. The employee, subcontractor and material costs such as hourly rates, overtime rates, one-time-only rates or ongoing costs can be defined. Accounting and material codes can also be specified to each resource. This information is used to calculate and track the budgeted and actual costs of the project. Actual individual resource, group resource and subcontractor costs as well as actual costs of the entire project can be compared to the planned budget at any time during the project.

### Resource management

A list of resources can be added where details concerning each resource or resource group can be maintained and updated. Resources have an identifying name, standard and overtime rates and an invoicing method. Each resource can have a personalised calendar and constraints when the resource is available. Resources can be assigned to several activities at the same time and have a certain percentage of the level of input to an activity. The software highlights over allocation and helps to correct and level resources.

### Report generation

Reports can be generated from the entire project or a part of the project. For partial reports the user can set a date range, select activities that are completed or ongoing, activities that start or finish in a certain time frame, or choose to report the milestones of a project.

### What-if analysis

When activities are linked together to make precedential relationships different manipulations can be performed. Since the software adapts changes in one activity into the entire project the user can explore different effects of various scenarios. For example if an activity is changed to occur later the software will automatically calculate how this change will affect the rest of the project. This way the project manager can better control risks involved with the project costs, schedule and resources.

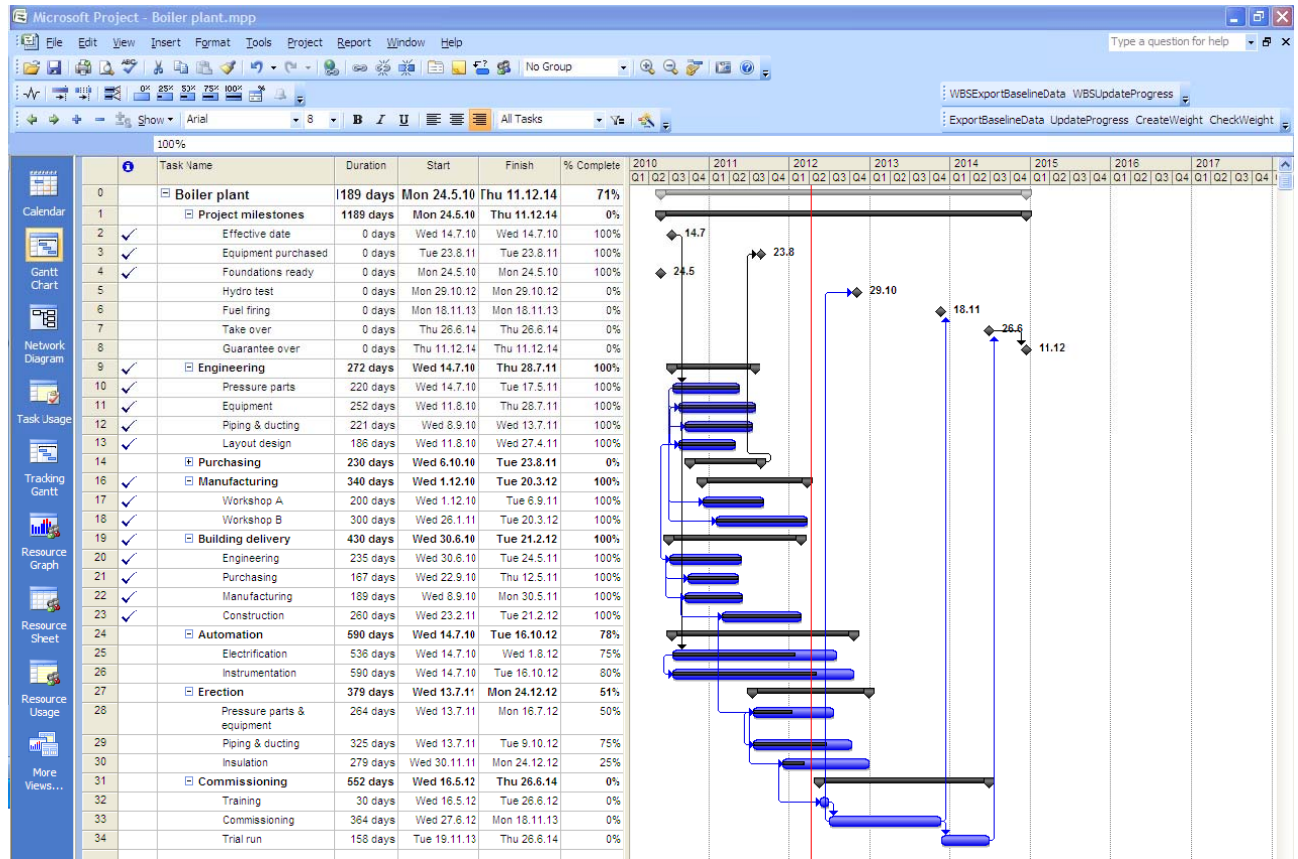


Figure 10: Example of a Gantt chart view in the project management software Microsoft Project

## 2.5 Risk and Opportunity Management

The environment around projects is filled with uncertainty. Problems can occur in almost any aspect of the project; budget, resources, customer requirements, any outside factors out of the control of the organisation and so on. (Pinto 2007, 221) PMI (2004, 238) defines project risks as possible events that can affect the objectives of the project either negatively or positively. PMI continues that one or more of these objectives such as for example scope, cost or time may be impacted and risks may have one or more causes.

Risk management is to recognise, analyse and react to these risk factors throughout the project life cycle and in the best interests of its main objectives. Risks are assessed on the basis of the likelihood of the event occurring as well as the consequences they may have. (Pinto 2007, 222) PMI (2004, 237) describes the project risk management process with the following steps:

- Risk Management Planning – deciding on a plan how to identify, plan and manage risks of the project.
- Risk Identification – identify and document possible risks that are likely to affect the success of the project.
- Qualitative Risk Analysis – prioritising identified risks by how likely they are to occur and how they would impact the project.
- Quantitative Risk Analysis – analysing with numbers how the identified risks would threaten the project objectives.
- Risk Response Planning –developing precautions and minimising the impact of likely risks.
- Risk Monitoring and Control – executing, evaluating and documenting identified risks and risk response plans throughout the entire project.

Projects encounter different kind of risks with impact on different areas of the project. Risks commonly fall under certain classifications. Pinto (2007,223-224) classifies risks under the five following clusters:

- Financial risk
- Technical risk
- Commercial risk
- Execution risk
- Contractual or legal risk

## **2.6 Cost Management**

Cost Management is composed of planning, estimating, budgeting and controlling costs of the project. Cost Management is mainly interested in the costs of the resources that are needed in completing the scheduled activities. This should be done without forgetting the life-cycle costs. These are costs of using, maintaining and supporting the project end product, service or result. Decisions done to reduce costs of the project can increase cost for the customer such as in case of limiting reviews during the project phase can bring additional operational costs to the customer. (PMI 2004, 157)

Estimating the costs of the project includes evaluating how much costs it will take to perform each work package in the WBS structure. There can be several different alternatives as to how much a work package is expected to cost. Additional work during the design or engineering phase can reduce costs in the operational phase and save total costs in the long run. The estimation process is to find these possibilities and consider whether the savings in the end will cover the costs of additional input. (PMI 2004, 161)

Project costs are often estimated during development of project proposal for a customer. Depending on the required level of detail the proposal includes the total bottom-line costs or detailed breakdown of various costs. Costs include labour, materials, subcontractors and consultant, equipment and facilities as well as travelling costs. In addition there can be included contingency costs. These are to take care of any unexpected situations which have been overlooked such as changes in cost of labour especially in multiyear projects or when producing a new product. (Gido & Clements 2003, 254-255)

Estimation should be as realistic as possible. If too much contingency costs are estimated in case of pretty much anything that can go wrong there is a risk of overpricing the project and loosing to a competing contractor. On the other hand, if the estimation is too optimistic and unexpected costs arise the profits of the project may be lower than expected or facing the embarrassment of having to go to the customer to request additional funds. (Gido & Clements 2003, 255-256)

Gido & Clements (2003, 254) clearly state that it is vital during the project, from the beginning to the end, regularly monitor actual costs and progress of work to ensure that everything is going within the budget. They continue that any variance or inefficiencies in costs is crucial to recognize early in order to take action before the situation spirals out of control.

PMI (2004, 171) includes the following into cost control:

- monitoring cost performance to find any variance from baseline
- managing and documenting changes to budget when they occur

- making sure potential changes do not exceed the authorized funding in the total budget for the project
- preventing inappropriate or unapproved changes going into the reported costs

## **2.7 Project Evaluation and Control**

During project implementation it is of uppermost importance to monitor and control the project. Since projects have one or more constraints (time, budget, scope or performance) set by the customer or the project sponsor, these constraints require particular monitoring. Once baseline is set for schedule and budget the ongoing current status can be compared and evaluated against these original estimations. During the duration of the project cumulative work or budget can be broken down by time. (Pinto 2007, 410-412)

### **2.7.1 Reviews**

Project Performance Reviews are held periodically during the running of the project to assess and compare cost performance, schedule activities, planned budget and milestones. Actual performance is analysed and compared to the planned or expected performance. Also a trend analysis can be done where project performance over time is analysed to determine whether performance is weakening or improving. (PMI 2004, 176)

Kerzner (2006, 238) mentions three types of reviews; project team, executive management and customer review meetings. Meetings can be held in a variety of timely manner such as weekly, alternate weeks, monthly, quarterly and so on. Most project teams hold regular meetings to keep the project manager and the project team informed in current issues and the project status. Executive management most often require monthly status review meetings. Customer reviews are often the most critical and require preparation in advance. (Kerzner 2006, 238-239)

In complex project review gates are held to close a certain phase in the project. The review gates are usually scheduled as milestones in the project schedule. The gates are determined based on deliverables and activities that need to be completed. These periodical evaluations have to be carried out in order to proceed to the next phase of the project and are often a requirement in the contract. (Pinto 2007, 415)

### **2.7.2 Tracking Gantt**

Tracking Gantt is a form of Gantt chart where project schedule performance can be evaluated at a given date during the project. The tracking Gantt chart offers a visual graph to detect positive or negative deviation of the current situation to the originally planned baseline. (Pinto 2007, 416-417)

The tracking Gantt chart is easy to interpret and it can be updated quickly to give a real-time control of the project. The chart does show when activities are ahead or behind the schedule but as a drawback it does not offer information to the underlying cause of this kind of activity slippage. (Pinto 2007, 417) Projections to the future can be difficult with the tracking Gantt chart. When an ongoing activity is behind schedule on a given date it is difficult to tell whether the activity is not going to be completed before the finish date or whether it is just momentarily late and can still be completed before the finish date.

### **2.7.3 Milestone Analysis**

Milestones are events or dates in the project where significant deliverables are completed. The deliverables can be one single task or a combination of several different tasks. Milestones give indication to the project team of the current status of the project and especially in multiyear projects provide a good picture of the overall progress. (Pinto 2007, 415)

### **2.7.4 S-curve Analysis**

The classic S-curve displays graphically the actual accumulated amount of cost or work against time. The analysis is done for both the actual cost or work and the planned cost or work. Any variation between actual and planned can potentially signify a problem. Simplicity is the biggest advantage with the S-curve analysis. It offers real-time information of the project status in a timely manner. (Pinto 2007, 412-413)

Simplicity can also be considered as the biggest downfall of the S-curve. The information it provides is not always easily interpreted. The S-curve provides an easy way to identify

positive or negative variance but does not give any indication as to the cause of this variance. (Pinto 2007, 413)

## **2.8 Project Closeout and Termination**

The final stage of a project is termination. Projects are one-off with a definite ending where the termination is planned from the beginning. The termination is a series of events where project acceptance is handed over to the customer or project sponsor and various project documents and records are finalised, revised and completed. (Pinto 2007, 445)

Pinto (2007, 445-446) lists four different reasons for project termination:

- Termination by extinction –the project can be concluded unsuccessfully or successfully. In successful termination by extinction the project has been handed over to the customer and all termination activities are conducted. The final budget is audited and team members disbanded.
- Termination by addition – the project has been institutionalised as a part of the parent organisation. The project team has been in a way promoted to a formal part of the organisation's structure.
- Termination by integration – the project resources, with the project team included, are reintegrated within the existing structure in the organisation to perform other duties or to wait for new project assignments. There is a chance that the project team members have no desire to go back to their old functional department duties and the risk of losing key organisational members is significant.
- Termination by starvation – the project can starve out for a number of different reasons. Due to budget cuts some projects may be kept on the books waiting for better economic times to be reactivated. Some projects may be kept on file for political reasons where the organisation has no real intent for the project to succeed or ever finish. Starving a project may even to be a conscious decision to neglect and slowly decrease the project budget resulting in making the project unviable.

Even though project termination can be conducted for a variety of reasons, the termination activities should be included already in the planning phase. The termination activities can begin after all the project execution phase is completed and the results are accepted by the

customer. When the project is completed it must be verified by the project that deliverables in the contract have been supplied to the customer or the project sponsor. These deliverables can include documents such as training and instruction manuals, drawings, reports or as-built documentation, equipment, software and data. The documentation is to be properly organised and filed appropriately for future reference. (Gido & Clements 2003, 84)

All payments have to be received and paid by the project organisation. Once the final payments are made the project's final budget can be audited closed. Evaluations of performance can be held during the termination process. The evaluations should be held both internally within the project organisation as well as between the project organisation and the customer or project sponsor. The purpose is to provide valuable information on performance, find out whether anticipated benefits were achieved and receive suggestions for future projects. (Gido & Clements 2003, 86)

In some projects termination is required before the project is completed and before it was originally planned. Early termination can be caused by a number of reasons such as for example circumstances where the benefits from the project are exceeded by costs, customer dissatisfaction or when the expected results of the project are found to be unrealistic or otherwise unattainable. (Gido & Clements 2003, 91)

### 3. Company Overview

The development work was conducted for the case company Metso in the Power business unit's Capital Projects business line. In the following chapter the company is further introduced and the organisation presented.

#### 3.1 Metso Corporation

Metso Corporation is a worldwide deliverer of technology and services in pulp and paper, mining, construction, power generation, oil and gas and recycling industries. The customers are typically industrial companies such as paper companies, mining companies and energy companies. Multiyear project deliveries are typically in pulp and paper industries, mining and power generation. Deliveries to the construction, oil and gas industries are mostly smaller package solutions and individual equipment components. The services business totals up to over 40 percent of the net sales. (Metso Corporation 2010)

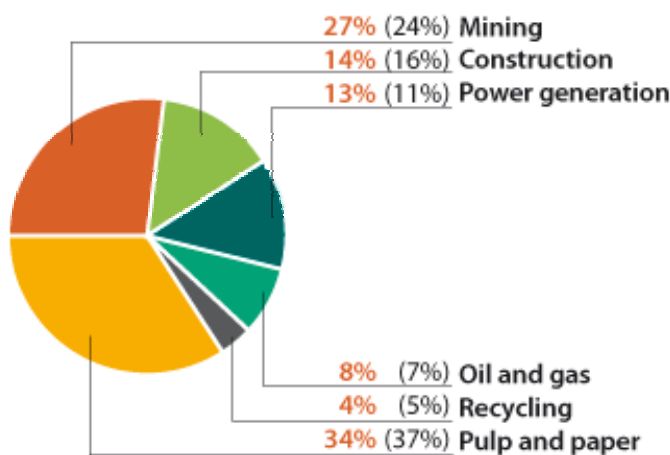


Figure 11: Net sales by customer industry in 2009 (Metso Corporation 2010)

Metso traditionally receives orders from the Western Europe, North America, Japan, Australia and New Zealand. In 2009 48 percent of received orders came from emerging markets such as Eastern Europe, South and Central America, the Middle East and Africa and Asia-Pacific (excluding Japan, Australia and New Zealand). Focus on investment is now more clearly in these emerging markets. (Metso Corporation 2010)

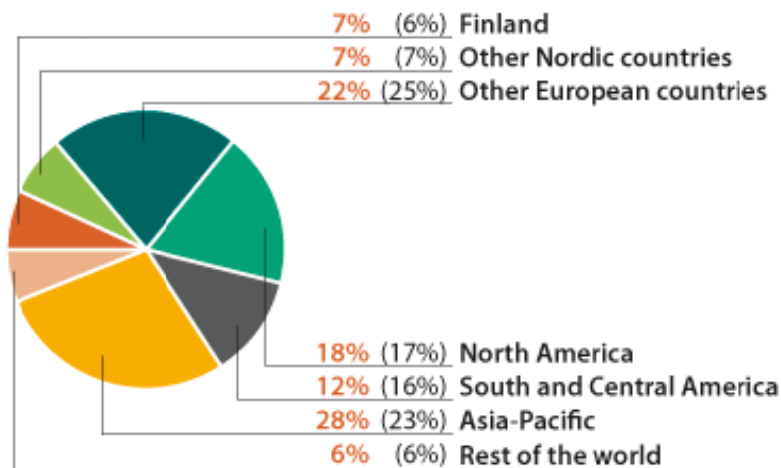


Figure 12: Orders received by market area in 2009 (Metso Corporation 2010)

Metso employs more than 27.000 professionals in over 100 countries worldwide. Metso has over 300 units with sales, engineering, procurement, production, services business and other operations in over 50 countries. (Metso 2010a)

### 3.2 Metso Power

Metso Corporation consists of three segments: Energy and Environmental Technology, Mining and Construction Technology, Paper and Fiber Technology. Metso Power business line is a part of Metso's Energy and Environmental Technology segment along with Automation and Recycling business lines. (Metso 2010a) Metso Power specialises in designing and manufacturing chemical recovery systems and power generation for pulp and paper industry as well as energy producers. Products include fluidized bed boilers and recovery boilers, oil and gas boilers, evaporator systems, environmental systems, and expert maintenance services. (Metso Power Intranet 2010)

Metso Power line is the world's leading chemical recovery equipment supplier with 300 delivered recovery boilers and 400 delivered evaporation units. Metso Power has also designed and delivered the largest delivery boilers in the world. Continuous research in processes increase production efficiency combined with reduced emissions, low fouling and corrosion characteristics. Metso Power main operations are in Finland, Sweden, USA and Brazil. Metso Power functions as a project organisation where new orders are executed as projects. (Metso Power Intranet 2010)



Figure 13: Jämsänkosken Voima power plant (Metso 2010b)

## 4. Conclusions

The purpose of this thesis was to develop the currently used Master Schedule Template in the case company. The first objective of the development work was to develop the schedule template into a functional tool in creating coherent project schedules. The second objective was to create a chain of activities that are easy to cross-check based on the company WBS logic. Both objectives were met during the development work and the result was a schedule template that has been implemented in new projects.

The theoretical study involved project management as a whole since scheduling is closely related to all project management areas. The main focus however was on planning and scheduling. Special attention was also given to Work Breakdown Structure because it was the key factor in the schedule template development process. Scheduling is a challenging area in project management and success in scheduling is directly linked to the success of the project. The literature offered different ways and methods on how to plan and schedule a project but the overall logic was similar. It was clear that there is a strong link between the WBS and scheduling. The WBS can have a number of different structures or categorisations depending on the needs of the company. The WBS final level work packages are divided into specific scheduling activities. These scheduling activities form the project schedule.

The case company project management analysis and the development work are confidential and not included in the public version of the Final Thesis.

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