Master Thesis - the Pre Study Report

The objective of the pre study report is to make sure that the student understands what kind of tasks she/he is going to perform, and that she/he is able to show how they will be fulfilled.

The pre study report normally has to be performed during the first three weeks of the thesis work. It also has to be approved by the supervisor before continuing the work.

The pre study report shall include a project definition, analysis and description of the project tasks and scope, activity lists and Gantt chart. The Gantt chart specifies different tasks/activities, their scope, scheduled start and end dates, dependencies, milestone meetings and progress reports.

A project definition template may be used (see attachment 1).

Use the front page shown in attachment 2.

A suggested content of the pre study report - see attachment 3.

An activity description template (see attachment 4) may be used to describe each activity.

MS Project (or any other simpler software) may be used to construct the Gantt chart.

Use Times New Roman 12 for the normal text, and use Times New Roman Fat 14 for main headings.

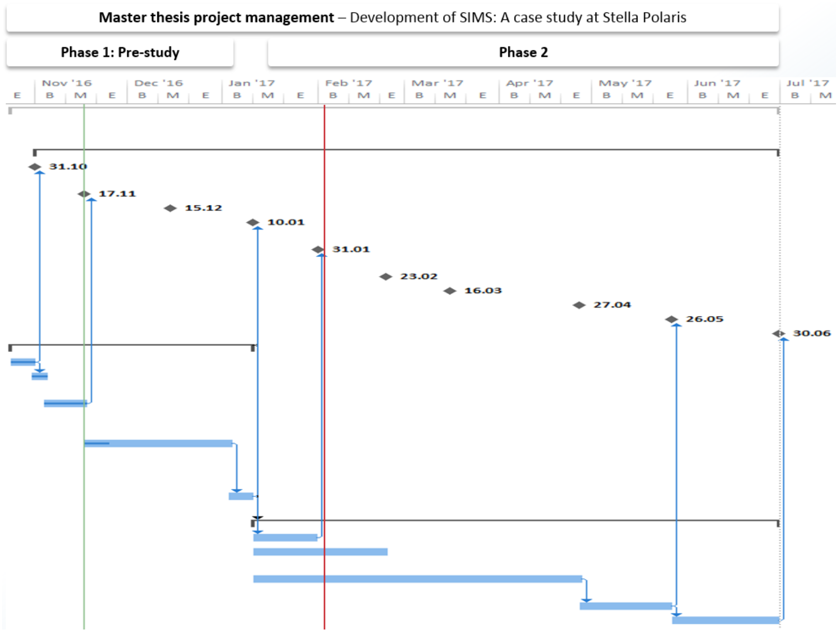
Use spellchecker.

Do not forget to specify any references!

Project definition:

Elements	Descriptions
Project title (4 – 12 words):	Development of Small-scale Intelligent Manufacturing System (SIMS): A Case Study at Stella Polaris
Project sponsor(s):	Department of Industrial Engineering, Narvik Campus, UiT
Project manager:	***Wei Deng Solvang***, Professor, Dept. of Industrial Engineering, UiT, Narvik ***Hao Yu***, Stipendiat, Dept. of Industrial Engineering, UiT, Narvik ***Tom Harry Klausen***, CEO, Stella Polaris AS, Finnsnes ***Taoying Huang***, Master student, Dept. of Industrial Engineering, UiT, Narvik
Project team:	Stud. Techn.: Taoying Huang – 100% of time committed to this project. *(It is supposed that a total workload of part II is about 800 working hours per student.)* Supervisor 1: Wei Deng Solvang, Professor, UiT Supervisor 2: Hao Yu, PhD researcher, UiT Supervisor 3: Tom Harry Klausen, CEO, Stella Polaris AS
Problem statement:	To develop the concept of small-scale intelligent manufacturing system (SIMS) and conduct a case study of implementing SIMS at Stella Polaris AS.
Project description/benefits:	Facing great challenges and fierce competition, it is imperative for manufacturing companies in the Northern Peripheral and Arctic (NPA) region to innovate and adopt new technologies or methods. The emerging concept of small-scale intelligent manufacturing systems (SIMS) is seen as a novel approach aiming at enhancing the competitiveness of the small and medium-sized manufacturers (SMMs). One of the purposes of this project is to further develop the initiative of SIMS in order to support SMMs in overcoming challenges and transforming and adapting themselves to the upcoming Industry 4.0 era. Besides a theoretical framework, a case study will also be conducted regarding the implementation of SIMS in a prawn producer Stella Polaris AS. The current manufacturing systems are to be analyzed and solutions/ suggestions for further improvement or development are to be provided.

Theory/hypothesis:	Small-scale intelligent manufacturing systems (SIMS)[1]
Assumptions:	It is pre-assumed that SIMS can be applied to the target company.
Risks/constraints:	Stella Polaris AS[2] has already established sophisticated and automated manufacturing systems in its production plant. Innovation in technology can be some difficult. Constrains might occur when collecting data or information both from the internet and from the company.
Specific objectives:	To develop the concept of Small-scale Intelligent Manufacturing System (SIMS); To conduct a case study for SIMS at the company Stella Polaris AS based on the theoretical development of SIMS; To provide solutions/suggestions to Stella Polaris (and other companies in the prawn or other seafood industry) on implementing SIMS and/or its approaches in order to enhance the competitiveness of the company.
Scope:	1) Making a Gantt chart based on the project assignment and determining milestones for project management. 2) Conducting an extensive literature review on the concept of small-scale intelligent manufacturing systems. 3) Conducting an extensive literature review on the most commonly used methods and systems for companies in the fishery/seafood industry regarding their manufacturing systems. 4) Performing an analysis of the currently used manufacturing systems at the target company Stella Polaris. 5) Providing suggestions for implementing SIMS at Stella Polaris in order to improve the competitiveness of the company. 6) Preparing reports and PowerPoint presentations and giving oral presentations of the performed work.
How status will be reported:	Information will be exchanged with supervisors (and external organization's liaison) via regular progress meetings throughout the project cycle. E-mail contact will be used when necessary.
Start date /Est. timeline:	Phase 1 starts in the end of October 2016 and Phase 2 starts in the end of January 2017. (See the Gantt chart below for a detailed timeline.)

<table>
<tr><td></td><td>


(With normal progress and full time work you will have a total of 21 weeks (including eastern) to complete the thesis work part II. This means from the official start date until the date of hand in of the final report.)</td></tr>
<tr><td>Completion target date:</td><td>Final report is to be delivered on 2nd June 2017 and presented in June 2017. After that the project team is disbanded.</td></tr>
<tr><td>Relevant links/references:</td><td>[1] Huang, T., Solvang, W.D., & Yu, H. (2016, June). An introduction of small-scale intelligent manufacturing system. Paper presented at the 1st International Symposium on Small-scale Intelligent Manufacturing Systems (SIMS 2016), Narvik, Norway.

[2] Stella Polaris: The company. Retrieved from http://www.stellapolaris.no/</td></tr>
</table>

Attachment 2

Faculty of Engineering Science and Technology

Master of Science – Industrial Engineering

Master Thesis Part II – Pre Study Report

(SHO6266)

Development of Small-scale Intelligent Manufacturing System (SIMS): A Case Study at Stella Polaris

Author(s):

Stud. Techn. Taoying Huang

Supevisors:

Wei Deng Solvang

Hao Yu

Tom Harry Klausen

30th January 2017

UiT THE ARCTIC UNIVERSITY OF NORWAY

Faculty of Engineering Science and Technology

Title: Development of Small-scale Intelligent Manufacturing System (SIMS): A Case Study at Stella Polaris	*Date:* 30.01.2017 *Classification:* Open
Author(s): Taoying Huang	*Number of Pages:* *Number of Attachments:*
Subject Name: Master Thesis – Pre Study Report	*Subject Code:* SHO6266
Faculty: Faculty of Engineering Science and Technology	
Master Program: Industrial Engineering	
Supervisor: Wei Deng Solvang	
Co-supervisor: Hao Yu	
External Organization/Company: Stella Polaris AS	
External Organization's/Company's Liaison: Tom Harry Klausen	
Keywords (max 10): Intelligent manufacturing system; small-scale manufacturing; Industry 4.0; SMEs	
Abstract (max 150 words): Facing great challenges and fierce competition, it is imperative for manufacturing companies in the Northern Peripheral and Arctic (NPA) region to innovate and adopt new technologies or methods. The emerging concept of small-scale intelligent manufacturing systems (SIMS) is seen as a novel approach aiming at enhancing the competitiveness of the small and medium-sized manufacturers (SMMs). One of the purposes of this project is to further develop the initiative of SIMS in order to support SMMs in overcoming challenges and transforming and adapting themselves to the upcoming Industry 4.0 era. In this report, the purpose and significance/benefit of developing SIMS are analyzed. A framework regarding features and approaches for SIMS towards its objectives is established. Appropriate approaches are introduced based on literature reviews.	

Table of Contents

1. Introduction

The Northern Peripheral and Arctic (NPA) region bears abundant natural resources, including oil and gas, mineral resources, renewable energy, and fishery resources. Manufacturers in this region are mostly small and medium-sized enterprises (SMEs). Facing challenges primarily caused by the size and location of enterprises, manufacturing companies in the NPA region are constantly driven to take new measures to survive from the fierce competition against its domestic and international competitors, under the industrial environments of globalization of markets, rapidly changing customer needs and the coming era of Industry 4.0.

Aiming at enhancing the competitiveness of the small and medium-sized manufacturers (SMMs) in the NPA region, a novel concept for small-scale intelligent manufacturing systems (SIMS) has been put forward and introduced (Huang, Solvang, & Yu, 2016). One of the purposes of this project is to further develop the initiative of SIMS in order to support SMMs in overcoming challenges and transforming and adapting themselves to the upcoming Industry 4.0 era. Besides a theoretical framework, a case study will also be performed regarding the implementation of SIMS in a prawn producer in the seafood industry.

This report is a pre-study report for the master thesis project, representing the result of the first ten weeks' study on the project topic, including the literature review, the project planning, etc. The focus during this phase is on the theoretical study of the SIMS concept.

2. Background

There are three major factors that lead to the emerging of the SIMS initiative:

(1) Rapidly changing customer needs and globalization of markets and enterprises;
(2) Shifting manufacturing paradigms and the coming era of Industry 4.0;
(3) Challenges faced by SMMs in the resourceful NPA region.

Regarding these background facts, relevant contexts are described in detail in this chapter.

2.1. Industry revolution

Fig. 1 shows the four stages of the industrial revolution (acatech, 2013), from the mechanization of manufacturing facilities powered by water and steam in Industry 1.0, to the introduction of assembly lines for mass production powered by electricity in Industry 2.0, to the automation of manufacturing processes using electronic and IT systems in Industry 3.0, and to the autonomation of manufacturing using cyber-physical systems and the digitalization of value networks utilizing Internet of Things in Industry 4.0. The concept of Industry 4.0 (or "Industrie 4.0") originated in Germany at the beginning of 2010s, and stands for the fourth industrial revolution. There are many definitions for Industry 4.0, explaining it from different point of views, e.g.:

- *Industry 4.0 is "a comprehensive transformation of the whole sphere of industrial production through the merging of digital technology and the Internet with conventional industry" (Merkel, 2014).* (by the German Federal Government/ Federal Chancellor Angela Merkel)

- *"Industry 4.0 is a vision of integrated industry implemented by leveraging cyber-physical systems, embedded computing, and Internet of Things technologies"* (Lydon, 2016).
- *"Industry 4.0 is a term applied to a group of rapid transformations in the design, manufacture, operation and service of manufacturing systems and products"* (European Paliament, 2015).
- *"Industry 4.0 is a holistic automation, business information, and manufacturing execution architecture to improve industry with the integration of all aspects of production and commerce across company boundaries for greater efficiency"* (Lydon, 2016).

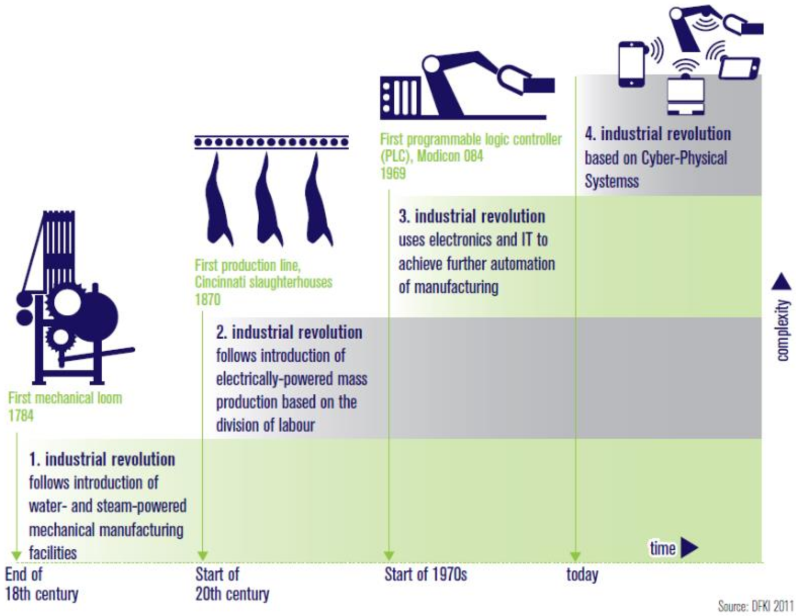


Figure 1: The four stages of the industrial revolution (acatech, 2013).

In the manufacturing environment of the new stage, vertical networking, end-to-end engineering and horizontal integration across the entire value network of increasingly smart products and systems is set to usher in Industry 4.0 (acatech, 2013). The entire value chain is organized and managed over the life cycle of products which is based on increasingly personalized customer requirements and extends from the product idea, test and development to its manufacturing and delivery to the end customer and ultimately to its recycling, including all associated services.

2.2. Manufacturing paradigm shift

Customer choices have increased sharply and customer and market needs have also increased steadily since one century ago. Driven by demands from human beings and supported by constantly advancing technologies, the manufacturing paradigm has shifted from the very early hand crafting to mass production along with the arising of Industry 2.0 to mass customization from the early 1990s. Extending from mass customization, individualized customization appears to be within reach lately. Building a unique product for each customer has been a popular trend.

Mass customization, different from mass production, seeks as its goal to develop, produce, market, and deliver affordable goods and services with enough variety and customization that nearly everyone finds exactly what they want, and focuses on variety and customization through flexibility and quick responsiveness (Pine II, 1999). While the focus of mass production is efficiency through stability and control and the goal is to develop, produce, market, and deliver goods and services which are often standardized at prices low enough that nearly everyone can afford them (Pine II, 1999). Mass customization is also described as "low-cost production of high variety, even individually customized goods and services" by B. Joseph Pine II in his book "Mass customizing products and services" (1993).

The trendy paradigm of individualized customization can be seen either as a branch of mass customization or as the next wave of mass customization. Individualized customization focuses on individualization/personalization and aims to tailor-made goods and services to the wants of individual customers. To better distinguish the four manufacturing paradigms, here we differentiate them by the scale of production volume and product variety:

- ***Craft***: low-volume, low-variety crafting;
- ***Mass production***: high-volume, low-variety production;
- ***Mass customization***: high-volume, high-variety production;
- ***Individualized customization***: low-volume, high-variety production.

While mass customization often refers to large scale production, individualized customization can be categorized as small scale production. The manufacturing paradigm shift also results in shortening product development cycles and shortening product life cycles.

2.3. Small and medium-sized enterprises

Small and medium-sized enterprises (SMEs) play a key role in driving economic growth and job creation and ensuring social stability worldwide, despite that different definitions of SMEs (often with large distinctions) are applied in individual countries (Edinburgh Group, s. 9).

SMEs including micro enterprises in the European nations are currently defined as enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million (European Commission, 2015). Table 1 shows the criteria for medium, small and micro-sized enterprises, respectively.

Enterprise category	Persons employed	Turnover or	Balance sheet total
Medium	< 250	≤ € 50 m	≤ € 43 m
Small	< 50	≤ € 10 m	≤ € 10 m
Micro	< 10	≤ € 2 m	≤ € 2 m

Table 1: Criteria for medium, small and micro-sized enterprises in the EU (eurostat, 2016).

According to the official statistics (eurostat, 2016), SMEs represent over 99% of all enterprises, account for around two-thirds of total employment, and contribute near 60% of gross value added in the European Union (EU) and also in Norway. SMEs also stimulate entrepreneurial spirit and innovation and are thus crucial for fostering competitiveness and employment (European Commission, 2015).

Under the influence of global economy, internationalisation is important for the competitiveness of enterprises of all sizes, no exception (or particularly) for SMEs (Edinburgh Group). SMEs are a major focus of EU policy, given their importance to Europe's economy (European Commission, 2015). Public policy at local, regional and national level plays a significant role in encouraging internationalisation of SMEs and assisting them to realise their full potential in global markets.

The industrial/manufacturing sector is one of the major sectors for both large companies and SMEs. The small and medium-sized manufacturing enterprises are now facing new challenges when embracing the upcoming era of Industry 4.0. For example, SMEs require flexible organisational structures because business areas that at present are clearly separated from one another are increasingly becoming interconnected, in order to substantial achieve advances in productivity raised by technological developments (Schröder, 2016).

3. Purpose of Developing SIMS

While the small and medium-sized manufacturers, especially in the remote NPA region, are facing intense competition and considerable challenges, external organizations (e.g. research institutes, government organizations) are actively seeking new approaches and measures to support SMMs against competition and challenges, leading to the emerging of the SIMS initiative. The ultimate goal of developing SIMS is to enhance the competitiveness of SMMs. Corresponding to the three background facts mentioned in the beginning of Chapter 2, the SIMS initiative is aiming to realize the following sub-goals:

(1) Quick changeover of manufacturing systems to meet customer demands and new markets;
(2) Transformation of SMMs to adapt themselves from the era of Industry 3.0 to Industry 4.0;
(3) Overcoming challenges caused by the enterprise size and location.

In order to achieve the above goals, the primary approach is to integrating technological, business, marketing and organizational transformation to strengthen the overall competence of SMMs where innovation is imperative. There are four types of innovation (the “4Ps” of innovation) (Tidd, Bessant, & Pavitt, 2005):

- ***Product innovation***: changes in the products/services;
- ***Process innovation***: changes in the ways in which they are created and delivered;
- ***Position innovation***: changes in the context in which the products/services are introduced;
- ***Paradigm innovation***: changes in the underlying mental models which frame what the organization does.

While the small scale of SMMs has always been a major restriction on further development of enterprises, new manufacturing paradigms and new technologies make SMMs rethink their roles and positions in the new era. Not only do SMMs want to break through the limitations caused by the small size (and distant location), they also want to benefit from this unique characteristic, distinguishing themselves from those large companies. It could be not easy but somewhere possible. Such a thinking also makes up a start point for initiating SIMS.

4. Significance of Developing SIMS

The development of SIMS is supposed to bring significant benefits for different partners (e.g. industries, manufacturers, and customers), presented in Table 2.

Targets	Significances to be brought by SIMS
Industries	- Highly flexible individualized customization that can be rapidly adapted to market changes under the influence of Industry 4.0; - Customer-oriented product life cycles; - Sustainable (e.g. user/resource/energy/environment-friendly) production.
Manufacturers	- A highly integrated, digitalized, automated and efficient production environment combined with a connected and responsive supply chain network for SMMs; - Customer-to-business (C2B) connected enterprise; - Customized product production at low cost and high efficiency.
Customers	- Individualized products at relatively affordable prices; - High-quality products and services.

Table 2: Significances to be brought by SIMS for different partners.

From Table 2, we can notice that the future manufacturing will focus more on the needs of human beings where customers are a major part, and workers/employees in the plant are also included. For example, a customer-oriented product life cycle means that customer wishes are adopted in all life-cycle phases from the initial product idea, development, production, use and maintenance to recycling and all associated services in order to make improvements continually and responsively. Cost, quality, responsiveness, efficiency and productivity are still the primary factors to be taken into consideration as objectives in developing SIMS. Sustainability is a rising factor to be considered as an objective. Flexibility, automation & autonomation, digitalization, integration and connectivity are also crucial features for SIMS.

5. Objective, Feature and Approach for SIMS

Based on the description in Chapter 4, a framework is established regarding important features and pertinent approaches towards objectives in designing and developing SIMS, shown in Table 3.

Both objectives and features for SIMS are divided into two levels, including:

- ***1st level objectives***: quick response to customer needs; low cost; high quality; high efficiency and productivity; sustainability;
- ***1st level features***: intelligence/smartness; small scale;
- ***2nd level objectives***: see the design objective tree in Figure 2;
- ***2nd level features***: flexibilization & mobilization; automation & autonomation; digitalization; integration, connectivity, communication and cooperation.

The relationship among objectives, features and approaches (displayed in the italic font style in Table 3) is explained as follows:

(1) Features can be seen either as approaches towards objectives or objectives to approaches;
(2) Generally, features serve objectives (vertical direction in the 2nd column from left to right), and approaches serve features (horizontal direction in the 3rd, 4th, 6th-9th rows);
(3) 2nd level features serve 2nd level objectives; 1st level features serve 1st level objectives; and 2nd level objectives serve 1st level features and objectives.

For example, automation as a 2nd level feature is an approach to achieve 2nd level objectives (e.g. automated and user-friendly) and further to realize 1st level features (e.g. intelligence) and 1st level objectives (e.g. high efficiency). Small-scale and intelligence of a manufacturing system, as the 1st level features making up SIMS, form the primary approach/solution to achieve 1st level objectives.

In the horizontal direction, approaches (e.g. in the 6th row: reconfigurable machines, flexible manufacturing systems) towards corresponding features/objectives (e.g. flexibilization) are listed out and categorized according to the hierarchy level in a manufacturing system. For example, reconfigurable machines are considered as an approach in the operational level that is applied to machines and equipment; flexible manufacturing systems are regarded as an approach in the tactical level that is applied to a shop floor; and the concept of agile company is an approach in the strategic level that can be applied to an entire enterprise. A more detailed classification for changeability related to hierarchical product and production levels can be found (Wiendahl, et al., 2007). Right to "enterprise" is a broader category named "value network" (in the most right column), and left to "machines & equipment" stands "products & work-in-process (WIP) parts". All of them together with human beings constitute a whole manufacturing system.

Hierarchy level in a manufacturing system →

SIMS objectives/features/ (O/F)		**Products & WIP parts**	**Machines & Equipment**	**Shop floor**	**Enterprise**	**Value network**
Level 1 (O)	Quick response to customer needs, low cost, high quality, high efficiency and productivity, sustainability					
Level 1 (F)	Intelligence / Smartness	*Smart product with self-managing capability*	*Smart machine*	*Smart factory with intelligent modules*		*Smart value-creation chains*
Level 1 (F)	Small scale	*Small-sized products*	*Small (or one) batch size*		*SMEs*	
Level 2 (O)	(See the design objective tree in Figure 2)					
Level 2 (F)	Flexibilization & Mobilization	*Customized (or individualized) product*	*Reconfigurable machine tools*	*Flexible manufacturing systems*	*Agile company though real-time information*	*Customized manufacturing & supply chain solutions*
Level 2 (F)	Automation & Autonomation	*Autonomous parts*	*Cyber-physical systems (from Industry 4.0*)*		*Holistic automation*	
Level 2 (F)	Digitalization	*Digital twin*			*Digital enter-preneurship*	*Digitalization of value chains*
Level 2 (F)	Integration, connectivity, communication and cooperation through *IoT, Cloud and Data*					

Table 3: A framework regarding features and approaches towards objectives in designing and developing SIMS.

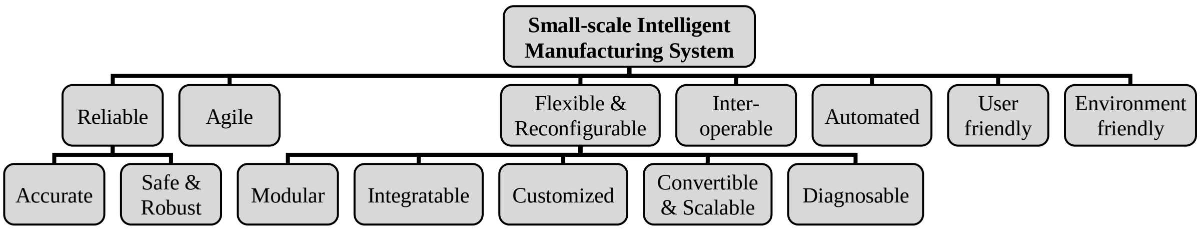


Figure 2: Design objective tree for SIMS (Huang, Solvang, & Yu, 2016).

In the following sections, approaches towards objectives/features are introduced mainly based on literature reviews. While many of the approaches are interrelated in concept, we try to give distinguished explanations with different emphasis or viewpoints.

5.1. Towards intelligence/smartness

Nowadays a high degree of product variation and personalization is becoming a prerequisite and production cycles will be radically shortened in a near future world. Industry 4.0 creates the scenario of "smart factory" – the factory of the future. A **smart factory** is more customer-centric, intelligent, flexible and dynamic, and enables the manufacturers to deliver products that meet better individual needs while driving new user experiences (Atos, 2014).

Smart machines and equipment (including smart sensors, etc.) are necessary components in a smart factory and will have the ability to improve processes through self-optimization and autonomous decision-making (Dreher, 2015). Technological innovation such as sensor technology and semantic technology, enables physical products to be filled with intelligence, sensing- and communication abilities in processes. Such products are called **smart products** (Mysen, 2015). Their unique properties also include context-awareness, pro-activity and self-organizing. Smart products or work-in-process parts are able to make decisions based on different contexts, and even attempt to anticipate the user's activities and choices.

In a smart factory, smart products, sensors, machines and the entire environment are networked with each other through data and information. Manufacturing environments in smart factories should be balanced to support a production model that delivers intelligent and appropriate customization and drives the "mass/individualized customization" reality (Atos, 2014). Manufacturing processes will be organized within entire production chains from suppliers to logistics to the life cycle management of a product, and closely connected across corporate boundaries (Dreher, 2015), forming **smart value-creation chains**. Networked companies in the supply chain make it possible to optimize individual production steps and the entire value chain.

5.2. Towards small scale

Small scale can also be applied to/interpreted from different levels:

- ***Product level***: small-sized product;
- ***Production level***: small batch size or one-off production;
- ***Enterprise level***: small and medium-sized enterprises.

Additive manufacturing technologies such as 3D printing enable small-scale manufacturing, make-to-individual manufacturing and manufacturing-on-demand to become a reality, and can be seen as an alternative to current manufacturing processes (Atos, 2014). Small-scale manufacturing supported by these technologies enables SMEs to deliver rapid prototyping of often small-sized products and variants and provide special products or irregular parts, eventually to meet an increasing requirement and expectation of more rapid bespoke production globally and locally.

5.3. Towards flexibilization & mobilization

As mention above, approaches towards achieving flexibility and mobility are categorized in different levels.

Reconfigurable machine tools (RMT) are considered as an approach in the operational level that is applied to machines and equipment. RMT is a modular machine with a changeable structure that allows adjustment of its resources, and eventually allows changes in customer demand volume and variety of products (Huang, Solvang, & Yu, 2016). RMT is economical for medium-volume production, high variety in production line, and can fill the gap between dedicated machine tools and CNC techniques

Flexible manufacturing systems (FMS) are regarded as an approach in the tactical level that is applied to a shop floor. FMS is an integrated group of processing CNC machines and material-handling equipment under computer control for the automatic processing of palletized parts (ElMaraghy & Caggiano, 2016). FMS is most suited for the mid-volume, mid-variety production range, and represents a compromise between the high flexibility of versatile job shops and the high production rate of a dedicated mass production system (e.g. transfer lines). FMS is essential to making small-batch production for mass/individualized customization low-cost and profitable (Gandhi, Magar, & Roberts, 2013).

The concept of **agile company** is an approach in the strategic level that can be applied to an entire enterprise. Agile companies support mass customization and individualized customization, cooperate with customers, suppliers and competitors, and bring products (often as solutions to customers' demands) to markets as quickly and cost-effectively as possible. Not only do they offer **customized products**, they also attempt to provide **customized supply chain solutions**.

5.4. Towards integration, connectivity, communication & cooperation

In an intelligent manufacturing environment, everything will be integrated and connected at different levels. Products including work-in-process parts, machines and equipment, people, and value chain partners communicate cooperate with each other directly.

Real-time information through communication allows manufacturers to be able to collaborate better and more effectively. They will also be able to respond more quickly to competitive pressures, shortening product life cycles, and rising demand for product and service personalization.

Internet of Things (IoT), cloud computing and Big Data analytics are some major technological enablers to realize networking, connectivity, communication and cooperation in a manufacturing system.

5.5. Towards digitalization, automation & autonomation

A key enabling technology integrating physical products with embedded software and computing power in Industry 4.0 is called **cyber-physical systems** (CPS). CPS uses ICTs to monitor and control physical processes and systems (European Paliament, 2015).

Based on connectivity and computing power, manufactured products will be **autonomous products** and incorporate self-management capability.

Integration of the real world into a functional, digital world enables a so-called "**digital twin**" to be created, which allows the real-time representation of processes, systems and entire production shops (Daimler, u.d.).

Digitalization enables manufacturers to make products more individual and production more efficient and responsive.

6. Project Goal

The goals of the master thesis project include:

1) To develop the concept of Small-scale Intelligent Manufacturing System (SIMS);
2) To conduct a case study for SIMS at the company Stella Polaris AS based on the theoretical development of SIMS;
3) To provide solutions/suggestions to Stella Polaris (and other companies in the prawn or other seafood industry) on implementing SIMS and/or its approaches in order to enhance the competitiveness of the company.

In Phase 1 (the pre-study phase), we are focusing on the first goal regarding theoretical development. In Phase 2, the other two goals of conducting case study will be emphasized

7. Project Scope

The project scope from the master thesis's task description can be put in four categories:

- Project planning and management
  - Understanding the project assignment;
  - Making a Gantt chart;
  - Determining the milestones for project management.
- Literature review – theoretical study
  - Conducting an extensive literature review on the concept of small-scale intelligent manufacturing systems;
  - Conducting an extensive literature review on the most commonly used methods and systems for companies in the fishery industry regarding their manufacturing systems.
- Case study
  - Performing an analysis of the currently used manufacturing systems at the target company Stella Polaris;
  - Providing suggestions for implementing SIMS at Stella Polaris in order to improve the competitiveness of the company.
- Reporting
  - Preparing reports and PowerPoint presentations;
  - Giving oral presentations of the performed work.

8. Project Management

Project planning and management on master thesis are conducted according to requirements. Main activities in the thesis project are listed in Table **5**, and milestones for project management are listed in Table 5.

Main Activities	***Start Date***	***End Date***
Master thesis project management	Mon 24.10.2016	June 2017 (not specified yet)
Phase 1 – Pre-study	Mon 24.10.2016	Tue 31.01.2107
Filling Task description 1	Mon 24.10.2016	Mon 31.10.2016
Understanding the project task and making a project plan using Gantt chart	Mon 31.10.2016	Fri 04.11.2016
General literature review: the concept of SIMS & fishery/seafood industry	Fri 04.11.2016	Thu 08.12.2016
More literature review: commonly used technologies/methods for companies in the seafood industry regarding manufacturing systems	Thu 08.12.2016	Tue 03.01.2017
Preparing for the oral presentation	Tue 03.01.2017	Tue 10.01.2017
Organizing and finishing the pre-study report	Tue 10.01.2017	Tue 31.01.2017
Phase 2	Tue 31.01.2017	##.06.2017
Filling Task description 2	Tue 31.01.2017	Mon 06.02.2017
Analyzing the currently used manufacturing systems at the target company Stella Polaris AS	Mon 06.02.2017	Thu 23.02.2017
Providing suggestions for implementing SIMS at Stella Polaris	Thu 23.02.2017	Thu 27.04.2017
Organizing and finishing the final report	Thu 27.04.2017	Fri 02.06.2017
Preparing for the final oral presentation	Fri 02.06.2017	##.06.2017

Table 4: Main activities with start- and end dates in master thesis project planning.

Milestones	***Start & End Date***
Task description 1 filled and agreed by the student and supervisors	Mon 31.10.2016
Progress meeting (with supervisors) – November	Thu 17.11.2016
Progress meeting – December	Thu 15.12.2016
Oral presentation – January	Tue 10.01.2017
Pre-study report hand-in	Mon 30.01.2017
Phase meeting – January	Tue 31.01.2017
Task description 2 filled and agreed by the student and supervisors	Mon 06.02.2017
Progress meeting – February	Thu 23.02.2017
Progress meeting – March	Thu 16.03.2017
Progress meeting – April	Thu 27.04.2017
Final thesis report submission	Fri 02.06.2017
Final oral presentation of master thesis – June	##.06.2017

Table 5: Milestones with specified date for master thesis project management.

Status reporting is indicated in Table 5 through the arrangement of report submissions, oral presentations and monthly progress meetings between the student technician and supervisors. The project management software – Microsoft Project – is used for the master thesis project planning and management. Progress monitoring can be performed and continually updated in Microsoft Project. A Gantt chart showing the schedule and the progress is also generated from the software (see in the Figure 3).

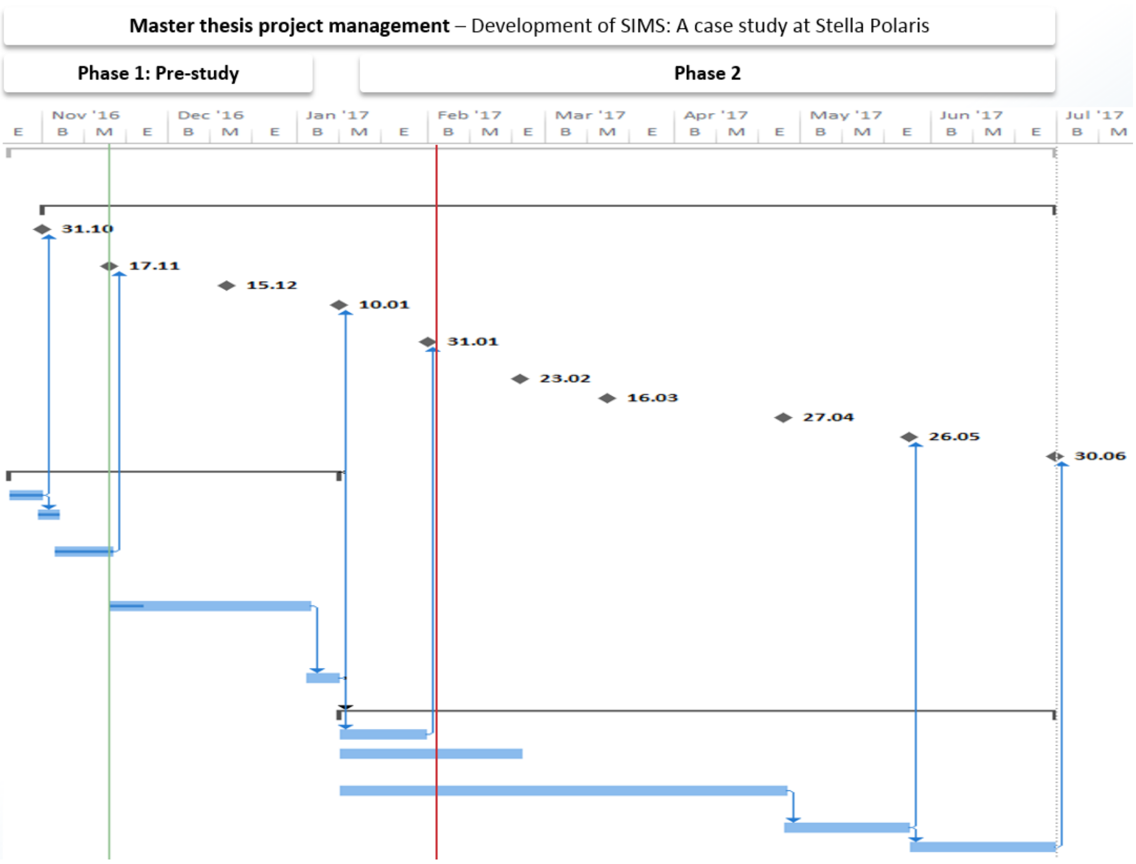


Figure 3: Gantt chart for master thesis project management from Microsoft Project.

9. Risks/constrains

Constrains might occur when collecting data or information both from the internet and from the company. It is not always easy to reach the most updated data and information from the internet. Methods against this type of problem include: direct contact with relevant contact persons via e-mail or telephone call, asking for help when necessary, etc.

Moreover, it might also be not easy to get all the needed information from the target company due to privacy. Good communication is important when dealing with such cases to make sure that both partners feel comfortable with the result.

10. Costs

During the pre-study phase (Phase 1), no cost is generated. For Phase 2, traveling expenses on visiting the target company might be generated.

11.References

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Activity description:

Project title: Development of Small-scale Intelligent Manufacturing System (SIMS): A Case Study at Stella Polaris		*Date:* 30.01.17	*Sign:*
Activity no:	*Activity name:*		
Responsible:			
Task description/intention:			
Scope:			
Method:			
Dependency:			
Documentation/results:			
Written by:	*Duration (days/weeks):*		