Knit On Demand - a performance study of the concept mass customized knitted fashion garments

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Abstract

Knit On Demand started as a project at the Swedish School of Textiles in Borås with the aim of evaluating complete-garment-technology. It is a mass customization concept within knitting technology. The key players are SOM Concept store in Stockholm and Ivanhoe, a producer of knitted garments in Gällstad.

The aim with this thesis is to identify and describe all processes in the concept from the moment when the client enters the store until the Knit On Demand garment is manufactured and delivered to the customer. The purpose is also to find and describe improvement opportunities as well as making an estimated cost calculation for them. To gather relevant data, a simulation of the whole process is performed. The method used is an action research case study of the Knit On Demand project based on quantitative data and qualitative interviews with key persons involved.

The process is described with a Value Stream Map of the current state and the future “ideal” state. The current state shows that total value-added lead time for producing one garment is 129 minutes. The future or “ideal” state shows how the processes can be improved and be more efficient, it also shows the importance of improving supplier delivery times.

To be able to improve the current Knit On Demand set-up, the order volume must increase from 1 to a minimum of 5 or more orders per week. The improvement suggestions are; new and better suppliers of yarn, new layout and improved down time, plan for the production, improved production time, inventory computer system, better communication between SOM Concept and Ivanhoe.

Key words: Knit On Demand, mass customization, mass customisation, Ivanhoe, SOM Concept, Lean production, Value Stream Mapping.
Sammanfattning

Textilhögskolan i Borås startade projektet Knit On Demand i syftet att undersöka och utvärdera complete garment teknologin. Idén bygger på konceptet masskundanpassning inom området stickning. Huvudaktörerna i Knit On Demand projektet är Textilhögskolan i Borås, återförsäljaren SOM Concept i Stockholm samt Ivanhoe, tillverkare av stickade kläder.

Målet med detta arbete är att identifiera och beskriva alla processteg, från den tidpunkt då kunden kliver in i butiken i Stockholm tills det färdiga plagget leverats. Vårt arbete går även ut på att hitta och beskriva förbättringsmöjligheter samt tillhörande kostnads kalkyleringar. För att frambringe relevant data utför och presenterar vi en simulering av hela processen. Metoden som har använts i arbetet bygger på observerade fallstudier från både SOM Concept och Ivanhoe. Den metod vi använder oss av är baserad på kvantitativ data och kvalitativa intervjuer med personer involverade i projektet.

Hela processen beskriver med hjälp av ett nutida och framtida flödesschema. I det nutida flödesschemat är den totala värdehöjande tiden för ett producerat plagg 129 minuter. Förslaget i ett framtida flödesschema visar att processen kan förbättras, bli mer effektiv och påvisar även hur stora förändringarna skulle bli med en snabbare garnleverantör.

För att förbättringarna för Knit On Demand ska gå att genomföras måste ordervolymen ökas från 1 plagg till minst 5 plagg per vecka. Förbättringsförslagen är; nya och snabbare garnleverantörer, ny layout plan för Knit On Demand processen hos Ivanhoe, snabbare produktionstid, installation av ett datasytem som hanterar lagerhållning, bättre kommunikation mellan SOM Concept och Ivanhoe samt förbättrad ställtid.

Nyckelord: Knit On Demand, mass customization, mass customisation, Ivanhoe, SOM Concept, Lean produktion, värdeflödeskartläggning
Acknowledgements

This assignment was given to us by Joel Peterson and from the very beginning we felt it was the right choice for us. We have enjoyed all the work involved and hope that we have been able to give something in return by finalizing this thesis.

We would like to thank all personnel at Ivanhoe AB, especially Ulf Göthager, for taking the time to answer all our questions, our supervisor Joel Peterson and Lotta Hjelte at SOM Concept store in Stockholm.

We would like to especially thank Jonas Larsson for your guidance and assistance whenever we needed it and for making us feel welcome when visiting both Ivanhoe and SOM Concept.

We are very happy to have been a small part of this project and hope that what we have done with this paper will contribute in some way.

Sandra-Maria Pettersson and Madeleine Hillman
May, 2010
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1. Introduction

This chapter describes the background of the problem and purpose of this thesis. It also explains the concepts of mass customization as well as the Knit On Demand set up today, which is the focus in this paper. Furthermore the scope and the outline are specified.

1.1 Background

In the article *Mass Customization of knitted fashion garments* by Joel Peterson and Heikki Mattila (2008) they write that the sell-through factor is 65 % - 70 % in ordinary fashion retailing. One of the reasons as to why so much must be sold at a reduced price is that the fashion industry has created a new behaviour among its customers. We are constantly bombarded with the latest fashion in TV and media and today’s customer expects to find the very latest in the shops as soon as possible.

Many companies have difficulties to respond to the faster-fashion world. Often lead times between the original order and actual delivery are very long and the customer demands have changed. The longer time the product spends on its way to the customer the lower the value of the garment becomes. Around 70 % of the logistic cost in the supply chain depends on not having the right products in stock. ¹

These are some of the problems that the mass produced fashion market are facing today and why concepts such as mass customization is a new approach to the fast and complex customer demands.

1.1.1 Mass customization

Mass customization was introduced by Stan Davis in 1987. He describe it as reaching a great number of customers in a mass market but simultaneously treating them individually as in the customized markets of pre-industrial economies (Davis,1987). The development of mass customization is built on three ideas: the first is to create more flexible manufacturing to get higher variety at lower cost. The second is a growing demand after customized products and the third is focus on the individual customer. ²

Mass customization developed from mass production where the products are organized around big batches and economies of sale. ³ The producers are using standard measurements for their garment that are assumed to fit all needs, except from some dimensional changes in the different sizes. A heavier, short man who is looking for a garment in size XXL often has trouble finding suitable clothes with the garment being often very long in both the back and the sleeve. The same goes for a long and thin person. He has problems finding suitable clothes that have long sleeves and a long body.

In mass customization each individual person can be a part of the process from the beginning. They can choose between several options in style, material, colour, attachments and sizes. The

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¹ Jonas Larsson, One-piece fashion (p. 1-2)
² Giovani Da Silvera, Mass customization: Literature review and research directions(p. 2)
³ J. Peterson, J. Larsson, A multiple choice system for designed knitted fashion garments(p. 2)
author Joseph Pine, has identified four levels that can explain the way of mass customization: collaborative, adaptive, cosmetic and transparent.\textsuperscript{4}

- Collaborative, the customer is working together with the seller to get the right product.
- Adaptive, the production and the staff need to be flexible so the products can be changed after customers demand.
- Cosmetic, each product is wrapped up for the customers.
- Transparent, the products are adaptive to different customer requirements.

Knit On Demand is based on the mass customization concept. The end customer receives assistance in the store to; design a knitted garment with a variety of the available choices, as well as having his measurements taken for the perfect fit. The customer will then get a customized garment that is designed by and made for him.

\textbf{1.1.2 Knit On Demand}

Knit On Demand started as a project with the aim to evaluate the complete-garment-technology. It is financed by the Knowledge foundation and is carried out at the Swedish School of Textiles in Borås. Knit On Demand is based on mass customization and complete garment knitting technology.

In this project, the Swedish School of Textiles have worked together with two companies, Ivanhoe; a fashion and production company, and SOM Concept, a men’s fashion store. SOM Concept specializes in mass customization of jeans and suits and is located in Stockholm. Ivanhoe produces knitwear for sportswear and leisure. During the spring of 2007 Simon Hjelte, the co-owner of SOM Concept, contacted the Swedish school of Textile with the objective of starting a collaboration. The collaboration would mean a development of his business to include customized knitwear.\textsuperscript{5}

Originally, the idea with Knit On Demand was to have a shop-in-shop concept where the garment is produced in the shop with the complete-garment-technology. It is an expensive investment to introduce and since Ivanhoe already had a set up of fully-fashion knitting machines and were involved in the project, the launching of the Knit On Demand concept began with production in Gällstad and the store in Stockholm.

During the autumn of 2008, the first garment was produced by Ivanhoe and sent up to SOM Concept for controlling (Jonas Larsson, 2009).\textsuperscript{6}

During the autumn of 2009 the sales of customized garments began in the SOM Concept store in Stockholm, using the fully-fashion technique. Fully-fashion provides a minimum of waste and there is no cutting after knitting. One reason why fully-fashion is used is because there are no bulky seams on the garments.\textsuperscript{7}

Below is an explanatory flow chart of the Knit On Demand process today. First end customer enters the store, SOM Concept, to design his own garment and to have it custom-made. SOM Concept provides the service of measuring the customer along with providing a variety of design selections. SOM Concept sends the order to Ivanhoe via e-mail to Ivanhoe who

\textsuperscript{5} Jonas Larsson, One-piece fashion(p. 2-3)
\textsuperscript{6} Jonas Larsson, One-piece fashion(p. 15)
\textsuperscript{7} Jonas Larsson, One-piece fashion(p. 16)
produces the Knit On Demand garment. The yarn suppliers are TNV in Portugal and Filartex in Italy. Which supplier is used depends on the costs and the urgency of the order. Filartex is 20-30% more expensive than TNV but the delivery lead time is much faster. The customer can request to have the garment delivered either directly to his home address by Ivanhoe or to have it delivered to SOM Concept. Normally Ivanhoe sends the completed garment to SOM Concept where SOM Concepts own label is added before the customer can come and pick up his customized garment at the store.

1.2 Problem background

Knit On Demand started as a project at the Swedish school of textiles in 2006. Today it is a working concept and a work-in-progress between the project, SOM Concept and Ivanhoe. Joel Peterson discovered that there was a need to identify the whole process as well as study fashion logistic key success factors in order to be able to compare it with ordinary fashion retailing and production concepts, and at the same time find improvements for the current set-up.

1.3 Research question and purpose

The aim with this thesis is to identify and describe all of the processes in the concept, from the moment when the client enters the store until the Knit On Demand garment is manufactured and delivered to the customer. The purpose is also to find and describe improvement possibilities as well as make an estimated cost calculation of these improvements. To gather relevant data, a simulation of the whole process is performed along with qualitative interviews with key persons. Involved parties are SOM Concept store in Stockholm, Ivanhoe in Gällstad, our supervisor for this thesis; Joel Peterson who is head of the technology work group for the Knit On Demand project at the Swedish School of Textiles in Borås and Jonas Larsson, head of the logistics work group for the Knit On Demand project at the Swedish School of Textiles in Borås.

The Knit On Demand process is described with a Value Stream Map of the current state and a future “ideal” state. To understand Knit On Demand, the concept of mass customization is
investigated as well as Lean production. A comparison of the three concepts is presented to further analyze and fully understand how to find improvements and where the focus should be in the Knit On Demand production.

Fashion logistic key success factors such as stock-turn rate, sell-through factor, and lost sales for the concept are calculated and presented in order to be able to compare with ordinary fashion retailing and production concepts.

The aim with this work is to study the performance of an existing mass customization fashion concept.

Main research question: To identify and describe all important processes from the moment when the client enters the store until the ready-made garment is manufactured and delivered to the customer.

Research question 2: What are the lead times for the identified processes involved in the concept?

Research question 3: What improvement possibilities can be found in the processes?

Research question 4: What are the rates of the key success logistics factors: stock-turn, sell-through and lost sales?

1.4 Scope

The main focus of this paper is to evaluate the current on-demand business concept of knitted fashion garments and especially the research questions mentioned.

The thesis explores the current Knit On Demand set-up and compares it with ordinary production at Ivanhoe. It would have been possible to further compare and research other production concepts.

To understand Knit On Demand the concept of mass customization is described as well as Lean production. A comparison of the three concepts is presented to further analyze and fully understand how to find improvements and where the focus should be in the Knit On Demand production.

SOM Concept is working with mass customization in other forms such as jeans and suits but we have chosen to only look into Knit On Demand.

1.5 Thesis outline

Chapter 1 - Introduction

This chapter describes the background of the problem and purpose of this thesis. It also explains the concepts of mass customization as well as the Knit On Demand set up today which is the focus in this paper. Furthermore the scope and the outline are specified.
Chapter 2 - Methodology

This chapter explains how the research was performed and how data was collected. We discuss and motivate chosen methods that correspond with our objectives.

Chapter 3 - Simulation

This chapter describes the simulations performed at SOM Concept and Ivanhoe as well as an analysis of the outcome. Some data calculations are presented as well as a description of fully fashion and cut-and-sew-garments. The layout plan at Ivanhoe is visualized and discussed.

Chapter 4 - Fashion logistics key performance indicators and a profit comparison

This chapter presents fashion logistic key success factors for Knit On Demand such as sell-through factor, lost sales, service level and stock-turn rate. A profit comparison between Knit On Demand and Ivanhoe’s normal production is discussed.

Chapter 5 - Value Stream Mapping

This chapter discusses and presents the Value Stream Maps of the current state and the future “ideal” state. Improvement suggestions are offered as well as a calculation costs.

Chapter 6 - The Toyota Way and Lean production

In order to fully understand the benefits of Knit On Demand, the similarities between Lean production and mass customization is analyzed in this chapter. First, an explanation of the Toyota way is presented and the 8 forms of waste in Lean production. Second, a summary of the concepts are displayed, as well as an evaluation of the Lean progress at Ivanhoe.

Chapter 7 - Summary and result

This chapter presents a summary and the result of the work performed. It summarizes the result of the main research questions.

Chapter 8 - Analysis and discussion

This chapter analyses and discusses the result from the research. A SWOT analysis of Knit On Demand and mass production is presented.

Chapter 9 - Further research

In this chapter, suggestions for further research are discussed.

1.6 Definitions

Cycle time (C/T)
The time it takes for one article or product to be finished in one process
Set-up time (S/T)
The time it takes to adjust/reset machines

Value adding time (V/T)
The time that adds value to a product in such a way that the customer is prepared to pay for it

Sell-through factor
The percentage of items sold at full price.\(^8\)

\[
\text{Sell-through} = \frac{\text{Number of sold items to full price}}{\text{Number of total sold items}}
\]

Lost sales
Lost sale is difficult to measure and you need to know how many customers enter the store on a daily basis.\(^9\)

\[
\text{Lost sales} = \frac{\text{Number of customer that doesn’t make a purchase in the store}}{\text{Total number of visitors}}
\]

Service level
Indicates how big part of the collection is available at the store.\(^10\)

\[
\text{Service level} = \frac{\text{Number of different models available in the store}}{\text{Total number of models in collection}}
\]

Stock-turn rate
Stock-turn rate is the ratio of sales to average inventory and it indicates how many times inventory is sold during a period (usually a year). If the rate is low it can indicate having too much in stock and if it is high it could mean insufficient inventory levels.\(^11\)

\[
\text{Stock-turn rate} = \frac{\text{Sales}}{\text{Average inventory}}
\]

2. Methodology

This chapter explains how the research was performed and how data was collected. We discuss and motivate chosen methods that correspond with our research questions.

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\(^{8}\) Larsson, Jonas. One-piece fashion.(p. 7)
\(^{9}\) Larsson, Jonas. One-piece fashion.(p. 7)
\(^{10}\) Larsson, Jonas. One-piece fashion.(p. 7)
\(^{11}\) http://www.retailtimes.com.au/index.php/articles/What_is_the_Stock_Turn_Rate_and_why_is_it_important
2010-05-07 13:30
2.1 Method

Qualitative research methods do not involve measurement or statistic. One qualitative method is the case study. Another model is the clinical method, which means to present a situation for someone to deal with whilst making observations and trying to understand the thought process. The naturalistic observation includes stepping back from the situation and not interfering. To summarize this method, it involves the researcher participating or being in the situation that is analyzed in order to capture and evaluate actions taken. One criticism is that it can be easy to influence the outcome, for example if the researcher doesn’t have enough experience. The argument behind this is that the method is based on realism. Qualitative methods are usually used when analyzing smaller populations.

Quantitative research methods focus on collecting empiric and quantifiable data, gathering them in a statistical form and analyzing the outcome. The result of the research is in the form of numbers, which are usually presented in tables, graphs or other statistical forms. Quantitative methods are mostly used when analyzing larger populations.

The method used is an action research case study of the Knit On Demand project based on quantitative data and qualitative interviews with key persons involved.

We have conducted interviews, study visits, constructed a simulation of the Knit On Demand process and researched literature. Interviews have been performed with Ulf Göthager at Ivanhoe, Lotta Hjelte at SOM Concept and Jonas Larson. We made study-visits to both Ivanhoe in Gällstad and SOM Concept in Stockholm. The simulation was also performed in both places in order to evaluate the whole process. The quantitative methods we have used are; gathering data during our research and study-visits to perform a Value Stream Map and to determine the lead times in order to make further calculations.

2.2 Research process

2.2.1 Simulation
To be able to describe the Knit On Demand process it is imperative to have the information of all the steps involved. To gather the information, a simulation of the process is carried out. A simulation is to perform an imitation of something real. Jonas Larsson acted as a customer and placed an order at SOM Concept store, where we carefully monitored all events. In order for the simulation to be as real as possible we went to Ivanhoe in Gällstad to follow each step involved in the actual manufacturing of the garment. Note that the simulation was performed for only one model type.

2.2.2 Value Stream Mapping
Value Stream Mapping gives an overview of the process and identifies leverage points of improving a value stream by following the process from beginning to end. It gives a view over the transformation steps, information flow, process flow and delay. Key metrics involved are process time (PT), lead time (LT), set up time (S/T) and value added time (V/T). We will

13 http://www.ne.se/kvalitativ-metod 2010-04-13 14:00
14 http://www.ne.se/kvantitativ-metod 2010-04-13 14:00
need to determine what triggers the action in every process, identify and quantify the waste between the processes and identify the flow stoppers and summarize it all to a map. The goal of the value stream is to reduce; lead times, process times and non value adding activities.

2.2.3 Literature research

Our literature research began with the concept of mass customization and logistics. We found that mass customization has many similarities to Lean production and the Just-In-Time principle. We extended our research to include Lean and JIT and compared these with Knit On Demand.

There are a limited number of articles on the subject of mass customization and Knit On Demand research. Internet has provided us with some good general background information. There is however a limited amount of literature regarding mass customization and there are only some articles regarding Knit On Demand. There is a large quantity of information regarding the quality management systems, The Toyota Way, and Lean Production, and in order to learn more about Knit On Demand a study of these concepts is necessary.

2.3 Validity and reliability

In an empirical research there are two concepts that are important when examining a source; validity and reliability. Validity means to examine that what is to be examined and nothing else. Validity is concerned with the study’s success at measuring what the researcher is set out to measure. The concept can be divided into external and internal validity. External validity refers to the extent to which the results of a study are generalizable and how the result and the reality are coherent. The internal validity refers to how fact and empiricism are coherent.

Reliability refers to the precisions in the measurements. It is the extent to which an experiment, test, or any measuring shows the same result after repeated trials.

The literature research is based on current scientific articles and literature by recognized authors, which should increase the validity of this paper. We have used a wide variety of different literature that has given us a broad approach to the studied subjects.

Regarding the simulation of the process it has been performed in the same way as for a regular customer. People involved in the simulation are experienced key persons from SOM Concept and Ivanhoe respectively. However since it was not performed by an actual customer who did not have anything to do with the project the personal thoughts or views on the matter have not been considered during our research. The simulation at the manufacturing site, Ivanhoe, was performed by experienced personnel who would normally handle the order. The simulation was performed in the exact same way as during normal production. The data is considered relevant and reliable. Only one model was chosen to be evaluated in this simulation. This means that the data in the thesis can vary somewhat.

Interviews have been performed with experienced persons who have the best knowledge in Knit On Demand today. They have been involved from the start of the project and are

16 http://writing.colostate.edu/guides/research/relval/pop2b.cfm 2010-05-20 18:47
17 http://writing.colostate.edu/guides/research/relval/pop2a.cfm 2010-05-20 19:00
considered the most reliable sources. The interviews have not been carefully prepared as they have evolved from study visit to study visit. We have not gathered any interview questions however the facts in this paper are based on these meetings.

3. Simulation

This chapter describes the simulations performed at SOM Concept and Ivanhoe as well as analyzes the outcome. Some data calculations are presented as well as a description of fully fashion and cut and sew garments. The layout plan at Ivanhoe is discussed.

3.1 SOM Concept

SOM Concept is located in PUB department store in Stockholm City Center. All the shops in PUB are open plan and they are not divided into little mini stores. You can barely notice the difference between one shop and the other next to it. The shops float together into one big store. SOM Concept is about 40 m² and located on the second floor in one of the corners. When you enter there are clothes, shoes and accessories hanging and lying nicely on racks. SOM sell other garments such as Bergman’s, Atlas Design, Amanda Christensen and Brunngård. About 60% of the store is for; Knit On Demand, customized jeans and suits.

There are a couple of boards with text hanging from the ceiling explaining the jeans and the Knit On Demand process for the customer; just a few simple steps regarding how to design your own knitted garment. The text for the Knit On Demand board is:

“1. Try on a sweater in the basic size XS-XL. Together we will adjust the width and the length so it fits YOU.
2. Design the sweater by choosing yarn and neck. The types of neck available are: V-neck, Deep V-neck, Round neck, Roll neck or Cardigan.
3. The sweater is, according to your measurements and design, knitted into a unique specimen. This is done in Gällstad, outside Borås where sweaters have been knitted since the 1940’s

Delivery is made to the store or to your home within three weeks after the order is placed. Your unique size is saved in a measurement profile that you can use the next time you order.”

Figure 2. Available models for Knit On Demand at SOM Concept

Together with Jonas Larsson we performed a simulation of the Knit On Demand process in the store and in the production site at Ivanhoe in Gällstad. See Appendix 3 with pictures. The documented steps are as follows:

1. Customer enters the store
2. Customer can see and choose from examples of Knit On Demand garments hanging in the store
3. There is one board hanging from the ceiling with information text regarding how to purchase a garment
4. Customer gets help form a shop assistant. The shop assistant must have formal sewing training or similar skills to be able to help the customer with correct fitting
5. Customer decides on a model
6. The sizes available are XS, S, M, L, XL and XXL. Customer tries on a test garment in a suitable size and the assistant helps with the fitting. The correct size is decided and then it is possible to change the sleeve length, bottom length, waist width and length from shoulder to waist. The lengths are added or withdrawn from the basic size (from ±1 to ± 8 cm)
7. The shop assistant fills in an ordering document during the process of choosing the design and size
8. Customer chooses a color for the garment
9. If customer wants Contrast 1, the color is chosen
10. If customer wants Contrast 2, the color is chosen
11. If customer has chosen a cardigan he can also choose different colors for the button holes
12. Neck-plate details can be chosen
13. The shop assistant fills in the order specification and also attaches a yarn sample of the chosen colors to the form
14. When the fitting and the design is completed, customer pays 50% of the cost for the garment in advance
15. The filled form is sent to Ivanhoe via email on the same day or next working day
16. Garment is produced in Gällstad at Ivanhoe production site
17. The completed garment is sent to SOM within 3 weeks
18. When it arrives, SOM attaches their own label to the garment
19. The garment is ready and SOM contacts the customer to come and pick it up and make the final payment. It is not possible to retract the purchase or return the garment at this point, (according to Swedish consumer laws it is optional for the store to have a return policy). When first payment is made the customer must finalize the purchase of the garment
20. It is also possible for Ivanhoe to send the garment directly to the customer if specified on the order form

The picture below shows the customer design process at SOM Concept.
Figure 3. SOM Concept design process
Design options are presented in the table below.

<table>
<thead>
<tr>
<th>Sizes</th>
<th>Model</th>
<th>Colors</th>
<th>Contrast 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>XS</td>
<td>V-neck</td>
<td>Currently 16 to choose from, mostly basic.</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Deep v-neck</td>
<td>Some colors vary from season to season.</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Cardigan</td>
<td>Possible to choose striped</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Round neck</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XL</td>
<td>Slip over</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XXL</td>
<td>Turtle neck</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contrast 2</th>
<th>Button holes</th>
<th>Neck plate fabric</th>
<th>Buttons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detail on the sleeves in any of the available 16 colors</td>
<td>Button holes can be sewn in different colors</td>
<td>A detail on the neck, a fabric in woven material to chose from</td>
<td>One type of button is sewed on to the cardigan. In the future more buttons will be available to choose from</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stripes</th>
<th>Stripe option available in all colors, the stripes are produced in two colors</th>
</tr>
</thead>
</table>

Table 1. SOM Concept design options

The price list below is for the customer and it includes basic prices for the different models. Customer can add extra details in exchange for a fee of 100 SEK. It is also possible to have the garment delivered to a specified address. The neck-plate is a woven fabric which is sewn on the back of the neck on the inside as a detail.

<table>
<thead>
<tr>
<th>Customer price list Knit On Demand garment at SOM Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip over</td>
</tr>
<tr>
<td>Cardigan</td>
</tr>
<tr>
<td>Turtle neck</td>
</tr>
<tr>
<td>Other (Round neck and V-neck)</td>
</tr>
<tr>
<td>Change button hole color</td>
</tr>
<tr>
<td>Stripes</td>
</tr>
<tr>
<td>Contrast 1</td>
</tr>
<tr>
<td>Contrast 2</td>
</tr>
<tr>
<td>Neck plate</td>
</tr>
<tr>
<td>Home delivery (by post)</td>
</tr>
</tbody>
</table>

Table 2. SOM Concept Knit On Demand price list

The table below shows the cost and the selected choices for Jonas’s garment. Total sum for the garment is 1395 SEK. The profit for SOM Concept is 795 SEK.
<table>
<thead>
<tr>
<th>Jonas garment cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep V-neck (grey)</td>
</tr>
<tr>
<td>Contrast 1 (lime green)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Table 3. Deep V-neck cost calculation

Normally it takes 20 minutes for a customer to have his measurements taken and choose a design for the garment. This time can vary from one customer to another but this is very unusual. The staff at SOM, usually Simon, sends the completed order specification on the same day or the next working day to Ivanhoe. It is sent by e-mail or by post. See Appendix 2.

Lotta at SOM estimates that there are 1-2 customers per week who buys a Knit On Demand garment in the store. The short term goal is to sell at least 8 garments per week. They believe that when more customers find their way to SOM and hear about their concept the sale will increase in the long term. A customer who has bought one garment at SOM will most likely be back again. It’s a long term relationship that is built with the customer which focuses on customer service. This is also why it is more unusual that a customer is unhappy with a garment and wants to return it. SOM have a non refund-policy and do not have any clearance sale of their garments, as this is unnecessary.

It has taken SOM three and a half years to get where they are today with Knit On Demand garments. Swedish School of Textiles in Borås was working on the project when Simon contacted Jonas Larsson. Simon was working with the customization of jeans and thought that this would suit his business model. The project had already established contact with Ivanhoe in Gällstad regarding the production and soon involved them in SOM’s business idea. Today SOM is satisfied with the relationship with Ivanhoe. They wish to shorten the lead time and would prefer to have the finished garment within 1-2 weeks, preferably 1 week. According to SOM, the communication with Ivanhoe could improve. There have been instances that a yarn is out of stock and SOM is notified of this after the order has been sent to Ivanhoe. The customer is then informed a couple of days after the purchase. This is negative for SOM’s credibility.

SOM is content with the models, which they have chosen themselves. They wish however to have more colors to choose from. This is an issue for Ivanhoe and their supplier.

SOM would like to include wool garments in their assortment, but this is something Ivanhoe is more reluctant to work with today. There is more work involved with wool garments. Cotton fabric is easily reshaped. If the knitted fabric is a couple of centimeters too large or too small this can be adjusted to the correct size by steam and press. This is not the case with wool fabric. If the garment is adjusted it will later go back to its original shape. This is the reason why Ivanhoe is reluctant to work with wool. It would increase unnecessary waste and work time.

When the demand for Knit On Demand garments increases, SOM is considering having a real time chart by the cash register with information regarding what garments have been sent to Ivanhoe and when they are expected to be finished and delivered. This would be a constructive way to manage the flow of the garments and to calculate when they can be ready.
SOM has a web shop for their jeans. The jeans are sold and produced with the same concept as Knit On Demand. The measurements are taken for each customer and there are a number of design options. The measurement profile is saved and now the customer can design and buy the jeans online. The goal is to have the shop up and running for the Knit On Demand as well. Customer must make an appearance at the store and get a measurement profile before he can buy garments online.

During the autumn of 2010 SOM will increase their collection with knitted scarves and hats in cotton.

3.2 Ivanhoe

The order is sent and received by Ulf Göthager at Ivanhoe two working days after Jonas has placed the order at SOM Concept. At Ivanhoe we followed the process closely and documented each step as per below.

1. Ulf at Ivanhoe receives the order specification from SOM Concept by e-mail
2. When it can be fitted in to Ivanhoe’s normal production process, this is when Ulf has time and there is no other production on the machines, they can start producing the Knit On Demand garment
3. Knit On Demand garments are produced on a Stoll CMS 311, 12-gauge knitting machine. The machine is programmed according to the order specification. The base model is already programmed on the machine. Several adjustments are made of the waist width, the garment length, the shoulder length and the sleeve length. Contrast 2, on the sleeves is also programmed. Every time a new garment is produced the machine is adjusted, this takes about 2 minutes. Change of yarn color takes about 3 minutes. The disadvantage with Knit On Demand garments is that the machine has to be reprogrammed and adjusted for every model.
4. The knitting machine produces 4 parts; two sleeves, one front and one back side. Problems and other issues occur during knitting and there is a lot of down time.
5. The collar is produced on another knitting machine. This takes about 2-3 minutes and at least two collars are made at the same time. In order to get a good sample two or more collars are always made at the same time. The knitting machine for this is a Shima Seiki, SFE-161. Contrast 1 is programmed on this machine.
6. It takes 33 minutes to knit the parts for Jonas garment. This time doesn’t include problems or other issues that were dealt with during the production. With down time the total production time was doubled, almost 66 minutes.
7. The parts are cut and separated
8. All parts are washed and tumble dried. The rinse program is used, which takes about 5 minutes. The garment is tumble dried for about 60 minutes.
9. After washing, the parts must be steamed and pressed. This is done in a steam and press machine, Nepi Otello. It takes 2.5 minutes. Cotton is an uncomplicated material to work with, it can easily be adjusted during press and steaming.
10. A seamstress uses ready-made pattern to cut the pieces according to chosen model.
11. The parts are sewn to a finished garment. It takes about 15-20 minutes. For every garment the machines are adjusted and change of thread is needed.
12. When sewing is completed it is time for final press, form adjustment and inspection. Measurements are taken on the finished garment and compared to a measurement list. If it does not match, the garment can easily be adjusted with a little steam and press.
13. When the garment has passed inspection it is packed in a plastic bag and sent by post to SOM Concept or directly to customer.

This way of producing garments is not good business for Ivanhoe at the moment. It takes too much time to adjust machines every time one garment is being produced. Compare with producing 100 or more garments in one go where the machine is adjusted only one time. This also means that Ivanhoe’s other production is prioritized before Knit On Demand. Ulf handles a Knit On Demand order when a 12-gauge knitting machine is available and when he or his personnel have time.

If SOM Concept or another customer would like a completely new model, it would take from 30 minutes to 3 weeks to reprogram a machine.

Ivanhoe has a range of 5, 8, and 12-gauge machines. Lotta at SOM Concept has chosen to have their garments produced on a 12-gauge machine. This is a design and preference aspect.

During production, downtime for one Knit On Demand garment is 100%. The machine is stopped many times because it needs to be adjusted each time a new model is being produced. Problems occur during the initial knitting phase and it results in a longer production time, almost the double compared to normal mass production.

In 2009 SOM ordered 29 Knit On Demand garments from Ivanhoe (statistics from Ulf). According to Ulf they would prefer to have a minimum of 1 order per day so they could produce 5 garments in one go each week.

Ivanhoe’s price to SOM Concept is 600 SEK for each model with the exception of striped, for which they charge 660 SEK. It takes longer time to sew a striped garment due to pattern matching. Knitting time is the same as for one colored garment.

### 3.2.1 Calculations

In the table below the value added lead is time presented for each operation that is performed during manufacturing.

<table>
<thead>
<tr>
<th>Calculation production time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moment</strong></td>
</tr>
<tr>
<td>Program knitting machine</td>
</tr>
<tr>
<td>Change thread on knitting machine</td>
</tr>
<tr>
<td>Knitting on machine</td>
</tr>
<tr>
<td>Cut pieces</td>
</tr>
<tr>
<td>Washing (rinse program)</td>
</tr>
<tr>
<td>Tumble dry</td>
</tr>
<tr>
<td>Steam and press</td>
</tr>
<tr>
<td>Cutting</td>
</tr>
</tbody>
</table>
Please note that the times above are for Jonas deep v-neck and that they can vary somewhat for different models. Below is the calculated Standard Allowed Minute. The allowance is from 10% to 100% for the different operations. When knitting on the knitting machine the allowance is 100% because of the down time, set-up time and problems that occurs for each time the machine is reprogrammed when a new model is produced. In normal production the allowance is usually between 10-20%. For sewing we have added 50 % allowance because of long set up time for each model. The value added time to produce one Knit On Demand garment is 167,5 minutes. If we add allowance the total production time is 179,68 minutes for one garment.

<table>
<thead>
<tr>
<th>Calculation of SAM with allowance</th>
</tr>
</thead>
<tbody>
<tr>
<td>op no</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Below is a calculation for the costs to produce one Knit On Demand garment, in this case the cost for Jonas v-neck. According to Ulf at Ivanhoe the yarn cost for the v-neck is 30 SEK. The cost for knitting the garment is 2 SEK per minute. Programming machines, separating the pieces and steam and press is calculated to cost 6 SEK per minute. Cutting, sewing and finishing costs 4 SEK per minute. The reason why it is cheaper to sew is because the labor of sewing costs less money than managing the machines.

<table>
<thead>
<tr>
<th>Calculation production cost for Jonas garment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yarn</td>
</tr>
<tr>
<td>Knitting (33 min á 2 SEK/minute)</td>
</tr>
<tr>
<td>Washing</td>
</tr>
<tr>
<td>Programming, cut pieces, press (10,5 min á 6 SEK/min)</td>
</tr>
<tr>
<td>Cutting, sewing and finishing (26 min á 4 SEK/minute)</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
</tr>
</tbody>
</table>
Below is a list of all the machines that are used at Ivanhoe when producing Knit On Demand garments.

<table>
<thead>
<tr>
<th>Machines</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>STOLL CMS 311, 12 gauge</td>
<td>Knitting machine, flatbed</td>
</tr>
<tr>
<td>Shima Seiki, SFE-161</td>
<td>Knitting machine for collars and sleeves</td>
</tr>
<tr>
<td>ACG Nyström</td>
<td>1-needle machine, 301</td>
</tr>
<tr>
<td>Pegasus Mauser</td>
<td>4-thread overlock</td>
</tr>
<tr>
<td>Nepi Otello</td>
<td>Steam and press machine</td>
</tr>
<tr>
<td>Cylinda 2-11</td>
<td>Washing machine</td>
</tr>
<tr>
<td>Elektro Helios  ED36</td>
<td>Tumble dryer</td>
</tr>
</tbody>
</table>

Table 7. List of machines

3.2.2 Fully Fashion and Cut and Sew

Fully Fashion is a knitting technique that has developed from the Cut and Sew process where the pieces are knitted and then cut to get the right shape. The purpose is to reduce waste. When using Fully Fashion technique the pieces are knitted in the right shape from the start. Fully Fashion gives little or no waste and there is no cutting after knitting.¹⁸

The garments are knitted on a flat bed knitting machine using the flat bed technique. The disadvantage using Fully Fashion is that every step in the knitting process must be programmed in the knitting machine before start. After the knitting process the pieces are washed, which might change the shape and size.

¹⁸ Jonas Larsson, One piece fashion(p. 30)
Ivanhoe have chosen to combine Cut and Sew with Fully Fashion in order to offer the customer variety in shape and measurement. By using cotton yarn for knitting they don’t need to worry about shrinkage when washing. Small changes can be adjusted by steam and press both before and after sewing.

Figure 7. Combination of Cut & Sew and Fully Fashion

3.2.3 Yarn suppliers
Delivery time for the yarn supplier TMV is 5 weeks. Most of the suppliers are located in Portugal. Until recently Ivanhoe primarily worked with TMV, this changed due to problems with the orders. Ivanhoe is looking for a supplier in Germany but the minimum quantity order is 144 kg, which is much more then what they usually need and the lead time is also about 5 weeks. The cost for yarn is between 6,50 to 8,00 Euro per kilogram. Ivanhoe have recently established contract with a new supplier in Italy, Filartex. They can deliver within 1 week. The yarns are about 20-30% more expensive and cost 9,80 Euro per kilogram. For Knit On Demand the cost is not considered that high but for mass production it is a huge cost. Considering lead times for yarns it would not be possible to have yarns shipped within less than 3-4 days because of the transportation. Yarn companies are mostly situated around Europe and there are no similar yarn suppliers within Scandinavia.

3.2.4 Layout plan at Ivanhoe
The figure below shows the current layout plan at Ivanhoe. The plan is adapted for Ivanhoe’s normal production and is not optimal for Knit On Demand production. The layout is divided into 3 separate areas. One area is where all the knitting machines are, it is optimal to keep them separated from other parts of production because of the noise and security risks. Yarn storage is also in the same area as the machines and other storage located in the same space. In the second area there are desks and machines for the seamstresses and a lot of storage. It is much more quiet here than in the machine room. In the third space there is an office, staff room and an area for washing machines, tumble dryers and ironing table for finishing and also some space for storage. In the figure the machines that are used for Knit On Demand is marked in red color. They are also numbered according to the process steps. As you can see, to produce a Knit On Demand garment the personnel must do a lot of walking between all three different areas. To produce one garment follow step 1 to step 7 in Ivanhoe’s layout plan. Please recall the process steps mentioned earlier in the text, see Figure 4.
Figure 8. Ivanhoe layout plan

D = desk
W = wash
Sew = sewing machine
KM = knitting machine
KM1 = STOLL CMS 311
KM2 = Shima Seiki, SPE-161
Finish = finishing table
4. Fashion logistics key performance indicators and a profit comparison

This chapter presents fashion logistic key success factors for Knit On Demand such as sell-through factor, lost sales, service level and stock-turn rate. A profit comparison between Knit On Demand and Ivanhoe’s normal production is discussed.

4.1 Sell-through factor

The sell-through factor is the percentage of items sold at full price. In big chain companies such as H&M the value is usually 65-70 %, the rest is sold at a reduced price during sale.

• Sell-through Knit On Demand = 100 %

100% is an excellent figure for sell-through. The reason that it is so high is because the garments are produced according to demand. Customer places the order and is also obliged to follow through with the purchase. There are no garments left for clearance sales.

4.2 Lost sales

Lost sale is difficult to measure. SOM Concept doesn’t count exactly how many customers enter their store on a daily basis.

4.3 Service level

Service level for Knit On Demand is very high and should be 100% but it has happened that a yarn has not been in stock and has not been available for ordering.

• Service level Knit On Demand = Number of different SKU available in the store/Total number of SKU in collection = 97 %

4.4 Stock-turn rate

Stock-turn rate compares average inventory to sales and is a useful factor within retail. The stock-turn rate cannot be calculated for SOM Concept since they do not have Knit On Demand garments in stock. This is very positive for business and it means that there are no inventory problems to consider. There is no risk having too much or too little in stock. The orders are place on-demand and are immediately sent to customer.

• Stock-turn rate = sales/average inventory

4.5 Calculation profit

The chart below shows how much profit there is in Knit On Demand in comparison to normal production (mass production at Ivanhoe). For example the profit for one Knit On Demand garment is 335,00 SEK and for a similar garment in normal production at Ivanhoe it is 75,00 SEK. The correlation is based on Jonas deep v-neck garment and a sweater from Ivanhoe’s normal production. The calculation is based on a production point of view. From the chart we have drawn the conclusion that when producing 100 garments the profit for Knit On Demand is 33 500,00 SEK and for normal production it is 7500,00 SEK. This also means that in order
for normal production to have the same profit, Ivanhoe would have to produce 446,7 garments. The profit for Knit On Demand is 4,467 times bigger.

Figure 9. Garment profit; Knit On Demand vs. normal production
5. Value Stream Mapping

This chapter discusses and presents the Value Stream Maps of the current state and the future "ideal" state. Improvement suggestions are offered as well as calculation costs.

This value stream mapping was originally practiced in the Toyota Production System. It was used to describe a current and a future or "ideal" state of the production. A value map is all activities (value added and non value added) that creates value to the process.\(^\text{19}\)

The purpose is to only map the value chains that need to be improved. To map the value flow means to follow the process and draw all process steps (for material and information) for a product, all the way from door to door in the factory. VSM is a method to find a better, leaner way to produce. The intention is to create more value from the processes and to eliminate waste.\(^\text{20}\)

For production there are two value chains; one is material flow and the other is the information flow. It is important to map both. They are equally important for Lean production.

A good question to ask is: "How do we create an information flow which makes a production process to only manufacture what the next step in the process needs and when it is needed?"\(^\text{21}\)

It starts with a vision and a goal of what to achieve with the value flow. The last step is to make preparations and to start activities to be performed according to the action plan that has been produced as a result of the value stream mapping.

Steps\(^\text{22}\):
1. Choose a product group
2. Make a summary by gathering information from start to finish in the production line. Measure time
3. Make a value stream map of the current state
4. Draw a value stream map of the future (or ideal) state
5. Make an action plan

The Knit On Demand process is a pull system. The customer initiates the production, there is a need. The customer decides when the product shall be produced. In contrast to a push system, where the production is adjusted after forecast of what the customer might want.

5.1 A Value Stream Map of the current state

Today SOM Concept places about one Knit On Demand order per week. The order is sent via e-mail to Ulf Göthager at Ivanhoe of Sweden. Ulf initiates the production process. First he checks if the yarns are in stock. If not he will get back to SOM Concept and inform them of this. This is problem number one. A couple of times per year, SOM Concept choose colors for

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\(^{19}\) Rother, Mike & Shook, John. Lära sig se.

\(^{20}\) Bergman, Bo & Klefsjö, Bengt. Kvalitet från behov till användning.

\(^{21}\) Rother, Mike & Shook, John. Lära sig se.

\(^{22}\) Rother, Mike & Shook, John. Lära sig se.
their yarn collection from what is in stock at Ivanhoe. It has happened that a specific yarn has run out of stock and SOM is not informed of this in advance. If a customer places an order and the yarn is not in stock, he will be informed of this, a couple of days after his visit to SOM Concept. SOM sends the order to Ivanhoe 1 or 2 working days after the order is placed by customer at the store. Ulf takes care of the order when he can find the time in their normal production schedule, this means when a 12-gauge knitting machine is available and when he has the time to do this (Ivanhoe has three 12-gauge knitting machines in Gällstad). It can take from 1-11 working days before he starts to produce the garment. In the agreement between SOM Concept and Ivanhoe, Ivanhoe has a responsibility to deliver the finished garment within 2-3 weeks. The current yarn supplier that Ivanhoe is working with is situated in Portugal and if a yarn has run out of stock it takes more than 5 weeks to have it delivered. Due to the long lead time for yarn delivery, customer must choose a color that is available in stock.

The process steps to produce a Knit On Demand garment are presented in the figure below.

![Figure 10. Knit On Demand process steps](image)

The cycle time (C/T) and set up time (S/T) for each process are:

<table>
<thead>
<tr>
<th>Process</th>
<th>C/T (min)</th>
<th>S/T (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knit &amp; cut</td>
<td>36</td>
<td>5</td>
</tr>
<tr>
<td>Wash &amp; dry</td>
<td>65</td>
<td>0,5</td>
</tr>
<tr>
<td>Press</td>
<td>2,5</td>
<td>Ø</td>
</tr>
<tr>
<td>Cut &amp; sew</td>
<td>20</td>
<td>2,5</td>
</tr>
<tr>
<td>Finish &amp; inspection</td>
<td>3,5</td>
<td>Ø</td>
</tr>
<tr>
<td>Pack &amp; send</td>
<td>2</td>
<td>Ø</td>
</tr>
</tbody>
</table>

Table 8. Cycle and set up time for the processes

Please note that the times can vary somewhat depending on what model is being produced. The lead times above are for Jonas garment (deep v-neck).

The process lead time (L/T) is in total from 168 minutes to 11 days. The value added lead time (V/T) is in total 129 minutes. This means that it takes 129 minutes to produce the garment but if we add set up time and waiting time it can take from 168 minutes to 11 days. The goal is to reduce the process lead time (L/T) to a maximum of 4 or 5 days. This would mean that Ivanhoe could deliver the garment within a week. The value added lead time is considered very good and can only be improved at a minimum if at all.

The finished product is sent by post to SOM Concept Store in Stockholm and the delivery time is 1-2 days. If specified the garment can be sent directly to the customer. SOM is however adding some final details to the garment when it arrives at the store. The details are labels with SOM Concept logo, which is attached to the garments. The customer is informed by phone or e-mail that the finished product is available at the store and ready for pick up. The garment can be sent to the customer by post for an additional fee and if prepayment has already been made.
One big issue with producing only one garment at a time is the down time. It takes a lot of time to reprogram a machine and install yarn on knitting machines and threads on sewing machines. It’s a lot of time for producing only one garment. This time is more easily motivated if a machine is producing 100 garments in one go, where the down time can be divided by 100.

The layout plan at Ivanhoe is not optimal for Knit On Demand production, note that they are not dedicated to this kind of production. As you can see on the layout plan for Ivanhoe the different stations and machines are far away from each other and located in three separate areas. The worker must run back and forth in order to process steps to finalize the garment.

The problems or issues that arise when evaluating and mapping the production process are:

1. When yarn is not in stock
2. Lead time for placing order towards Ivanhoe is 1-2 working days, this could be shortened
3. Yarn supplier too long delivery time, 5 weeks
4. Process lead time (L/T) too long, maximum should be about 4-5 days
5. Lay out plan
6. Down time when producing one garment at a time

Below Value Stream Map shows the current production process for Knit On Demand at Ivanhoe of Sweden as described above. See Appendix 6 for the VCM guide.
5.2 Value Stream Map of the future state

In order to make a Value Stream Map of a future or “ideal” state we must first identify the problems, issues or wastes in the current state. The problems were identified above, in the value stream of the current state. Below is some improvement ideas based on above findings.

Improvement ideas

1. New supplier who provides a better and faster delivery service of yarn. If a yarn is out of stock it should take only a couple of days to order and have it delivered.
2. New layout plan for Knit On Demand production. Can be done when the orders increase (minimum 5-8 orders per week). It must be calculated that it is a good idea to make this investment. When the orders have increased and one knitting machine is dedicated to Knit On Demand.
3. When Knit-On-Demand-orders increase, several garments can be produced at one time. This will improve the production time. Less time to reprogram machines and set up time. Pile up the orders for one week and produce them in one go.
4. A computer system that keeps track of the yarn inventory and indicates when a specific yarn is low in stock. This system could send an indication to both Ivanhoe and to SOM Concept.
5. Better communication between SOM and Ivanhoe, telephone call for each order?
6. Improved down time if more garments are produced in one go

The improvement ideas are first and foremost based on a larger production scale. This means that the orders must increase from 1 per week to at least 5 per week. Ivanhoe claims that 5 is a more reasonable number. The ideal scenario would be that the amount of orders increases so that one machine is dedicated to Knit On Demand orders only. At Ivanhoe one 12-gauge STOLL knitting machine can produce 20 garments per day. If the orders increases to 5 per week, Ivanhoe could produce the garments in one go once a week and improve the lead times. This would however not be nearly enough for one dedicated machine. See Appendix 6 for the VSM guide.
In the Value Stream map of the future state the orders from SOM Concept have increased from 1 order per week to 5-8 orders per day. The production planning is performed by Ulf, but he can hand over the task to anyone in his staff who can manage a knitting machine. Firstly the yarn stock levels are monitored, and if the yarn is missing an order is immediately placed at the yarn supplier. The new yarn supplier can deliver the yarn within 2-4 days.

When more garments are produced the down time and waiting time will be lower. This is due to the higher prioritization of the Knit On Demand production. Set up, reprogram and error time will be lower for each garment when more garments are produced at the same time. However there is still a lot of time for reprogramming and changing of thread and yarns since the concept of Knit On Demand is that each garment is individually designed in contrast to mass production where identical garments are produced which would lower the down time even further.

A 12-gauge STOLL knitting machine is dedicated to Knit On Demand garments. The process steps are the same but if the layout plan is improved the last two process steps can become one. The seamstress can perform all the steps of cutting, sewing, finishing, inspection and packing. See example of improved layout plans 1 and 2 to compare with current layout plan.

When the garments are finished after inspection they are packed and sent immediately by post to SOM Concept. The value added lead time (V/T) is now 128. The process lead time (L/T) is now 167.5 minutes to 4 days. The time depends on how many orders there are per
week, how prioritized the Knit On Demand production is and how long the, set up, error and waiting time is. This means that the order can be delivered to customer within 3 days to 2 weeks instead of 2-3 weeks.

Another way to improve problems with yarn stock is to keep track of the yarn supply with a computer system. The computer system could initiate to both Ivanhoe and to SOM Concept when the yarn supply is low so that the yarns are ordered in time and SOM Concept is informed when a color is out of stock.

5.3 Layout plans

The current layout at Ivanhoe is displayed in Figure 8. In this layout there is one room for all the machines and another room where the seamstresses work. In both rooms there is a lot of storage as well. In a third room there are washing machines and tumble dryers as well as inspection station with an iron. It is not optimal to walk back and forth between the rooms. A mistake is not as easily detected and communication between stations is not optimal either.

The ultimate layout plan would be a u-shaped display as seen in Figure 13. In this way all the machines are placed one after the other in the same order as in the process. The next production-step is close by and it is easy to communicate between the stations. For example if an error is detected at a later stage it can easily be notified and adjusted. The problem in this layout plan is the noise. The machines are located in the same room as the sewing machines. It is not good working conditions for the seamstresses. The idea of having one room for machines, such as knitting, press and washing machines is better when giving consideration of working conditions.

Figure 13. Suggestion Layout plan 1
In the layout plan 2 the noise problem is considered, see Figure 14. The layout is similar to layout plan 1 where it follows the process steps but the machines are separated from the seamstresses working place. The machines should be nearby and visible but isolated. The machine room can be left when the machines are on and no attending is necessary.

5.4 Calculations improvements

Below is an estimated calculation of improvement costs. Please note that point 3 and 6 are depending on an increase in Knit On Demand orders.

1. New supplier with a better and faster delivery service of yarn. The cost for yarns from a new supplier with faster delivery is an increase with 20-30%.
2. New layout plan. The cost calculation for this includes the machine costs and the rent.
3. Knit On Demand order increase will improve production time. In order to achieve an increase in orders SOM Concept must put money into marketing. They must reach out to and attract potential customers.
4. Computer system that is keeping track of the yarn inventory and indicates when a specific yarn is low in stock. Invest in a new computer system and take the time for inventory and updating the system continuously.
5. Better communication between SOM and Ivanhoe. If SOM Concept always makes a telephone call for each order they would have regular communication and the risk of a yarn or something else being out of stock before ordering would minimize. The value would be to not loose customer trust if a specific color is out of stock or similar problems occur. The calculation is based on loss in sales. This is difficult to measure because we wouldn’t know for sure how a
6. Improved down time if more garments are produced in one go. Faster production and an increase in orders. This is possible when the orders for Knit On Demand increases and at some point there will be a discussion to hire a new staff member to handle the work load. This calculation of the costs per year for one staff member. An order increase demands more staff.

<table>
<thead>
<tr>
<th>no</th>
<th>Improvement</th>
<th>Description</th>
<th>Costs/lost income (SEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>New supplier</td>
<td>20-30% increased yarn cost</td>
<td>6-9 SEK per garment</td>
</tr>
<tr>
<td>2</td>
<td>Layout plan</td>
<td>One time costs for machines and rent</td>
<td>1 070 000</td>
</tr>
<tr>
<td>3</td>
<td>Improve production time</td>
<td>Marketing costs per year</td>
<td>200 000</td>
</tr>
<tr>
<td>4</td>
<td>Inventory computer system</td>
<td>Set up new computer system of inventory</td>
<td>10 000</td>
</tr>
<tr>
<td>5</td>
<td>Communication Ivanhoe – SOM</td>
<td>Decrease in customer trust = loss in sales</td>
<td>335 SEK per garment</td>
</tr>
<tr>
<td>6</td>
<td>Improve down time</td>
<td>Cost per year for one new staff member</td>
<td>324 000</td>
</tr>
</tbody>
</table>

Table 9. Improvement costs

Below is calculation of the layout plan. It includes all the machine costs and rent. Please note that all costs are an estimate.

<table>
<thead>
<tr>
<th>Layout plan cost (SEK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent costs</td>
</tr>
<tr>
<td>Knitting machine, flat bed, fully fashion</td>
</tr>
<tr>
<td>Washing machine</td>
</tr>
<tr>
<td>Tumble dryer</td>
</tr>
<tr>
<td>Steam and press machine</td>
</tr>
<tr>
<td>Cutting table</td>
</tr>
<tr>
<td>Sewing machine x 2</td>
</tr>
<tr>
<td>Iron and table</td>
</tr>
<tr>
<td><strong>TOTAL SUM</strong></td>
</tr>
</tbody>
</table>

Table 10. Layout plan costs
6. The Toyota way and Lean production

In order to fully understand the benefits of Knit On Demand, the similarities between Lean production and mass customization are analyzed in this chapter. First, an explanation of the Toyota way is presented and the 8 forms of waste in Lean production. Second, a summary of the concepts are displayed, as well as evaluation of the Lean progress at Ivanhoe.

6.1 The Toyota way

Today Toyota is a world leading company in safety cars. But it has not always been so. In the beginning of 1930’s Toyota produced poor quality vehicles.23 The manager of Toyota realized that they needed to focus more on continuous flow and the best example at that time was Fords moving assembly line. Toyota started to implement the system in their production and suddenly the demand after cheap Japanese goods was higher than they could produce. After The Second World War, the demand increased again and Toyota needed to find a way to adapt mass production to the Japanese market.24

Mass production is made to make large quantities of the same model. That’s why all Fords car were black at that time.25 To compete with Ford, Toyota needed to make small quantities of different models using the same production line.26 By adopting Fords production line Toyota developed Just In Time and could simultaneously achieve high quality, low cost, short lead times, and flexibility.

Just In Time is a management philosophy meaning that nothing is produced before demand to meet customer needs.27 It’s an integral part of Toyotas production system and can be said to consist of a continuous working flow of goods in stock and standardizing.

Some of the benefits of implementing JIT into the company are28:

- Reduce setup time
- Improve the order system
- Shorter lead time and more efficient processes
- Ability to produce small quantities
- Reduce productions cost
- Reduce the need of safety stock
- Reduce the error rate in the process

6.2 Lean production and Knit On Demand

Lean production was first mentioned in a MIT-study in 1990 where the result showed that the Japanese car production was twice as effective as the western market.29

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23 Liker. Jeffrey K, The Toyota Way. (p. 20)
24 Liker. Jeffrey K, The Toyota Way. (p. 20)
26 Liker. Jeffrey K, The Toyota Way. (p. 21)
28 Karlöf Bengt, Management. Begrepp och modeller. (p. 131)
29 Storhagen. G Nils, Logistik - grunder och möjligheter. (p. 25)
Lean Production is based on the philosophy to avoid waste in all form. Everything in the process line that does not create value is considered wasteful.  

Different types of waste:
- Over production
- Waiting
- Transportation
- Waste in the process
- Excess motion
- Inventory
- Scrap & rework
- Unused employee creativity

Toyotas success lays not only in the production system but also in the company’s management culture and in the management principle that is followed.

The Knit On Demand process is in itself a leaner way to produce. Consider the 8 forms of wastes. (Lean production):

1. Over production: The biggest factor for waste is overproduction. This means producing too much, too soon and too fast in the process. Overproduction causes all sorts of waste, i.e. too much material and money is tied up in storage. Components must be stored and ties up space, demands handling, resources and staff. This is not an issue for Knit On Demand (or a very small one) since what is produced is exactly what customer needs and is prepared to pay for.

2. Inventory, there is some inventory of course but not excessive. The inventory is mostly yarns, before production. Since the garments are shipped and sold as soon as they are produced there is no need for stock keeping.

3. Errors and defects, errors and defects are usually noticed right away during production and the risk for a faulty garment being sent to customer is minimal. Errors and defects do occur but since the garment is being produced in one go it is easy to detect and correct them early on in the process.

4. Over processing, faulty or flawed processes creates error in products that needs to be corrected in order to not create more waste. The Knit On Demand process is already optimal. It couldn’t be improved much but if the order flow increases a lot than it would need to be reconsidered, adjusted and improved.

5. Waiting, waiting time is an issue. At Ivanhoe their other production is prioritized since the need for Knit On Demand garments is very low today. It is not good business to focus on and produce only one garment at a time. This means that the garment is constantly kept waiting in the process until someone has time to finish the next step. When production would increase this would become a minor problem.

6. Safety flaws, creates a risk for injury and an unsafe environment which causes a non safe and a less effective working place. The knitting machines are kept in one separate area which is good for safety reasons and because of the noise. However the layout plan is not optimal and personnel must run back and forth in the work place which could cause harm.

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30 Liker. Jeffrey K, The Toyota Way(p. 27)
31 Liker. Jeffrey K, The Toyota Way(p. 27-31)
7. Transportation doesn’t in itself create any value. If possible remove transport so it doesn’t create any problems. The garments are produced and sold in Sweden which makes transportation relatively low. The yarns are transported from Portugal or Italy, which is considered good since it is within Europe.

8. Underutilized people, since Ivanhoe doesn’t focus on Knit On Demand production today this is not an issue. The garment is produced when they have the time. If one person would be dedicated to Knit On Demand production this could be an issue if the demand didn’t increase excessively.

### 6.3 Lean production versus mass customization

<table>
<thead>
<tr>
<th></th>
<th>Lean Production</th>
<th>Mass customization</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beginning</strong></td>
<td>• The concept <em>Lean Production</em> was founded by Toyota in 1990</td>
<td>• The concept mass customization was introduced in 1987</td>
<td>• Both concept is relative new</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>• Create a value for the customer</td>
<td>• Focus on the individual customer</td>
<td>• Focus on the customer</td>
</tr>
<tr>
<td><strong>Hypothesis</strong></td>
<td>• No waste</td>
<td>• No or little waste</td>
<td>• Avoid overproduction</td>
</tr>
<tr>
<td></td>
<td>• Pull-system (start producing after customer order)</td>
<td>• Produce customized products after order</td>
<td></td>
</tr>
<tr>
<td><strong>Method</strong></td>
<td>• Understanding customers value</td>
<td>• Produce after customers demand</td>
<td>• The customer order a customized product</td>
</tr>
<tr>
<td></td>
<td>• Create a value stream and use the Pull system</td>
<td></td>
<td>and the order is send to the producer</td>
</tr>
<tr>
<td></td>
<td>• Level out workload</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overview</strong></td>
<td>• Improve flow in process by reducing waste</td>
<td>• Flexible production</td>
<td>• Improve flow leads to continuous</td>
</tr>
<tr>
<td></td>
<td>• Continuously working flow</td>
<td>• High quality and reduce cost</td>
<td>improvement of quality and flexibility</td>
</tr>
<tr>
<td></td>
<td>• Standardizing</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Procedure</strong></td>
<td>• Involve both management and worker to work for continuous improvement</td>
<td>• Collaborative between the seller and the producer.</td>
<td>• Understanding. Let the leader understand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Adaptive standard</td>
<td>the workers work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cosmetic (package)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Transparent</td>
<td></td>
</tr>
<tr>
<td>Philosophy</td>
<td>Primary Effect</td>
<td>Secondary effect</td>
<td>Observation</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| • All personnel understand the vision of the company and know how they can contribute | • Reduce lead time
• Improved flow
• Improved quality                                                            | • No inventory
• Reduced gods in stock
• High variety at low cost                                                      | • Reduces inventory, increase efficiency and happy customer                      | • Low cost for goods in stock
• Pull-system with Kanban                                                         | • Specify the product from a customers perspective                             | • By creating a flow it can bring problems to the surface                     | • High staff turnover                                                 |
| • Qualified personnel                                                                        | • Reduce cost
• Reduce waste                                                                 | • Create a closer relationship between customer and seller. Loyal customer       | • Provides flexible staff                                                      | • No goods in stock
• Produce when customer has placed their order                                      | • High value when the product is produced after customers demand                | • Customer is involved in the process (value)                                 | • Companies have problems to achieve different targeted levels        |
| • It is important that everyone understand and share the company’s vision to work for continuous improvement | • Reduced cost for inventory and happy customer                                |                                                                                  | • By letting the staff learn the processes it creates a higher product quality and working satisfaction among workers | • Little cost for gods in stock                                        | • Happy customer                                                       | • Customized goods                                                      | • The staff is starting to resist towards the working routines |

Table 11. A summary of Lean production and mass customization
Knit On Demand, is based on mass customization, which has some similarities to Lean production as we have presented in the table above. Further is an explanation in how mass customization is used at Ivanhoe both in regards for their normal production and for Knit On Demand. Please note that Ivanhoe’s primary focus is their normal production and the Knit On Demand volume is too low to be prioritized.

**Beginning**
Both lean productions and mass customization was introduced on the market in the late 80’s. Ivanhoe was founded in the 1940’s, and have a long history of producing knitted garments.

**Focus**
Knit On Demand focuses on the individual customer. By producing one garment at a time Ivanhoe can follow the process and stop it right away if problems were to appear. No problems are hidden.

**Hypothesis**
For the Knit On Demand project, Ivanhoe are using the pull-system. Instead for pushing the products out on the market, the customer needs creates a suction through the factory. This method provides no overproduction and no goods in stock.

**Method**
The process starts when a customer enters SOM Concept store in Stockholm, and orders a customized knitted garment. The seller sends the order to the producer who starts producing. The task is handed out to the staff.

**Overview**
Together, Ivanhoe and SOM Concept are continuously working towards improvements in regards to quality and flexibility. The persons working with Ivanhoe’s production are divided into two groups. One group is working in the machine area and taking care of the knitting machines. The personnel are flexible and can manage every machine. The other group is working in the storage and sewing machine area. They take care of cutting and sewing of the garment as well as inventory. The seamstresses are well educated but not all of them can manage all parts of garment sewing. There is only one girl who knows how to set banding around the neck hole. If she doesn’t have the time to sew the collar or she’s sick the garments are put on hold.

Improvement possibilities: Create a standard task and see so that everyone in the process knows what to do.

**Procedure**
The managers are working with the production. The workers are working for continuous improvement and no problems are hidden. In the future Ivanhoe might start using wool in their production. Right now wool is too complicated to knit with.

**Philosophy**
Ivanhoe produces knitted garments for their brand and for other customers. Since they have such a long history and experience with knitting the Knit On Demand concept was not so hard to implement. The time and effort was put into program the knitting machine with new models and sizes. The project Knit On Demand was not what Ivanhoe hoped for since the order volume is too low to be considered profitable.

**Primary effect**
Follow the company’s philosophy and use the pull system to prevent goods in stock.

**Secondary effect**
The primary effects contribute to fulfilling the customer’s wishes and the outcome is customer satisfaction.

**Observation**
Happy personnel produce higher quality garments and contribute to good working environment. The workers
feel that they are a part of the organization.

**Stock**
By using the pull system both Lean and mass customization has no need to produce goods to put in stock.

**Value**
Base the data on reliable facts. Investigate the customers demand and apply it into the process. If the customer can customize their own product it will give the product a value.

**Strength**
By creating a continuous flow the producer can see if there is any problem in the process.

**Weakness**
Lean provides flexible staff and that usually gives high staff turnover.

Note how much mass customization and Lean production is similar to each other.

6.4 The Lean progress at Ivanhoe

To implement lean production into a company it’s important that a company understands how their current state looks and learn how to use the information properly along the way. Ivanhoe have done an evaluation of transformation to lean production and below is a summary of the result.

In the evaluation Ivanhoe had to mark one number that best describe the company’s current state in the process of transforming to lean production. The range is 1 to 5. The number 1 means Ivanhoe has done very little to transforming the company toward Lean. A 5 means that the work is going well and they are following the recommendations to lean production.

**Cleaning of working places**
Ivanhoe think the routine of cleaning the working areas is working okay. Sometimes the working area is cleaned and sometimes when the workload is heavy it can get a little messy. On a scale from 1 to 5, Ivanhoe gave themselves a 3.

**Layout**
The layout in Ivanhoe is ranged so all materials have their specific place along the process flow in the factory. The yarn is placed near the knitting machines so the workers don’t need to look for them. The cutting machine is placed together with the sewing machines. On a scale from 1 to 5, they gave themselves a 4.

**Information**
Every week Ivanhoe has a meeting with the staff where they are going through the previous weeks work and check how the production is going. There are no large information boards with visible and clear information of ongoing orders. In the production of garments from the Knit On Demand project the staff handles the order form which says what is needed to be done. On a scale from 1 to 5, they gave themselves a 3.

**Equipments**
The equipment is cleaned and repaired on a regular basis. But knitting in the knitting machines causes sometimes problems and the needles are hooked on each other. On a scale from 1 to 5 they gave themselves a 3.

**Range of waste**
For Ivanhoe, different type of wastes is still appearing in the process. Ivanhoe is working on reducing it. On the evaluation scale from 1 to 5 Ivanhoe gave themselves a 3.

**Production flow**
In the production, Ivanhoe are using both bundle system and one piece production. Ivanhoe still produces small quantities of knitted garment in Gällstad. In the Knit On Demand process the pieces are sometimes put on hold and the waiting time between the different working stations is long. That creates long lead times. On the evaluation scale from 1 to 5, Ivanhoe gave themselves a 3.

**Working process**
Ivanhoe have established some working routines to give the best optimized possibilities for the worker and the machines to get the best result.

**Working speed**
The customers demand is deciding the working speed. The working speed is based on a regular week – and day planning. On a scale from 1 to 5, Ivanhoe gave themselves a 4.

**Down time**
The down time is proceeded quickly and is most efficient. In the evaluation task, Ivanhoe gave themselves the highest score, a 5.

**Pull - or push system**
The processes at Ivanhoe are partly driven by internal and external customers needs and partly driven by prediction. No Kanban system is used. On a scale from 1 to 5 they gave themselves a 3.

**Teamwork**
The different working teams work partly with standardized processes and individual tasks. Ivanhoe is working to improve their routine. On the scale, Ivanhoe gave themselves a 3.

**Flexibility**
The staff in each working team can handle all working tasks within the team. On the evaluation scale from 1 to 5 they gave themselves 4.

**Progress work**
Not everyone in Ivanhoe participates or show interest in the work progress. Ivanhoe gave themselves a 3, on a scale from 1 to 5, where 5 refers to every worker in Ivanhoe is showing big interest in the work progress and comes with solutions to different problems.

**Reaction when mistake happens**
All staff working in the process has a responsibility to stop an ongoing process if a problem were to appear. In the evaluation scale from 1 to 5 Ivanhoe gave themselves a 4.

**Analyzing the causes of the problems**
The staff working with knitting process is helping each other to solve the problems. They work together to find the main cause of the problem. In a scale from 1 to 5 they gave themselves a 4.

See Appendix 5.

7 **Summary and results**

*This chapter presents a summary and the result of the work performed. It summarizes the result of the main research questions.*

The aim with this work was to study the performance of an existing mass customization fashion concept.
The main research question is to identify and describe all important processes from the moment when the client enters the store until the ready-made garment is manufactured and delivered to the customer. The production processes is described in a Value Stream Map of the current state and also a future “ideal” state. Each step of the simulation of the Knit On Demand process is presented in the chapter Simulation.

Research question 2: What are the lead times for the identified processes involved in the concept?

The value added lead time for the current state in the Value Stream Map is 129 minutes. This means that it takes 129 minutes to manufacture a garment, however if we add down-time, set-up time and waiting time it takes from 168 minutes to 11 days to produce one garment. 129 minutes and even 168 minutes are considered good results. The manufacturing process in itself is not the problem. It is the down time and the waiting time in between. Ivanhoe is obliged to have a Knit On Demand order ready within 2-3 weeks. SOM Concept would want this time to be 1-2 weeks instead. The biggest issue is the number of Knit On Demand orders. Today there is 1-2 order per week. It is too little in comparison with Ivanhoe’s normal production and is not prioritized in their production planning. Their normal production is manufactured first and when there is a time gap the order from SOM Concept is taken care of. The Standard Allowed Minute (SAM) is calculated to be 179,68 minutes.

In the future or “ideal” Value Stream Map the lead times have been improved somewhat. The value added lead time is 128 minutes, which is an improvement with 1 minute. The total lead time in production is now 167,5 minutes to 5 days, which is a big improvement.
Other valuable manufacturing process lead times are presented in the table below:

<table>
<thead>
<tr>
<th></th>
<th>C/T (min)</th>
<th>S/T (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knit &amp; cut</td>
<td>36</td>
<td>5</td>
</tr>
<tr>
<td>Wash &amp; dry</td>
<td>65</td>
<td>0,5</td>
</tr>
<tr>
<td>Press</td>
<td>2,5 ø</td>
<td></td>
</tr>
<tr>
<td>Cut &amp; sew</td>
<td>20</td>
<td>2,5</td>
</tr>
<tr>
<td>Finish &amp; inspection</td>
<td>3,5 ø</td>
<td></td>
</tr>
<tr>
<td>Pack &amp; send</td>
<td>2</td>
<td>ø</td>
</tr>
</tbody>
</table>

Table 12. Cycle and set up time for the processes

The time it takes to place an order and have your measurements taken at SOM Concept is approximately 20 minutes. It can take more or less time depending on the customer. This time is considered valuable in order to provide the best service and perform correct measurements. Since there is no return policy it is important that the client is content and that he will get exactly what he wants. The risk of a customer regretting his purchase at this stage is very low.

Research question 3: What improvement possibilities can be found in the processes?
The following improvement ideas have been presented in this thesis.

1. New supplier who provides a better and faster delivery service of yarn. If a yarn is out of stock it should take only a couple of days to order and have it delivered.
2. New layout plan for Knit On Demand production. Can be done when the orders increase (minimum 8 orders / week). It must be calculated that it is a good idea to make this investment. When the orders have increased and one knitting machine is dedicated to Knit On Demand.
3. When Knit On Demand orders increase, several garments can be produced at one time. This will improve the production time. Less time to reprogram machines and set up time. Pile up the orders for one week and produce them in one go.
4. Computer system that is keeping track of the yarn inventory and indicates when a specific yarn is low in stock. This system could send an indication to both Ivanhoe and to SOM Concept.
5. Better communication between SOM and Ivanhoe, for example a telephone call for each order.
6. Improved down time if more garments are produced in one go.

Research question 4: What are the rates of the key success logistics factors: stock-turn, sell-through and lost sales.

The sell-through factor for Knit On Demand is 100%. This is very good. In big chain companies such as H&M the value is usually 65-70 %, the rest is sold at a reduced price during sale. The reason that it is so high is because the garments are produced after a need. Customer places the order and is also obliged to follow through with the purchase. There is no garment left for clearance sale.

Lost sale is difficult to measure. SOM Concept doesn’t count exactly how many customers enter their store on a daily basis.
Service level for Knit On Demand is 97%, which is very high but should be 100%. It has happened that a yarn has run out of stock and has not been available for ordering. Stock-turn rate compares average inventory to sales and is a useful factor within retail. The stock-turn rate cannot be calculated for SOM Concept since they do not have Knit On Demand garments in stock. This is very positive for business and it means that there are no inventory problems to consider. There is no risk in having too much or too little in stock. The orders are placed on-demand and are immediately sent to customer.

8 Analysis and discussion

This chapter analyses and discusses the result from the research. A SWOT analysis of Knit On Demand and mass production is presented.

The work with this thesis has been very rewarding and has given us an understanding of the Knit On Demand concept as well as manufacturing processes, customer demand and some aspects in regards to mass production. There are a lot of positive things to say about Knit On Demand and we hope that this concept will grow and develop in the future.

There are so many possibilities and we can understand why there is such an interest in this concept. If we look at the data it does say it is much more profitable and the fashion logistic key factors speak for the concept. However there is still much work to be done before it is a winning concept. Someone has to put the time, money and effort in to this and this is what SOM Concept, Ivanhoe and the research project at the Swedish School of Textile are doing. We are very happy to have been a small part of this project and hope that what we have done with this paper will contribute in some way.

If we look at Lean production, Just In Time and Toyota who are all quality management philosophies, there are many aspects that resemble Knit On Demand. Knit On Demand is a leaner way to produce and when considering logistics also have better figures.

8.2 SWOT analysis

To further analyze Knit On Demand we have performed a SWOT analysis that compares Knit On Demand with mass production.
<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knit On Demand</strong></td>
<td><strong>Long delivery time</strong></td>
</tr>
<tr>
<td>• Customized garments</td>
<td>• Costs a lot to invest</td>
</tr>
<tr>
<td>• Make your own design</td>
<td>• Small scale production, not prioritized</td>
</tr>
<tr>
<td>• No inventory</td>
<td>• Only for men (at the moment)</td>
</tr>
<tr>
<td>• No return or sale out of garments</td>
<td>• Too few design options</td>
</tr>
<tr>
<td>• Good service for customer</td>
<td>• Too small company with little marketing possibilities</td>
</tr>
<tr>
<td>• Production located in south of Sweden (environmental friendly)</td>
<td>• Low customer demand, people are not aware of the concept</td>
</tr>
<tr>
<td>• Quality garment</td>
<td><strong>Mass production</strong></td>
</tr>
<tr>
<td>• Garment is custom fitted, customer gets correct size</td>
<td>• Available sizes doesn’t fit everyone</td>
</tr>
<tr>
<td>• No over production = minimum waste</td>
<td>• No demand for customer service</td>
</tr>
<tr>
<td><strong>Mass production</strong></td>
<td>• More waste, when produced more than needed</td>
</tr>
<tr>
<td>• No delivery time for customer</td>
<td>• Only approximately 65% sold at full price</td>
</tr>
<tr>
<td>• Cost less to produce a large quantity</td>
<td>• Store personnel doesn’t need higher education in textiles</td>
</tr>
<tr>
<td>• Customer doesn’t have to design</td>
<td>• A lot of storage use</td>
</tr>
<tr>
<td>• Less expensive garments (normally)</td>
<td><strong>Opportunities</strong></td>
</tr>
<tr>
<td>• A lot of designs to choose from</td>
<td><strong>Knit On Demand</strong></td>
</tr>
<tr>
<td>• Many competitors, lower prices</td>
<td>• New way to shop clothes, new concept</td>
</tr>
<tr>
<td><strong>Opportunities</strong></td>
<td>• Mass production as is today</td>
</tr>
<tr>
<td>• New way to shop clothes, new concept</td>
<td>• Little or no interest to start this kind of production</td>
</tr>
<tr>
<td>• Possibility to grow</td>
<td>• Too much investment and not a “sure thing”, new idea = risky business</td>
</tr>
<tr>
<td>• Not only for knitting</td>
<td>• No interest in designing own clothes</td>
</tr>
<tr>
<td>• New trend to “design” your own garment</td>
<td>• Not enough marketing</td>
</tr>
<tr>
<td>• Shop-in-shop concept</td>
<td>• Customers who don’t have the time to wait for the finished garment</td>
</tr>
<tr>
<td>• Magazines writes about this new concept, free publicity</td>
<td><strong>Threats</strong></td>
</tr>
<tr>
<td>• EU subsidy for the concept to buy machines and relevant equipment</td>
<td><strong>Mass production</strong></td>
</tr>
<tr>
<td></td>
<td>• People want a unique look</td>
</tr>
<tr>
<td></td>
<td>• Many competitors in the business</td>
</tr>
<tr>
<td></td>
<td>• Wrong prognosis can have enormous effects on businesses</td>
</tr>
<tr>
<td></td>
<td>• Problems with suppliers can have great impact, i.e. bad publicity or bad quality</td>
</tr>
</tbody>
</table>

| **Knit On Demand** | **Mass production** |
| **Mass production** | **Knit On Demand** |
| • Can produce garments cheaper | • Mass production as is today |
| • Easier to start this kind business, it’s everywhere in the world | • Little or no interest to start this kind of production |
| • Easy to find relevant, cheaper or better producer and supplier | • Too much investment and not a “sure thing”, new idea = risky business |

Figure 15. SWOT analysis Knit On Demand and mass production

In the SWOT analysis above the upper half describes the current state and internal factors. The lower half describes the future and external factors. On the left side are the positive factors and on the right side, the negative. SWOT stands for strengths, weaknesses, opportunities and threats. This is a way to get an overview of and to analyze both production ways. The conclusion of the analysis is that both types of production have positive and
negative sides. What is lacking for Knit On Demand is many times what is working for mass production and the other way around. There are a lot of positive factors for Knit On Demand but it is also more expensive, more complicated to produce and to reach out to customers. Knit On Demand is today relatively unknown and it needs time to grow and to reach out to customers. Someone must want put in the time and effort in order for this concept to blossom. Mass production is the most common way to produce garments today, it has both positive and negative sides but the focus is to produce cheaper garments in larger quantities. Mass production is depending on forecasts of what customer wants whereas for Knit On Demand the customer initiates the need before production. One big positive factor that has already been presented earlier in the text is that Knit On Demand is a leaner way to produce.

9 Further research

In this chapter, suggestions for further research are presented.

It would have been possible to further compare Knit On Demand against other production concepts. For example H&M’s production or even the well analyzed and investigated car production (i.e. The Toyota Way).

Furthermore SOM Concept is working with mass customization in other forms such as jeans and suits and it would be an interesting aspect to investigate how it is working compared to Knit On Demand.
References

Literature
Rother, Mike & Shook, John. Lära sig se: att kartlägga och förbättra värdeflöden för att skapa mervärden och eliminera slöseri: en handbok för praktisk tillämpning av metoder och verktyg för Lean produktion. Enterprise Institute, 2003


Thesis

Articles
Peterson, Joel & Larsson Jonas. A multiple choice system for designing knitted fashion garments. Swedish School of Textiles, University College of Borås


Web
Research projects: Knit On Demand. <http://www.hb.se/wps/portal/?ut/p/c1/hc?7NDo1wEATgJzLd_lDxSC201dLGCEnyIRyyI1RHwY1yPL8bibiHz_DKZRTWaM7bP_to--mlsb6hCNW8ydpSh4BTgkMdgQAhnA8VeRrNfeOM8KTNmMI55ioFwzYQNBpsKsf9pFN6LzssmbNlfTuAFefZiJTsU61UZZ9aSn7exKBBweN5BbW3UcfIX_txcfhnCScnp6FD96F6md5s3sjaV0w!dl2/d1/L2dJQSEvUUUtQS9ZQnB3LzIfRU11VTCMaEwME85RJAvM0E5SEIBUTNBQzY>! The Swedish School of textiles, University of Borås. 2010-04-08

SOM Concept <www.somconcept.com> SOMconcept 2010. 2010-05-05

Ivanhoe of Sweden. <http://www.ivanhoe.se/> Copyright Ivanhoe AB. 2010-05-05


Interviews
Jonas Larsson, head of the logistics work group for the Knit On Demand project at the Swedish School of Textiles, Borås. 2010-05

Ulf Göthager, co-owner at Ivanhoe of Sweden. 2010-03-30

49
Lotta Hjelte, co-owner at SOM Concept. 2010-04-09

Joel Peterson, head of the technology work group for the Knit On Demand project at the Swedish School of Textiles, Borås. 2010-05-04
Appendix 1

SOM Concept

SOM Concept store sells men’s fashion wear, shoes and accessorize and is located on the second floor in the department store PUB in central Stockholm. SOM Concepts target group is men from the ages 13-70 years old. There are two employees working full time in the shop and one hourly employee. The staff is educated in tailoring and pattern cutting to be able to give the customers professional help with fitting and size.

SOM stands for son and mother (Son Och Mor) and is a family business owned and run by Simon Hjelte and his mother Lotta Hjelte.

Simon has been working in the fashion industry since he graduated from high school. In early 2000 he worked in a well known fashion store called, RNB. His interest in fashion grew when he saw the new upcoming Swedish fashion miracles like Filippa K, Whyred and J. Lindeberg. To really understand how the fashion world works Simon had explored every aspect in fashion. From inventory worker and purchasing assistant to retail. He has also studied Construction and Design at Tillskärarakademin in Stockholm.

Lotta is an educated tailor at S:t Göran in Stockholm. She started her career by working as a designer for the small company Capoine. At the late 80’s and almost whole 90’s Lotta worked for the famous tailor company Kellerman. Under that time she learned how to push the boundaries when it came to commercialized design. For a short period of time she also worked as a freelancer for both Swedish and foreign companies and after that she started to work as a teacher in textiles. In 2006 she opened SOM Concept store together with her son Simon at Målargatan in central Stockholm.

SOM Concept is not your typical garment store; here you can design and get your jeans, knitwear and suits custom made. In the store you have your measurements taken and the data is saved in a measurement profile for the next time. One purpose is to have a web shop for you to design your garments from home and have it delivered to your door. This is already up and running with the jeans that SOM are selling and the idea is to have it working for Knit On Demand as well. The manufacturing sites for the jeans and the suits are located in Borås and Dalsjöfors respectively.

The cooperation between SOM Concept and Ivanhoe has been ongoing for three and a half years but the sale of knitwear only for about a year. The Knit On Demand concept is still rather unknown and the demand for custom made knitwear is low. Today SOM Concept sells almost one Knit On Demand garment per week.

One future goal for SOM Concept is that the concept and customer demand grows. They would like to reach out to more customers and to someday be able to open a SOM Concept store in Gothenburg.

32 www.somconcept.com 2010-04-05 11:15
33 www.somconcept.com 2010-04-05 11:15
Ivanhoe
Ivanhoe is a production company based in Gällstad, outside Borås. The factory was founded in 1946 by Martin Göthager. At the present Ivanhoe is run by his three sons, Lars-Erik, Ulf and Göran. Ivanhoe produce and sells clothing for active leisure.

Today not many know about Ivanhoe but in the 70’s the company was one of Sweden’s most famous sportswear producers. One who was wearing their clothes was the well known skier Ingemar Stenmark.

Ivanhoe has opened a store which is linked to the textile factory and sells many different brands such as Eton, Henri Lloyd, O'Neil, North Sails and Carin K by Ivanhoe amongst others.

34 www.ivanhoe.se 2010-03-29 17:30
## Appendix 2

SOM Concept order form

<table>
<thead>
<tr>
<th>Plaggval</th>
<th>Tillval</th>
<th>Garnprov Plagg</th>
<th>Garnprov Kontrast 1</th>
<th>Garnprov Kontrast 2</th>
<th>Tygprov Nackplatta</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Färgval Nr</td>
<td>13. Nackplatta</td>
<td></td>
<td>Tyg Nr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Grundfärg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Kontrast I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Kontrast II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mått</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Storlekslikare Nr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ändring i cm</td>
<td>7. A</td>
<td>8. C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Mått från axel, M cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. 1/2 M.vidd cm +/- Nr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maskinkod</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pos.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Val</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
<td>00</td>
</tr>
</tbody>
</table>

Tröja OK

SOM

Ivanhoe
Appendix 3

Simulation process steps in pictures at SOM Concept store and Ivanhoe

A. Customer arrives at SOM Concept store

B. Inside the shop the customer will find an information board explaining the process steps
C. The customers can choose between different models

D. The customer gets help with size and fitting from the employees at the store

E. A selection of yarn colors
F. After customer have found the right size and model the employee fill in an order form that is sent to Ivanhoe

G. Ulf Göthager at Ivanhoe is programming the knitting machine according to the order form from SOM Concept

H. After washing and drying the pieces are steamed and pressed in a machine
I. The pieces are cut according to a pattern.

J. One seamstress is sewing the pieces together

K. Another seamstress is sewing the binding around the neck line
L. During the finishing of the garment it is measured and ironed
Appendix 4
A guide for the Value Stream Map

External organizations

Transport

Production process and information chart

Manual information flow

Material flow

Inventory

Operator

Check availability in storage

Transfer of finished product to customer

Information

L/T = lead time in production

V/T = value added time in production

Electronic information flow
**Appendix 5**

**HellingGruppen AB**

**Självutvärdering av transformation till Lean Produktion**


<table>
<thead>
<tr>
<th>1. Arbetsplatsens skötsel</th>
<th>Arbetsplatsen är rörlig, dälikt organiserad och ofta ostadad</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Det finns en plats för allting och allting finns på rätt plats. Rent och snygg överallt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material spritt överallt</td>
<td>Onödiga förflyttningar medför onödigt slöseri med resurser</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Allt material har givna platser långs tillverkningsflödet. Få ytor är utnyttjade</td>
</tr>
<tr>
<td>3. Tydlig information</td>
<td>Det saknas tavlor med aktuell information. Du måste fråga för att få veta var saker finns och vad som pågår</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Det är mycket tydligt vad som händer och var. Alla problem upptäcks snabbt och lätt. Stora info-tavlor</td>
</tr>
<tr>
<td>4. Utrustningar</td>
<td>Utrustningar lagas först när de går sända. Det är vanligt med splittid</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>All utrustning rengörs och underhållsständigt. Det är ovanligt med splittid.</td>
</tr>
<tr>
<td>5. Slöseriets omfattning</td>
<td>Det är vanligt med slöseri med resurser i olika former i alla delar av verksamheten</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Alla former av slöseri har påtagligt minskat och hålls hela tiden under uppsikt</td>
</tr>
<tr>
<td>6. Tillverkningsflöden</td>
<td>Tillverkning i stora partier. Många mellanlager och långa ledtider i processerna</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Enskilda artikel bearbetas och förflyttas snabbt genom hela bearbetningsprocessen</td>
</tr>
<tr>
<td>7. Arbetsprocesser</td>
<td>Var och en utför sitt arbete på sitt eget sätt och så bra som fastställda omständigheter medger</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Arbetsrutin är enhetliga med optimerade möjligheter för människor och maskiner. Att nå bästa möjliga resultat</td>
</tr>
<tr>
<td>8. Arbetskultur</td>
<td>Arbetskulturen är självständigt och baseras på måndagseller veckoplanering samt tillverkning i stora partier</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Kundernas verkliga behov och taktid styr arbetsdagen. Arbete utförs enligt dagseller timplanering</td>
</tr>
</tbody>
</table>

Källa: Quest International – The Lean Toolbox
### 9. Ställtider

| Omställningar av maskiner är långsamma, reflekterande och sällan förekommande | 1 | 2 | 3 | 4 | 5 | Omställningar sker snabbt, förekommer ofta och är effektiva |

### 10. Dragande eller tryckande system

| Produktionen styrs av prognoser eller vad som för tillfället kan tillverkas | 1 | 2 | 3 | 4 | 5 | Interna och externa kunders behov styr tillverkningen. Kanban-system används |

### 11. Lagarbete

| Alla arbetar individuellt enligt arbetsorder. Få arbetsuppgifter förutsätter lagarbete | 1 | 2 | 3 | 4 | 5 | Arbetslagen styr sina egna standardiserade processer enligt rutiner som de ständigt förbättrar |

### 12. Mångkunnighet

| Var och en har sin egen befattning, yrkesroll eller maskin att sköta | 1 | 2 | 3 | 4 | 5 | Alla lär sig många uppgifter, blir mångsidigt kompetenta och kan flytta runt vid behov till andra arbetsuppgifter |

### 13. Förbättringsarbeten

| Få deltar i förslagsverksamheten eller varar intresse för att delta i förbättringsarbeten | 1 | 2 | 3 | 4 | 5 | Stort engagemang och omfattning på arbetet i förbättringslag. Förbättringar i verksamheten vanliga |

### 14. Reaktioner vid misstag

| Inga uppmuntras att stoppa tillverkning när de upptäcker fel. Felaktiga produkter kan tillverkas under lång tid | 1 | 2 | 3 | 4 | 5 | Alla har rätt och skyldighet att stoppa tillverkning samt att vidta åtgärder så fort de upptäcker fel och brister |

### 15. Analys av grundorsaker

| Åtgärder vidtas när problem upptäcks, men det är inte ovanligt att de återupptäcker | 1 | 2 | 3 | 4 | 5 | Alla engagerade i problemlösningen. Grundorsaker till problem söks alltid |

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**Personliga kommentarer**

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*Källa: Quest International – The Lean Toolbox*
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