

## CO-DESIGN TOOL FOR CUSTOMISED KNITWEAR

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### ABSTRACT

This paper presents a mass customisation co-design tool for knitted fashion garments, and how this tool could reduce time both in programming of the knitting machine, and in the co-design process between the customer and the company. Initial results in this paper shows that it is possibly to customise and design the fashion product with much less help than before from a shop assistant. Customer information is transformed and transferred into program code automatically, and the garment can be knitted without time consuming programming of the knitting machine. The work is based on literature study, company visits and interviews.

**Key Words:** mass customisation, co-design, knitting technology, fashion design, complete garment

### 1. INTRODUCTION

The aim with this paper is to present a co-design software tool that facilitates the customisation and manufacturing process of flat knitted fashion products. This is a breakthrough in the case of mass customisation of flat knitted garments that opens up and simplifies both the co-design process, and the manufacturing of the product in the knitting machine. It is now possible to make complete garments directly in the flat knitting machine without post knitting processes such as cutting and sewing [1]. Tseng and Jiao [2], defined mass customisation as technologies and systems that can deliver products that meet an individual customer's needs with nearly the same efficiency as that of mass production. Mass customisation is a future direction for the fashion and apparel industry, but garment fit and colour selection has limited its use [3]. Since April 2008, a new developed "Multiple choice design system" called Ordermade WholeGarment<sup>®</sup> is used in the customisation process of the garments. In this system several options are presented for the customer when it comes to styles, materials, sizes, attachments and colours. The system was launched in Factory Boutique Shima, a store where the customer takes an active part in the design process and the garment is customised to fulfil actual demand. The flat knitting machines and other production equipments are located near-by. The result shown with this system is that it gives the possibility for the customer to customise and design the fashion product with much less help than before from a shop assistant. Another advantage is that it is the first system in the world that makes it possible to customise a garment, and the information is then automatically transformed to knitting machine control data.

### 2. METHOD

The aim with this paper is to give an example of a new co-design tool for flat knitted fashion garments. The work is based on literature study, company visits and interviews. This paper describes the concept and customisation process of design, sales and production of customised flat knitted fashion garments. The method used is with an inductive approach where a specific co-design tool is studied and conclusions about the combination of mass customisation and knitting technology are drawn.

### 3. PRODUCTION METHODS FOR KNITTED FASHION GARMENTS

The flat knitting machine has a linear needle bed that makes it possible to produce flat knitted rectangular panels for products like cardigans, sweaters, skirts, scarves and other garments. The production from yarn to ready-made garment with this technology could be done in several ways, depending on production methods and the type of machinery used by the company. The production from yarn to ready-made garment consists of several processes where yarn on yarn-cones is knitted to panels in the flat knitting machine. The panels are often steamed or washed in the finishing process after knitting, to get the right quality and not shrink when the customer washes the garment in the future. In the cutting process the panels are cut to the right shape and size according to design and size requirements. The panels are joined together into a garment in the sewing process. To accomplish the right quality, the garment is often passed through a final finishing process such as steaming or washing. The traditional manufacturing of coarse flat knitted garment consists of several time consuming processes after knitting. The manufacturing process of flat knitted garments can be divided in four different production methods: Cut & Sew, Fully fashion, Integral knitting and Complete garment.

Cut & sew is the conventional and most common method for production of flat knitted garments. Panels for front, back and sleeves are knitted in a rectangular form and then cut in the right form in the cutting process. After the cutting process, the panels are sewn together with separately knitted trimmings and pockets to complete the garment. Both cutting and sewing are post-knit processes, separated from the knitting machine. Fully fashion or shaping is a method of knitting production where the front, back and sleeve pieces are knitted in the right shape directly in the knitting machine. The cutting process is at a minimum or totally eliminated, but some post-knit cutting can still be necessary. Integral knitting means that trimmings, pockets, buttonholes and other accessories are directly knitted in the fully fashion produced panels. With this technique there are fewer post-knit processes such as cutting and sewing. Compared with cut & sew and fully fashion production methods, savings could be done both in cutting and sewing post-knit processes.

In complete garment production the entire garment is ready-made directly in the flat knitting machine and the different parts of the garment are shaped and knitted together with trimmings, pockets and other accessories [4]. The advantages with this technique are many, such as: no waste of material as cut-loss in the cutting process and no expensive post-knit processes such as sewing or cutting.

### 4. FACTORY BOUTIQUE SHIMA

The Japanese knitting machine manufacturing company Shima Seiki presented in 1995 the first complete garment knitting machine that could produce a flat knitted garment ready-made directly in the knitting machine. The company launched the complete garment concept with the name WholeGarment®. In 1995, Wajima Kohsan Ltd. opened its first Factory Boutique Shima in Wakayama, Japan, a shop for on-demand production of customised knitted garments. Factory Boutique Shima is a business concept based on a combination of knitting technology and mass customisation. It is a mass customisation concept with the possibility for the customer to design and customise a flat knitted garment in the shop and then the manufacturing of the garment takes place after the point of sales in the production facilities near by. The entire garment is knitted in just one process in the knitting machine. If a person

wants to design his/her own garment they will be guided by a shop assistant, skilled in design, to create a customised and personal design of the garment. First, the customer selects one of the sample garments that become the basis for the customisation of the product. Then, body measurements of the customer are taken by the shop assistant in a dialogue and then put on a special form containing all information needed to produce the garment. The customer sits down together with the shop assistant to customise the garment and the choices to be made are material, sleeve length, neck style, v-neck, round neck etc., trims, patterns and colours. All information is put down on the product form and the co-design process continues until the customer is satisfied with the self-designed product. After the co-design process is finished the customer decides if the garment should be bought or not. If the answer is yes, the product is paid for and an order for production, containing all information about the product can be sent to the manufacturing unit of the company.

Manufacturing begins in the CAD-programming room where a knit computer program is made out of the customised information as a result of the co-design process in the shop earlier. If the garment is a WholeGarment® product the entire garment is knitted ready-made directly in a knitting machine with no after coming cutting and sewing processes. This type of manufacturing, with reduction of processes, makes it possible to manufacture the garment faster than with the conventional methods. Non-value added time is reduced due to the fact that waiting time between many processes in the production of the garment is eliminated. Customers in Japan can have the goods delivered within 1-2 days of production.

## **5. CO-DESIGN AND PRODUCT CONFIGURATION**

Kaplan and Haenlein [5], describes mass customisation as a strategy that creates value by some form of interaction between the company and the customer at the fabrication/assembly stage. In the co-design process the customers express their product requirements and these requirements are transformed into ideas of a product that can be manufactured, [6-8]. The customer chooses a combination of options that often are presented in a co-design system or a “configurator”, and involved in this process, Toffler explains this as the customer becomes a co-producer or “prosumer” [9]. It is important to keep time to market as short as possible to fulfil actual demand [10]. One example of this is the importance to reduce processes in order to eliminate time in the manufacturing and handling of the product after point of sales. The aim with this is to give the customer a shorter waiting time of the product. It is important to fullfill actual customer demand as quick as possible, otherwise it is a risk to lose customers.

## **6. CO-DESIGN SOFTWARE TOOL - ORDERMADE WHOLE GARMENT®**

### **6.1 Co-design in the Ordermade wholegarment® system**

The software tool Ordermade wholegarment® is developed by the knitting technology manufacturing company Shima Seiki and launched as a test version in one of the Factory Boutique Shima stores in Wakayama, Japan. The co-design system or toolkit, function as an interaction between customer and the company in a way that options are presented to the customer in several steps, and the customer can choose the most suitable options when it comes to material, style, colour and details as pockets and trims. Ordermade wholegarment® gives the possibility for the customer to customise and design the fashion product with much less help then before from a shop assistant. The way from customer entering the shop until sales and delivered is shown in table 2:

**Table 2.** Co-design in the Ordermade wholegarment<sup>®</sup> system

<b>Customisation in the Ordermade wholegarment<sup>®</sup> system</b>
Material of the product is chosen
Colour of the product is chosen
Item and style
Details as pockets, trimmings etc
Input of body measurements
Customisation ready
Knitting data is automatically created by the software
The customised product is shown in a loop simulation picture

The idea is that the customer comes into the shop and looks at sample garments, yarn and swatches that are displayed. After decision that an own garment will be designed, the shop staff, a design technician, will take body measurements of the customer and these measurements will be put in the Ordermade wholegarment<sup>®</sup> system. This is an ordinary multiple-choice-system where the customer gets options in several stages, from the beginning to the end of the process, and the system present options and at the end a complete designed garment is shown to the customer on the screen. The choices to be done are between alternative styles, materials, colours and structures and the style can be cardigan, sweater, slipover or something else that is presented in the system. The customer will be involved in the design process but it will not be a free fashion design in the sense that the customer can create a new product without limitations. The customer can see the result of the work on the computer screen and decide if some changes have to be done before the customisation and design of the garment is finished. After this procedure the customer can decide if the garment will be bought and if the answer is yes this will generate an order to the production unit of the shop.

The design options in the multiple-choice-system will directly be transformed to knitting information directly without any time consuming programming in the knit CAD computer. This is the first system for flat knitted products in the world that makes it possible to customise a garment, and then information automatically is transformed to knitting machine control data. It is a breakthrough in the case of mass customisation of flat knitted garments which opens up, and simplifies, both the co-design process, and the manufacturing of the product in the knitting machine. All information about styles and other options must however be pre-programmed in the Ordermade wholegarment<sup>®</sup> system and this information is then combined with the customer's body measurements and directly transformed to a knitting machine control program. The positive effects of this concept are time reduction in the customisation and co-design process of the product, and also that the time consuming programming for the knitting machines are eliminated.



Figure 4. Co-design in the Ordermade wholegarment® system

## 6.2 A system suitable for customisation in fashion stores

In the concepts of sales and manufacturing of mass customised clothing, in this case, knitted garments, it is very important to reduce the processes from customer demand to customer demand fulfilment with the aim that the customer should have the product as quick as possible. Especially the processes after the point of sales are important, when the customer has paid for the garment it is an advantage if manufacturing and delivery could be done as quick as possible. The development of the Ordermade wholegarment® system shows that it is possible to do the programming of the customisation options before the customer starts the co-design process, and after the point of sales the product can be knitted without this time consuming programming. This is an important factor that reduces one process after the point of sales and moves the co-design process in the shop one step closer to customer demand fulfilment. A concept that combines the complete garment knitting technology with a mass customisation co-design system like Ordermade wholegarment® makes it now possible to offer customised knitted garments to customers in fashion stores. One solution can be collaboration between a fashion retailing company with stores and knowledge about market demand, and a knitwear manufacturing company for the development and production of the products.

## 7. CONCLUSIONS

A bottle neck in a mass customisation concept for knitted products has been the co-design process between customer and the company. It has been a manual process with interaction between customer and shop assistant in the customisation process of the garment, a time consuming process where the customer needs help to choose different options from start to end. The co-design tool Ordermade wholegarment® have some advantages that simplifies the customisation process and opens up for a reduction in delivery time of the product to the customer. The main benefits of the system are identified in this paper. It is that the customer can do a lot more of the customisation on their own, without time consuming help from shop personnel. The second is that the customisation options in the co-design tool is pre-

programmed, also control information for the knitting machine, which means that when the customisation process is ready the garment can be knitted without any time consuming programming. There are some limitations in the co-design tool Ordermade wholegarment<sup>®</sup> system that must be further developed in the future. The system is a multiple-choice-system with, at this stage, not so many choices for the customer as desirable; this is recommended to be further developed.

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