

## COMPUTERISED MADE-TO-MEASURE SYSTEM FOR CUSTOMISATION

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### Abstract

Developing and fast growing segments of the apparel industry include made-to-measure (MTM) and mass-customisation. MTM refers to clothing that is sewn from a standard sized base pattern. The fit of a MTM garment is expected to be superior to that of a ready-to-wear garment, because ready-to-wear garments are constructed to fit the manufacturer's definition of an average customer, while MTM garments are constructed to fit each customer individually. However, MTM items are seen by many to involve less workmanship than bespoke or "custom made" garments, as MTM garments always involve some form of standardization in the patterning and manufacturing processes, whereas a bespoke garment is made entirely from scratch based on a customer's specifications. A tailored suit is a common example of a MTM garment.

**Key words:** made-to-measure, CAD, body measurements, alterations

### 1. Introduction

Most of the clothing products on the market are ready-made industrial products manufacturing, where the customer has no direct effect on the final product. Garments are manufactured in a sizing range, may vary with different manufacturers. Industrial methods made clothes are relatively cheap and accessible to a wide range of customers. The problem usually has the people of abnormal posture or striking proportions, which does not meet the sizing range.

Another option is individual clothing production bespoke or "custom made" garments carried out by the tailors. In contrast of a ready-to-wear garment amount of the individual production is negligible. So individual produced clothes are made according to customer requirements, but are considerably more expensive. Garment product is always testing as an unfinished garment directly on the customer figure (sometimes repeatedly). The term construction is variable. Modern methods of bespoke are based on different grounds. Bespoke system, named Made To Measure makes it possible to manufacture garments for individual customers by industrial way with all the advantages that come together with of the industrial process and individual needs of the customer. It is a system that combines both elements of as a ready-to-wear as bespoke. On the one hand, uses the advantages of mass production, such as high quality and lower price level and on the other side adapts clothing sizes and proportions of a particular customer. Of course there is a possibility to choice a style, shape, colour and suitable fabric.

### 2. MTM technology - The automatized solution for industrial custom tailoring

Computerised Made To Measure (MTM) is the program used for the production of individual and personalized garments. The specific measures of a customer are employed for the adaptation of standard pieces already saved in the system. Garments can be modified for all the sizes available in a store, so the customer could try on the best fitting size and adjustments would be made to it. When at the garment factory the order arrives, the pieces are altered, a new marker is created and this is automatically nested if wanted.

Thus, in a very short time the new order is ready to be cut and manufactured.

### **2.1. Reception of custom tailoring orders may be made as follows:**

- A consistent measuring method required taking measurements for individual customers (accurate definition of body measurements as well as a product size).
- Number of samples of the reference garment (in stores) is required.
- Comfortable, easy and swift data input in the computer environment, performed at each point of sale. The data to be input per order must include the reference garment and set of modifications to be performed to achieve adaptation to the customer's individual measurements.
- Custom tailoring garment order may also be issued by means of form of the custom sheet included information as are (style selection, fabric selection, accurate definition of body measurements as well as a product size, ornaments, complements, accessories selection, etc).
- The Internet may transmit the order from the points of sale to the MTM system. Custom tailoring order may also be issued by the corporate management computer and reach the MTM system by the uploading.

*The MTM system processed an order or batch of orders automatically for each component. MTM performs the following tasks:*

- Automatic performance of the pattern modification (main fabric, lining, interlining, etc.) on the reference garment to achieve the custom adapted garment patterns for the individual customer. Modification of the patterns is performed on the nearest reference size to the customer, as identified at the point of sale.
- Automatic fitting of the markers required to manufacturing the garment. The individual garment markers are fitted by copying from the reference marker, which will be the one that matches the nearest size to the customer's shape.

*To be able to offer a custom tailored garment at the points of sale, the following are required:*

- To define a complete set of size charts with different size ranges for categorised figure types, which should provide measurements for the standard sizes.
- To design the patterns for reference garment in the standard sizes, which should accurately reflect the characteristics of the categorised figure types and measurements in the corresponding size charts. The design may be performed by creation or transformation using any CAD pattern generation system.
- To fit the reference markers, which will be used as a style in the custom tailoring-ordering process. This task is performed by the marker generation system.
- To define the set of modification, that may be performed to adapt the garment to each customer, for example shortening sleeves, raising shoulder, shortening hems, etc. The set of modifications may be defined using the MTM modul in the Pattern generation system.

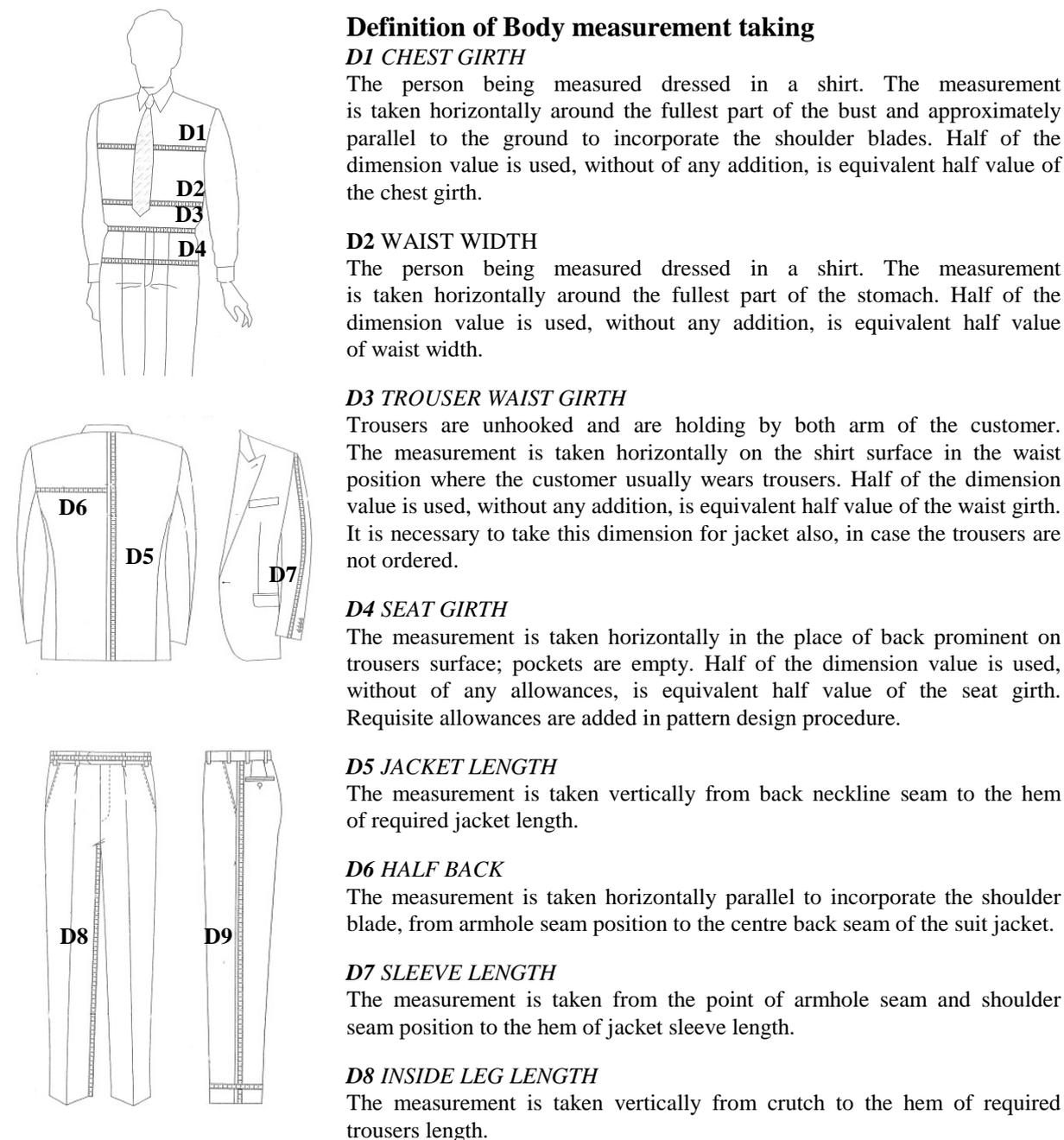
### **3. Application of the MTM technology in tailored suit production**

A tailored suit is a common example of a made-to-measure garment. To order a made-to-measure tailored suit, the customer's measurements are first taken by a made-to-measure retailer. Then a base pattern is selected that most closely corresponds with the customer's measurements. This base pattern is altered to match the customer's measurements. The suit is constructed from this altered pattern.

### 3.1 Custom ordering process of a MTM tailored suit

#### 3.1.1 Body and garment measurements required to MTM tailored suit

- We can take body measurements manually or with the help of computerized body measuring systems.
- An important aspect of custom manufacturing is accurate definition of body measurements as well as a product size. Measurements of MTM tailored suit required and definition of measuring procedure you can see in *Fig. 1*.



**Figure 1.**  
Body and garment dimensions  
measurement [1]

#### Definition of Body measurement taking

##### *D1 CHEST GIRTH*

The person being measured dressed in a shirt. The measurement is taken horizontally around the fullest part of the bust and approximately parallel to the ground to incorporate the shoulder blades. Half of the dimension value is used, without of any addition, is equivalent half value of the chest girth.

##### *D2 WAIST WIDTH*

The person being measured dressed in a shirt. The measurement is taken horizontally around the fullest part of the stomach. Half of the dimension value is used, without any addition, is equivalent half value of waist width.

##### *D3 TROUSER WAIST GIRTH*

Trousers are unhooked and are holding by both arm of the customer. The measurement is taken horizontally on the shirt surface in the waist position where the customer usually wears trousers. Half of the dimension value is used, without any addition, is equivalent half value of the waist girth. It is necessary to take this dimension for jacket also, in case the trousers are not ordered.

##### *D4 SEAT GIRTH*

The measurement is taken horizontally in the place of back prominent on trousers surface; pockets are empty. Half of the dimension value is used, without of any allowances, is equivalent half value of the seat girth. Requisite allowances are added in pattern design procedure.

##### *D5 JACKET LENGTH*

The measurement is taken vertically from back neckline seam to the hem of required jacket length.

##### *D6 HALF BACK*

The measurement is taken horizontally parallel to incorporate the shoulder blade, from armhole seam position to the centre back seam of the suit jacket.

##### *D7 SLEEVE LENGTH*

The measurement is taken from the point of armhole seam and shoulder seam position to the hem of jacket sleeve length.

##### *D8 INSIDE LEG LENGTH*

The measurement is taken vertically from crutch to the hem of required trousers length.

##### *D9 THROUSER LENGTH*

The measurement is taken vertically from waist belt seam to the hem of required trousers length.

- Body measurements taking is very complicated procedure and requires expertise and experience. Each product has its own specifics, and without any practical experience of the body measurement we can achieve no corresponding shape of the product for a specific figure.
- Customer should go to the store intending to make a purchase, he should dressed in shirt whose fit satisfies him.
- The dressed shirt is a key element in the suit-fitting process; its collar height and sleeve length inform the tailor how you expect those components of the suit jacket to fit.

### 3.1.2 Determination of the nearest reference suit size

Based on the measurement of a customer and according to set of size charts with different size ranges the nearest reference size is defined. The Standard body measurement chart of main somatotypes must be available as well as definition of body measurement procedure.

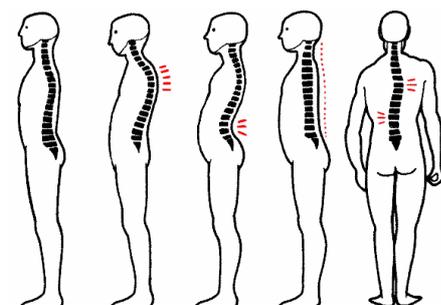
### 3.1.3 Making a plan of pattern alterations

When making an alteration plan for figuration through the creation of a personal measurement alteration chart, the subject's figure type should be categorised accurately and the standard graded blocks at the nearest size selected correctly.

The schemes see *Tab.1*, *2* and *Fig.2*. may be useful for accurate somatotype description as well as for the quality of pattern alterations.

**Table 1.** Variation in posture

	Code	Body stands Definition	Dist. [cm]
	400	Normal	-
	401	Slightly stooping	1.5
	402	Stooping	3
	403	Very stooping	4.5
	404	Extremely stooping	6
	405	Slightly erect	1
	406	Erect	2
	407	Very erect	3
	408	Extremely erect	4



**Figure 2.** Variation in posture [1]

**Table 2.** Determination of shoulder slant

Code		Shoulder Definition	Dist. [cm]	Side L/R Code
<b>Left</b>	<b>Right</b>	Normal	-	-
501	601	Slightly square	0.5	S6
502	602	Square	1	S6
503	603	Very square	1.5	S6
504	604	Extr. square	2	S6
505	605	Slightly slanting	0.7	S7-S8
506	606	Slanting	1.4	S7-S8
507	607	Very slanting	2.1	S7-S8
508	608	Extr. slanting	2.8	S7-S8

[1]

**Assessing the figure shape and suit fit for pattern alterations can be diagnosed as:**

**JACKET - Normal posture:**

- Incorrect lengths
- Incorrect widths
- Incorrect shoulder slant

**- Stooping posture**

**- Erect posture**

**TROUSERS - Normal posture:**

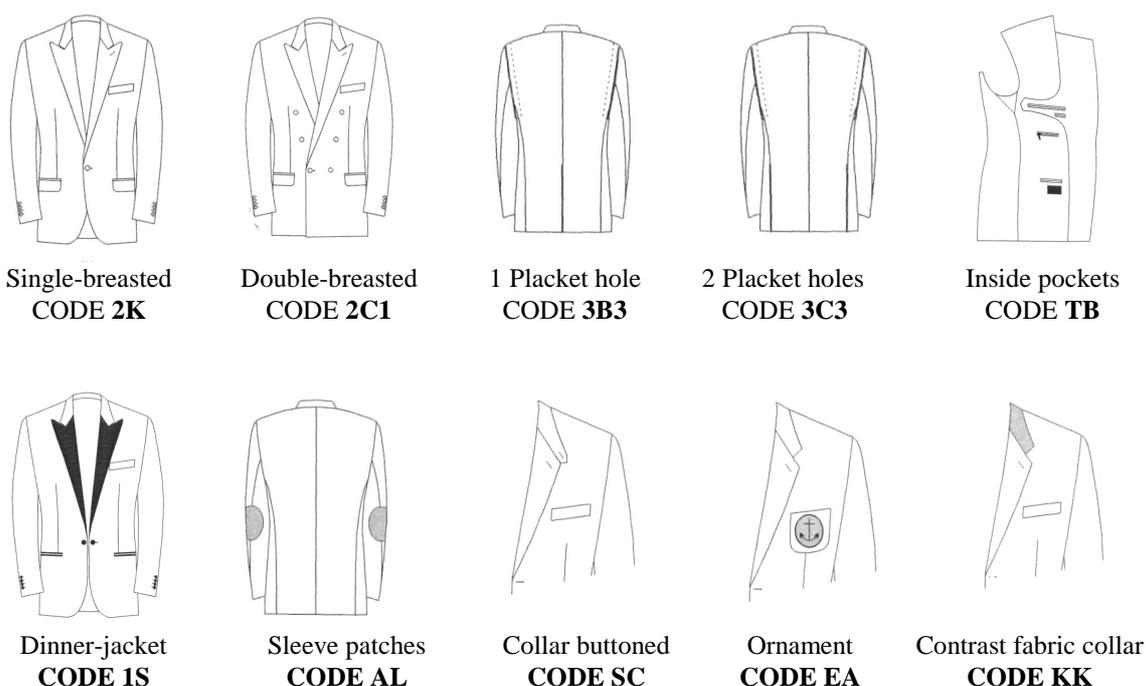
- Incorrect lengths
- Incorrect widths

**- Open stance**

**- Close stance**

### 3.1.4 Creation of suit style

In ordering process a customer creates own suit style according her/his wish with the help of samples of reference garments (in stores) and catalogue of suit details. Sketches of suit components e.g. front part, back part, pocket, sleeve, type of lining, ornaments, complements, accessories etc. with codes are displayed in catalogue. Customer has opportunity to collect all details of suit from thousands of combinations of one product type. Some of components you can see in *Fig.3*. Fabrics they prefer are selected by sample swatches and displays, as are textures, fabrics, and accessories also.

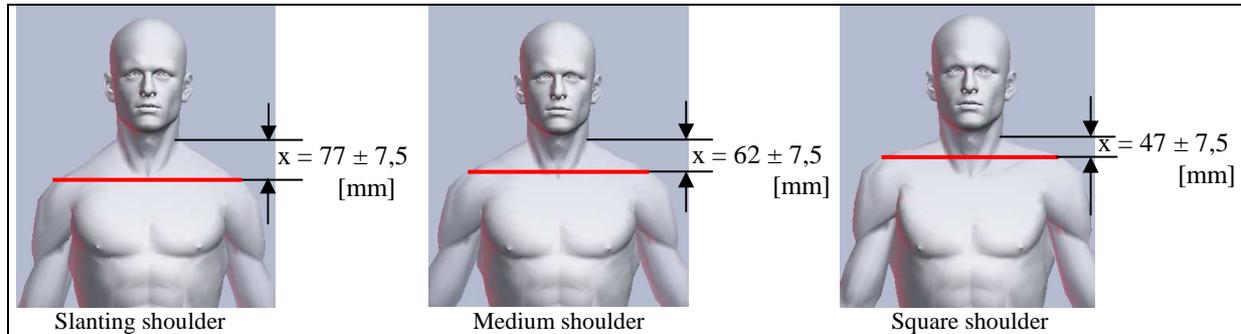
**Figure 3.** Suit jacket details [1]

### 3.2 An Example of the MTM technology applied to Mass customisation in a suit jacket production

The set of raising shoulder modification is defined, that may be performed to adapt the suit jacket to each customer.

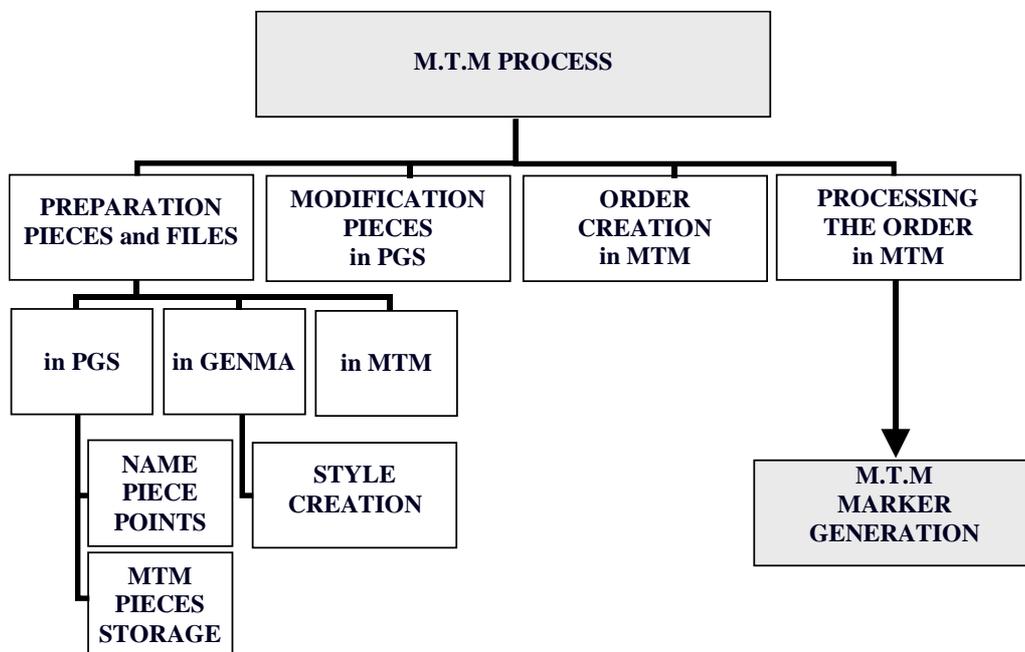
Shoulder slant is determined by the distance “ $x$ ” between the horizontal level of the acromion and the horizontal level of highest point on the neck.[3]

Shoulder slant types you can see in *Fig. 4*.



**Figure 4.** Shoulder slant types

The following sections focus on CAD software developed by technology of Investronica Sistemas. Computerised MTM pattern drafting software is implemented either by programming the traditional tailor's code methods. In *Fig. 5* you can see the general chart of MTM process of a tailored suit jacket.



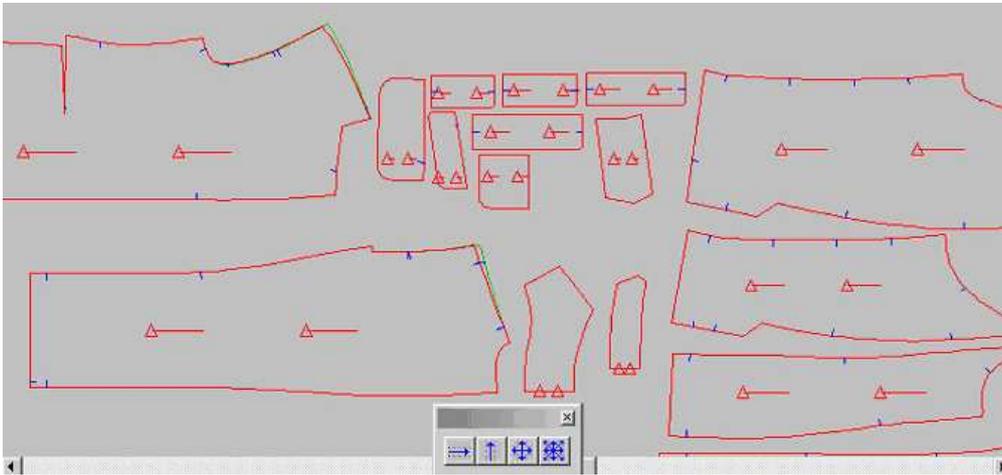
**Figure 5.** General chart of MTM process of a tailored suit jacket

Before an order can be processed, the pieces and the modification files have to be prepared.

- **PGS**

In PGS we have to name the points on the pieces that we want to modify. In this case there are 2 points on the contour of pattern, one on the armhole line and one on neckline. We have to create in this program the modification files that we will apply to the MTM orders.

In the *Fig. 6* you can see pattern pieces modification of shoulder raising by 1 cm.



**Figure 6.** Pattern pieces modification: Shoulder raising by 1 cm in the armhole point.

- **GENMA**

The styles can be created whether in PGS or in Genma. If we will MTM Garments, we need reference markers to define the standard widths and type of spreading used in the MTM orders.

- **MTM**

The orders will be processed with the suit jacket that exists in the database. This suit jacket can be created in MTM.

Then we introduce the orders data and process them, obtaining as a result a new marker ready to be cut. The Final report of new marker you can see in *Fig. 7*.

<b>MTM REPORT</b>			
<b>ORDER #</b>	12	<b>MTM Garment:</b>	<b>GENERIC</b>
<b>Customer</b>		<b>SELL POINT:</b>	<b>INVADM</b>
<b>COMMENTS:</b>	InCoTex		
<b>Date order:</b>	2010-06-25	<b>Date proces:</b>	2010-06-25
<b>STATUS:</b>	<b>Processed</b>	<b>FABRIC</b>	<b>STATUS:</b>
Suit Jacket - shell	MTM- jacket		OK
<b>Length:</b> 1526.14	<b>Width:</b> 1500.00	<b>Perimeter</b> 29691.17	
<b>Efficiency:</b> 79.62%	<b>Total pieces:</b> 24	<b>Fit pieces:</b> 24	

**Fig. 7** Final report of new marker ready to be cut

#### 4. DISCUSSION

This study partially supported a concept that satisfaction in the customisation process may increase using the Computerised made-to-measure system that was introduced.

In mass customisation practices, the processes of in-store activity are as follows. When customers enter the store, with the help of trained salespeople, their sizes are taken by body scanning or by hand, and the styles and fabrics they prefer are selected by sample swatches and displays. After that, information about customers is entered and stored in the computer system. With the computer system, every byte of information about the consumers is worked into the style pattern after being sent by modem.

In every process, trained salespeople help the customer to choose what styles she/he desires as specifically as possible. Every step of the mass customisation process will be continued depending on the consumer's satisfaction. Specific styles and sizes are limited under mass customisation processes. Based on the variety in possible choices, customer satisfaction becomes a subjective affair. Also, depending on how well the computer system adjusts style and size information to specific patterns, this process may need designer support. Ultimate success will be based on how satisfied consumers are during the early, pre-manufacturing steps of the process. Another similar point of mass customisation in the apparel industry is that size and style selections are limited to reduce the overhead costs.

Mass customisation in the clothing industry is not widely implemented in the Czech Republic yet. Several companies use computerised MTM systems developed by technology of Investronica Sistemas. The other types of MTM systems are e.g. Gerber technology, Lectra technology, Assyst Bullmer and others.

The authors believe that this approach will ensure the customisation process could be systemically implemented in the apparel industries in Czech garment production companies.

#### ACKNOWLEDGEMENTS

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