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Virtual Garment Creation

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1. Introduction

The use of new information technologies and software provide the possibility to solve problems connected with raising work efficiency in the company (Hannelore, 1999). The first information on using information technologies in the sewing industry, particularly in construction designing, turned up in the beginning of the 70-ies of the XX century, but first publications on computer aided designing software – only in the 90-ies of the XX century. At present most of the companies use computer aided software.

Modern computer aided designing software provides the possibility to avoid small operations and manual work, to raise precision, productivity and organize information flow (Beazley, 2003). The usage of garment designing systems excludes the time consuming manual preparation of patterns, creation of layouts and relocation of written information. The computer systems are meant for the execution of every single process and the integration of all processes into one joint flow, for the organization of logistics and the mobility of work tasks.

The computerization of different processes in the garment industry is necessary to reduce the costs of a product and raise the competitiveness (Kang, 2000).

Computer systems allow making two dimensional as well as three dimensional product illustrations and visualizations (D'Apuzzo, 2009; Lectra, 2009). It is possible to create computer aided garment constructions, as well as gradations, and create a virtual first pattern of the model - such computer aided operations significantly decrease the time consumption and cost necessary to design a product. The costs of the product itself can be calculated with the help of the product management systems following the development parameters, the layout of patterns, textile expenditure, model complexity and specification, as well as previous experience of the company stored in a data base.

Although computer systems significantly facilitate the development of a product, the knowledge and skill of the user are still very important. One of the most important garment creation stages is constructing.

Constructing is the reproduction of a spatial model (clothing) on a plane (construction); this transformation has to be reflexive when joining the parts of the construction a garment is originated. The creation of the drafts of the construction is the most complicated and responsible stage of garment designing, because a non-existent complicated spatial shape product surface layout has to be created (drawn) (Vilumsone, 1993; Koblakova, 1988). One of the most topical problems in garment designing has always been the search of garment designing methods scientifically reasoned, precise and as little as possible time and labour consuming. Several factors depend on a precise development of garment surface layout – material expenditure, garment set quality, labour intensity level, the aesthetical and hygienic characteristics of the finished product.

The traditional mass production ever decreases the volumes of series, the production becomes more elastic and the choice of goods expands; the wear time decreases. Along with the serial production, individual production becomes more and more popular. The current economic situation shifts the search for labour more and more to the East, but the creation of individually oriented products could make it possible to maintain working places and production units in Europe. People will be willing to pay more for this type of clothing and receive it in a possibly short term. Thereby the promotion of individualized production is affected by social and economic aspects.

The non-contact anthropometrical data acquisition methods are currently used to solve the problem of acquiring the clients' measures for individualized production, yet still the spread of individualized production is limited by the uniformity of assortment, the labour intensity of designing, the uncertainty of the result of the construction and the complexity of the constructing tasks creating an individual product for each customer (D'Apuzzo, 2008; Fan, 2004).

In its turn the potentialities of the virtual reality are used to create e-store offers that are more attractive to customers, create virtual twins, model fitting and the reflection of garment individualities.

2. Computer aided garment designing

Computer aided designing software (AceApparel; Assol; Assyst; Audaces; Bernina; Comtense; FashionCad; Gemini; Gerber; Grafis; InvenTex; Jindex; Lectra; Leko; Optitex; PadSystem; RichPeace; Staprim; WildGinger; TanyaGeo) not only provide the possibility to speed up the process of putting a new model into production and improve the quality of the products, but also to reduce material costs and labour intensity, ensuring an elastic change of the assortment. Most of the systems are made by the module principle in which separate garment designing stages are implemented (Razdomahins, 2007). The systems are constantly being developed according to the improvements of in production conditions, the implementation of new technologies as well as the optimisation of the designing process.

When introducing CAD/CAM systems, some main aspects have to be taken into consideration: costs of software, equipment, technical supply and training, the suitability to the particular production conditions, the safety of exploitation and improvement possibilities (Vilumsone, 1993; Pavlovskaya, 2009). Although the implementation of systems is an expensive process, the advantages compensate the high costs and difficulties that arise during the implementation.

Modern computer aided designing systems allow performing different designing stages including traditional 2D designing, as well as the imitation of a 3D garment, 3D virtual fitting.

Modern 2D CAD/CAM systems perform constructing in three ways:

Type 1 The construction is designed manually, but the production preparation is performed using computer technologies (manually prepared patterns are entered into the system with a digitizer).

Type 2 Manual work is completely excluded. The whole designing and preparation process is computer aided.

Type 3 Part of the designing stages are computer aided, without human help, but the rest is an interactive process.

The use of any kind of computerization has indisputable advantages: improved production quality, higher productivity, humanization of the working process, more elastic production, process control, the possibility to link the production with the desires of the customer (rapid response). Nevertheless each system can be improved. For a 3D imitation of a garment to adjust a parametric mannequin to the individual measures of a human body additional projection body measures have to be considered (at present only the height is integrated, but the width characterizing the configuration of transversal planes is necessary too.

The latest tendency in the CAD/CAM development is the creation of 3D designing. There are several reasons for the implementation of 3D designing:

- plane-like garment designing methods do not provide an absolute conformity of the garment with the expectations;
- the construction of garments in opposition to the object (garment) to be designed is a plane-like process – it does not provide a preview of the product. In its turn the preparation of patterns is an expensive and time consuming process;
- the 2D visualizations of the garment do not provide the evaluation of the characteristics of textile materials.

Although 3D designing where it is possible to create a layout of plane details by a 3D shape drawing already exists, such systems have several disadvantages: a limited assortment and shape of garment, segmentation.

Depending on the practicable task, 3D systems can be divided as follows:

Type 1 Imitation of the garments' appearance – the system allows changing the 3D sketch or photograph to evaluate the appearance of the garments' model with visually different types of textile materials;

Type 2 Garment imitation – the systems allows performing a virtual fitting, evaluate the external appearance, shape, set, proportions of the garment (the garment is created in 3D by joining patterns constructed in a plane, creating an imitation of the garment with the intention to ascertain the conformity of the outer appearance to the expectations);

Type 3 Garment designing – the system allows creating the shape of a garment, identify (define) dividing lines, create patterns in a 3D environment following a layout in a plane.

The apparel appearance imitation systems are suitable mainly for making catalogues and specialist communication to verify the visual conformity of the textiles with the particular model. To create the reality of the apparel perception a shading/lustre of a photograph/sketch. A new fabric is spread over the fabric in the image in a way that the direction of the pattern conforms with the pattern direction of the fragment defined with the help of a net structure (Figure 1). In case of a complicated model the preparation of the image for fabric "spreading" can be quite labour-intensive. Nevertheless it pays off since after that a large variety of patterns and colours can be tested within a very short period of time.

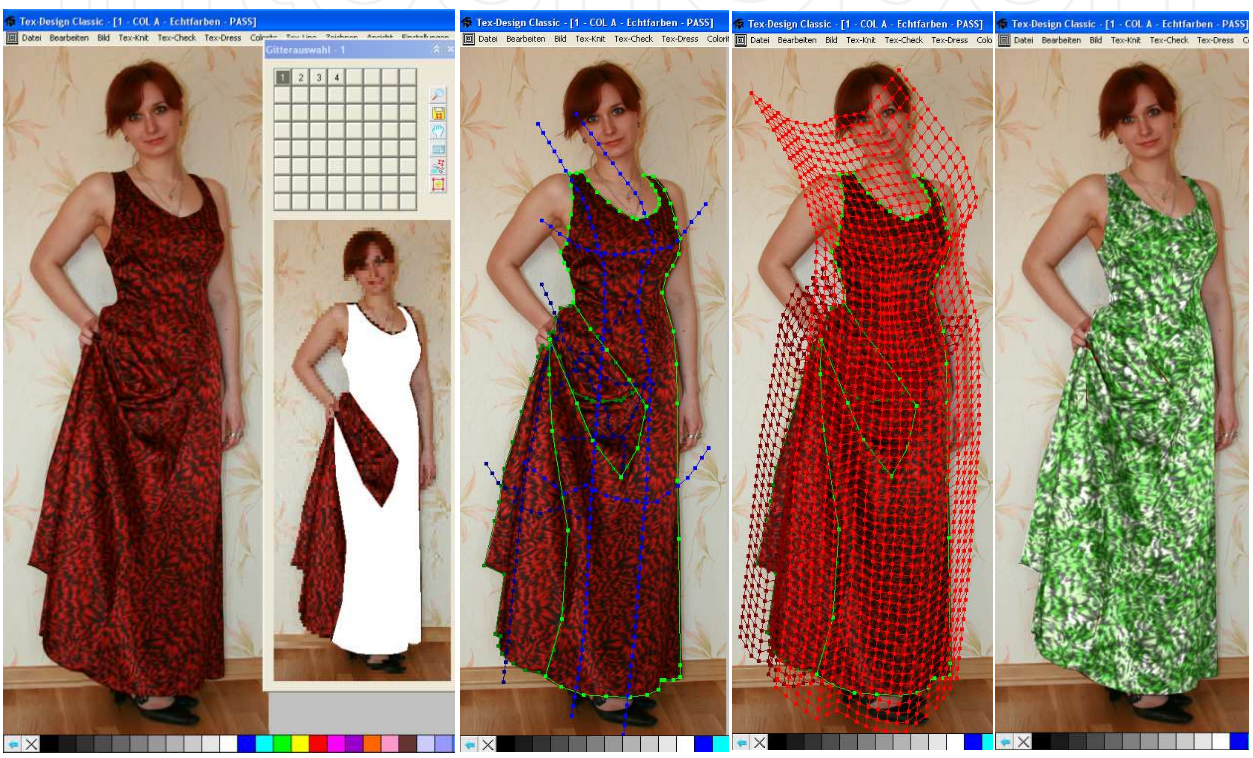


Fig. 1. Imitation of the garments' appearance KOPPERMANN Tex Design

There are several other 3D designing elaboration foreruns and finished elaborations, the usage of which is limited by different factors – assortment, segmentations of products, the fiction of 3D designing – all changes are made in a 2D environment (Viļumsone, 2007).

A structural scheme of the production process (Fig.4.), identifying the processes of typal production with the goal to determine the mutual relationship of the production preparation processes and the structure of the informative and software means, has been developed; it has been concluded that no matter what level CAD/CAM system is used, their usage provides a faster development of the product and shortens the working process. A complete 3D designing process would exclude different working stages connected with constructing and constructive modelling, 3D imitation and creation of a virtual prototype.

(a)

(b)

Fig. 2. Garment imitation a) LECTRA 3D Fit, b) BERNINA My Label

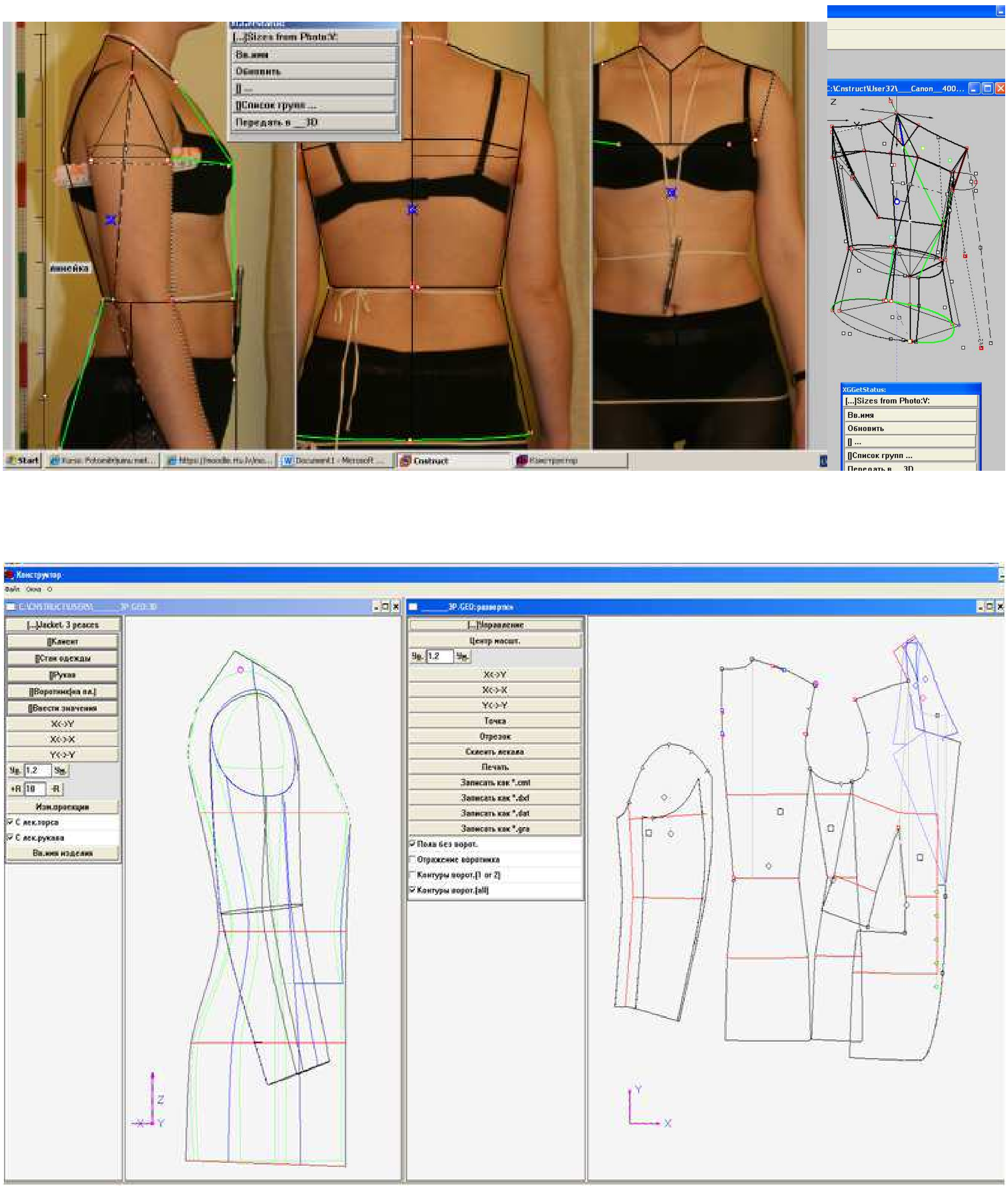


Fig. 3. Garment designing 3D CAD STAPRIM

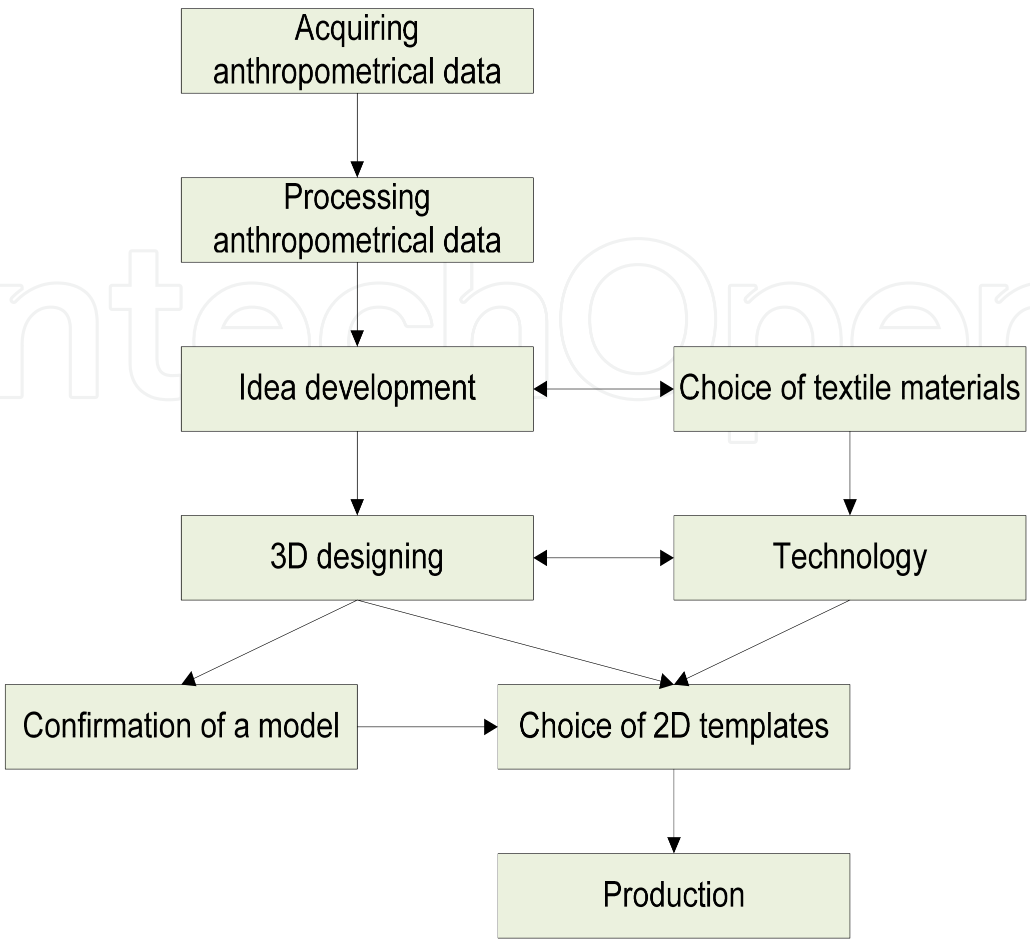


Fig. 4. The 3D process of garment designing

3. A comparison of the existent 3D designing systems

When developing 3D apparel designing systems three mutually connected tasks are being solved: the development of a virtual mannequin, the creation of a 3D shape of a garment model and the 2D layout of details (Winsborough, 2001; Yan, 2007). There are two sequences possible for these tasks. Systems, like Optitex (OptiTex CAD/CAM), that imitate garments, use 2D templates that are sewn together virtually. In its turn 3D designing systems create the surface of a garment in relation to a mannequin and acquire the layout of details afterwards (Staprim CAD/CAM). In addition problems connected with the qualities of the textiles. The imitation of the physical qualities of fabrics (elasticity, drapery etc.) when placing parts of a garment onto a 3D mannequin influence the correct set of a garment and the visual perception of a model (Szabó, 2008). The visual qualities of a fabric – colour, pattern, texture – are very important for a wholesome perception and evaluation of an apparel model.

The comparison table of the existent 3D designing systems examines the best known systems which offer 3D designing: Optitex (Israel; http://www.optitex.com/), Staprim (Russia; http://www.staprim.com/), Lectra (France; http://www.lectra.com), Assyst (Germany; http://www.human-solutions.com), Gerber (USA; http://www.gerbertechnology.com/), Assol (Russia; http://www.assol.org/), Bernina (Switzerland; http://www.berninamylabel.com/).

#	Parameter	Description		Optitex	Staprim	Lectra	Assyst	Gerber	Assol	Bernina
1.1.	**MANNEQUIN**	sex	feminine one type	x	x			x	x	x
1.2.			feminine several types			x	x			
1.3.			masculine	x		x	x	x		
1.4.		parametric		x	x	x	x	x	x	x
1.5.		individualiz ation	traditional measurements	x	x	x		x	x	x
1.6.			projection measurements		x					
1.7.			integration from 3D scan			x	x	x	x	
1.8.		imitation of movements	virtual movement	x						
1.9.			change of current postures			x	x	x		
2.1.	**CREATION OF GARMENT SHAPE**	designing of apparel parts on a 3D mannequin		x					x	
2.2.		definition of an intermediate layer (ease allowance)	projection distances		x				x	
2.3.			traditional ease allowances		x					x
2.4.		usage of finished apparel parts	3D construction templates		x				x	x
2.5.			„sewing" and "try on" using 2D templates	x		x	x	x		
3.1.	**CORRECTION OF GARMENT SHAPE**	in plane, checking 3D		x		x	x	x		x
3.2.		3D, automatical changes in plane		x		x	x	x		
3.3.		changing numerical parameters			x		x		x	x

#	Parameter	Description		Optitex	Staprim	Lectra	Assyst	Gerber	Assol	Bernina
4.1.	VISUAL CHARACTERISTICS OF A GARMENT	fabric characteristics	elasticity	x		x	x	x	x	
4.2.			drapery	x		x	x	x	x	
4.3.			structure	x		x	x	x	x	
4.4.			stiffness control			x	x	x		
4.5.		visual characteristics of the fabric	colour/ pattern	x		x	x	x	x	x
4.6.			Size of pattern			x	x	x	x	
4.7.			texture			x	x	x	x	
4.8.		placement of decorative elements		x		x	x	x	x	x
5.1.	EASE CONTROL	colour code		x		x	x	x		
5.2.		numeric evaluation		x	x	x	x	x		

Table 1. Comparison table of the existent 3D designing systems

The comparative table shows that despite the fact that most systems strive to use some of the 3D designing and/or fitting stages, most of the systems are made for 2D pattern fitting, whereas the actual indications of 3D designing would be the creation of garment patterns on the surface of a 3D mannequin and defining ease allowances by setting projection space between the garment and the mannequin. The systems reviewed in the table can be shortly described as follows:

- Using OptiTex 3D Garment Draping and 3D Visualization software system - designers, pattern makers, and retailers can visualize patterns, change the texture, colors, add/remove logos and buttons, instantly in 3D. It is possible to use modeling system software, analyze fabric behavior, proof-fitting assumptions, the product development process. It also provides a tool for sales and merchandising, allowing users to create 3D catalogs.
- In the 3D CAD system Staprim the patterns of clothes are created automatically by laying out the surface of the constructed model from three photoes on a plane (Viļumsone, 2008; Razdomakhin 2003 & 2006). This allows to solve a number of essentially important engineering problems, for instance: to set high quality of the layout of a product on a human body; to carry out maximum computerization of processes of clothes designing from the idea up to the layout of patterns; to estimate the created (virtual) model of a product before the manufacturing stage by rendering the image on a screen, etc. The computerization of the process from the idea to a layout of a

pattern is solved by means of merging 3D CAD Staprim with traditional 2D CAD Comtense (Russia; http://www.comtense.ru/). The Comtense ensure development of production patterns comprises: pattern creation, modeling, grading, marker making, plotting, and CNS-cutter control file generation.

- Lectra and its consultants accompany apparel businesses in the design, engineering, and manufacturing of their products. CAD application software for product design, pattern-making, and 3D-prototyping addresses collection development from drawing board to cutting room. Developed especially for fashion, Lectra Fashion PLM meets the needs of the entire apparel development chain from brands, to suppliers, to retailers. Lectra Modaris is a solution for flat pattern making, grading, and 3D virtual prototyping. Modaris simulates virtual samples by associating flat patterns, fabric specifications, and 3D virtual mannequins.
- The Human Solutions GmbH has taken over all software products, software-related services and the software-related hardware supplies of the former Assyst GmbH from that company's insolvency estate. At present the cooperation between Assyst and Human Solutions has grown into a successful virtual fitting and prototyping system allowing more than just integrating individually scanned mannequins and fitting the chosen apparel model on it. It is also capable of a realistic analysis and reproduction of the characteristics of a model, seam allowance placement – constructively technological individualities. It is also possible to imitate and virtually control the fastener, pocket openings, cuffs, flaps and other covering details of a garment model.
- Gerber Vstitcher software is created in collaboration with Browzwear Int. Ltd. (Israel; http://browzwear.com/). Software is a 3D design and visualization system, it transforms two dimensional patterns into three dimensional garments. It interfaces seamlessly with Gerber's AccuMark pattern design, grading and marker making software, enabling a transformation of 2D patterns into 3D garments. Virtual samples can be used for internal design reviews before the factory creates actual samples. They also minimize the need to send physical samples through the mail, saving time and reducing costs. It is possible to simulate texture, draping and fit of garments by displaying them on a virtual human body form based on pattern created in 2D, fabric and texture data. Maintain fit consistency throughout the development process.
- Assol is an apparel designing system that, in cooperation with AutoDesk, have created a garment designing module on the basis of AutoCAD which provides the parametric designing of garment templates, as well as a parametric gradation of templates, usage of different mannequins (parametric and digitized) for 3D designing and the designing of 3D garments for limited assortments. The usage of AutoCAD as a base allows for a more elastic connection of software and hardware.
- Bernina My Label is pattern-making software with integrated 20 different styles based on parametrical mannequin which can be changed for individual measurements. It is possible to change wearing ease and make slight design details, like making a skirt longer, collar wider, etc. Once the measurements are entered, a 3D model is generated using Optitex imaging software. After individual mannequin is created and saved, garments may be selected and simulated on the model. If the garment is too tight or too loose, it is possible to vary the style properties. Wearing ease is included and it can be changed.

A more rapid development of 3D imitation systems is driven by the fact that the new “fitting” module is being developed as an addition to the existent traditional CAD system template designing, gradation, layout and other modules. The designers of the systems have the possibility to continue to improve the existent approbated modules and develop the new ones. It does not require the development of a basically new template designing process, namely, it allows to use the pattern making and gradation methods that have developed for centuries and which are relatively successfully used by companies to create the contours of the garment details of a particular assortment despite the specific weight of uncertainties and subjective solutions. As all creative processes the creation of the shape of a garment (both, in2D or 3D) is very complicated to formalize. The contours of details intuitively drawn or manually developed in the pin up process by skilful designers or constructors are entered into the computer system for further processing. The necessity for a digitizer module to be included into industrial CAD systems is determined by the inability to precisely forecast the shape of a garment using 2D template systems.

The virtual fitting of a model is visually very attractive for the designer as well as for the consumer thanks to the imitation of the physical individualities of textiles as well as the imitation of patterns, colour and texture. The effect of reality is becoming more and more convincing. The designers of the systems offer new and more convenient tools. Some have even implemented movements of a mannequin. Nevertheless the virtual "sewing" function procedures of more complex models have to be improved on almost all existent systems. The main problems are connected with defining the connectable layers, determination of tuck-up and roll-up parts of a garment, characterization of the multi-colouristic qualities of a fabric, the thickness of layers and the position of padding.

So far the 3D designing systems have coped better with designing products and developing layouts of details for close fitting models, where the apparel is smaller (or the same size) than the given layout of a mannequin's surface. As an example CAD Assol and Optitex can be mentioned.

Research on creating the surface of a garment in a particular distance from the surface of a mannequin is being carried out to be able to design a broad assortment of apparels. Since 1995 the STAPRIM software is on the CAD system market. The developers of this system were the first to be able to define projection spaces between the surface of the garment and the mannequin and connect them with traditional tailor measurements as well as transfer them into standard and individual patterns. Though the carcass type representation of the mannequin and garment does not produce the realistic sense characteristic to the "fitting" systems, but it is informative and the automatically acquired detail contours are mutually perfectly coordinated and ensure the set visible in the virtual image.

Such a system could be very suitable for the creation of different uniforms, since it allows creating well set constructions for different individual figures, but the result provided by the system is a basic construction and does not foresee full designing of special features of a model. Importing this construction into any other system the model construction and pattern designing process has to be started anew. Therefore it is advisable to develop an algorithm providing the in heritage of detail size and shape of individual figures up to the level of finished patterns (as it is, for example, in the software GRAFIS).

The developers of CAD Assol (Russia) also notify of the existence of such a module. In their informative materials they demonstrate examples of all types of 3D CAD apparels, developed by means of AutoDesk.

Which company CAD system is better? It is wrong to state the question in this way, and not just because it wouldn't be correct. All CAD systems, i.e. the CAD of various companies are actually identical. All of them computerize the same or almost similar plane-like methods for creating patterns of clothes. This is the circumstance and it is difficult to disagree. As to the layout of patterns there are some distinctive features between the systems, but they are never long-term considering the constant development of the software of all companies. Certainly there are differences in the choice of toolkits as solutions of some parts of the system, but in some period of time similar solutions appear on other systems. The preference is given by the user who studies the systems of various companies and chooses the most convenient one for the particular assortment and for him-/ herself. Certainly the greatest and maybe even the crucial impact are given by the price policy of different companies. But it is not that simple again. We cannot say that everything that is more expensive is better. Just as we cannot say the contrary - that everything that is cheaper is worse (Razdomakhin, 2006).

4. Possibilities of acquiring anthropometrical data

Since a virtual mannequin is necessary as the basis of any 3D CAD apparel system, great attention is paid by the scientists to its development and processing (Scharrenbroich, 2009).

There are two types of human body measurement acquiring methods:

Type 1 manual anthropometry methods (contact methods);

Type 2 optic anthropometry methods (non-contact methods).

Anthropometrical data (Fig. 5.) can be acquired with different tools (3D Ouest; 3D-Shape; 4D Culture; Bodymetrics; Cyberware; Digimask; GFai; Hamano Engineering; Human Solutions; InSpeck; Intellifit; Singular Inversions FaceGen; Telmat; VisImage Systems; Vitronic Stein Bildverarbeitungssysteme; Wicks and Wilson; XX Production online). Traditional methods use different manual tools (measuring tape, anthropometer, etc.). As the technologies develop, new tools are created and/or the existent ones are improved. The electronic measuring tape can be considered as an improvement of the electronic measuring tape, but its use for anthropometry is doubtful. It has been proved by an experiment that when using the electronic measuring tape, more than half of the measures taken were wrong.

Photo measuring methods are fast and effective, but the processing of data is time consuming and labour intensive. A relatively new tool (approximately since 1980 (Fan, 2004)) in anthropometry is the 3D scanner.

Considering the advantages of 3D scanning, the scanning technologies are being developed and improved. Most of the scanners can not only create a 3D image of the human body, but also read the x, y and z coordinates thereby acquiring precise information about the human body and its volumes (Hwang, 2001; Rupp, 2005; D'Apuzzo, 2003; Sanyo Electric Co.).

A human body surface reproduction dot cloud is created from the coordinate readings, which can be used as a virtual mannequin or only the coordinates themselves can be used. A virtual reproduction of the human body can be used in garment production, car production, engineering and medicine.

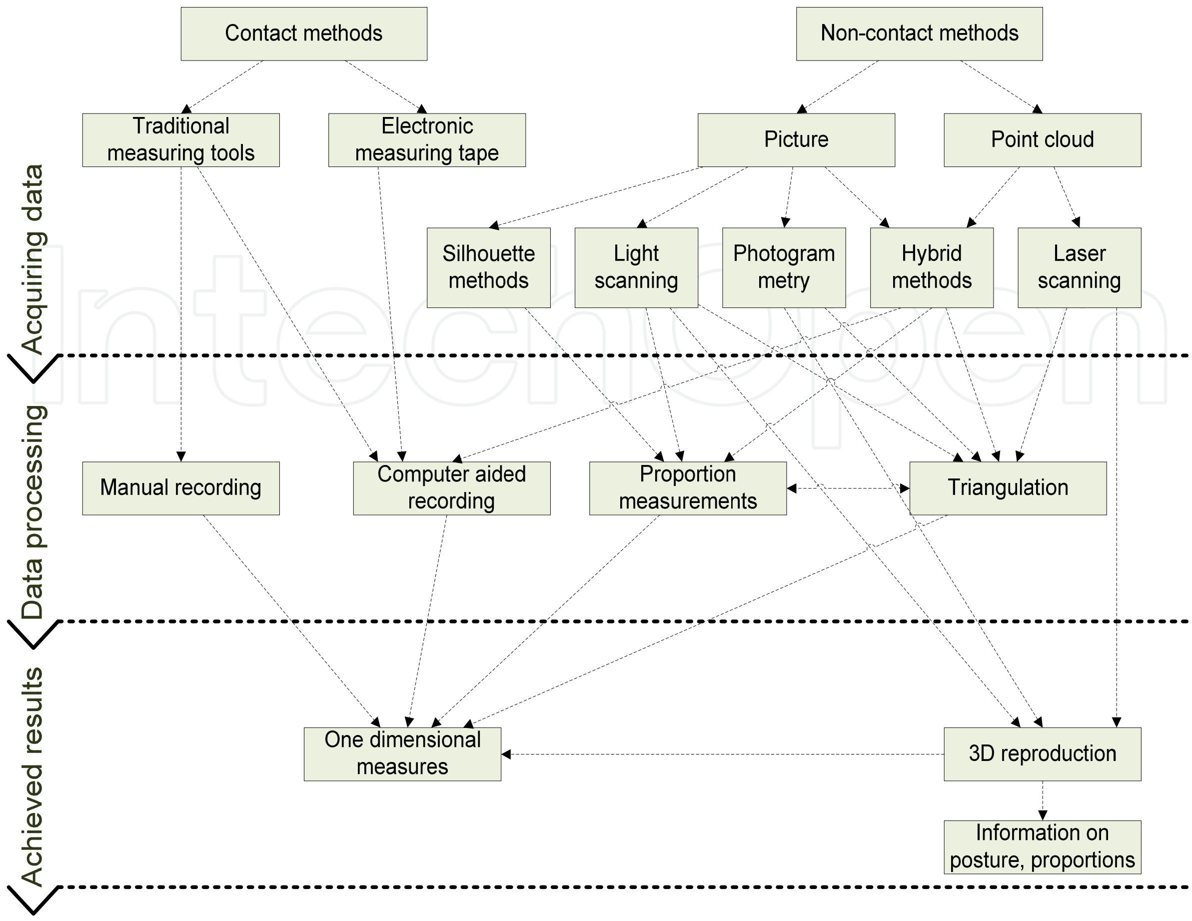


Fig. 5. Types of anthropometrical data acquisition

Any scanning device is equipped with optic (light) appliances to ensure non-contact measuring. Such optic measurement acquisition devices can be divided into categories: photogrammetry, silhouette methods, laser scanning, light projection, electromagnetic wave and hybrid methods (Vanags, 2003; Winsborough, 2001; Xu, 2002; Youngsook, 2005; D'Apuzzo, 2008).

Each method has its advantages and disadvantages (Wen, 2007; Devroye, 1998). In spite of the fact that laser scanning has been recognized as the most precise method and the gathered results are the most extensive (human body measurement data, a 3D virtual mannequin, a reflection of the actual texture, surface relief measurements, etc.), the light projection method is used more widely in the garment production industry since the equipment is much more cheaper than a laser scanner.

There is still not enough research and results as to use virtual mannequins for 3D garment designing. Mostly 3D scanning results are used to generate measures used in tailoring to use them in traditional or computer aided constructing methods (DOI, 2005; Dāboliņa 2007; Dekker, 1999; D'Apuzzo, 2008).

5. Limitations of human body 3D scanning

3D scanning of the human body can be used successfully in computer aided garment designing and individualized production (Buxton, 2006; CAD Modelling Ergonomics;

FitMe.Com; Hamamatsu Photonics K.K.; Hwang, 2001). Nevertheless the scanners have to be improved considerably – the data acquisition time has to be shortened, the way of displaying the scanned data has to be improved, the 3D scanner software has to be improved, etc (ISPRS, 2009; Istook, 2001; Simmons 2004; D'Apuzzo, 2003).

The scanning technologies are being improved constantly, the price has falls considerably comparing to previous developments, and nevertheless each system has individual imperfections (Siegmund, 2007; Sungmin, 2007).

Although it is possible to enumerate the deficiencies of each system, their data precision is sufficient so that 3D scanners can be considered as appropriate for anthropometrical data acquisition for garment designing.

Two researches connected with the limitations of 3D scanning have been described:

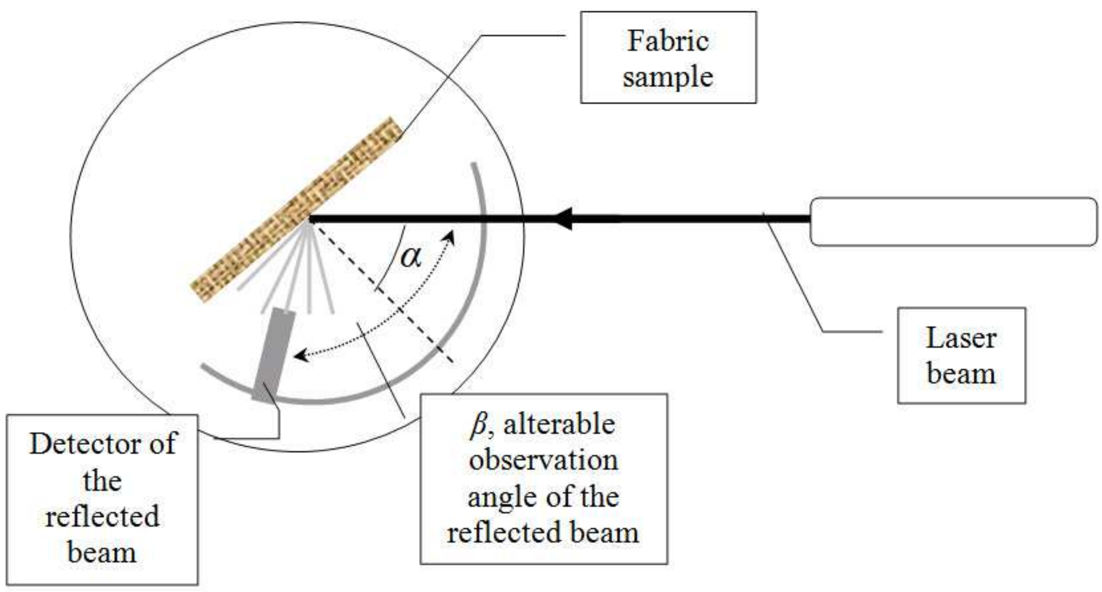


Fig. 6. Scheme of the reflection study experiment

The scanning systems for human body measure acquisition use different data acquisition ways: dynamic range (lights and darks), laser beams, etc. The experiment determines the laser beam reflective abilities of different textile materials and the curve characterising the reflectivity has been compared to the Lamberts' law diffuse reflectivity curve (Dāboliņa, 2008).

Studying the light reflections from different fabrics, essential deviations from the Lambert law were observed. Such deviations come from the geometry of the fabric surface (relief, texture, trim). Insignificant deviations from the standard curve can be observed on very smooth (bright) surfaces and uneven (relief) surfaces. Decorative elements – embroidery, applications can cause a too bright and uneven surface causing deviations from the standard division in these areas. If the underwear is decorated with crystals or other very bright materials, the reflection curve is very uneven with several extreme points. The reflectivity of different textile materials depending on the decoration varies from diffuse to mirror-reflectivity.

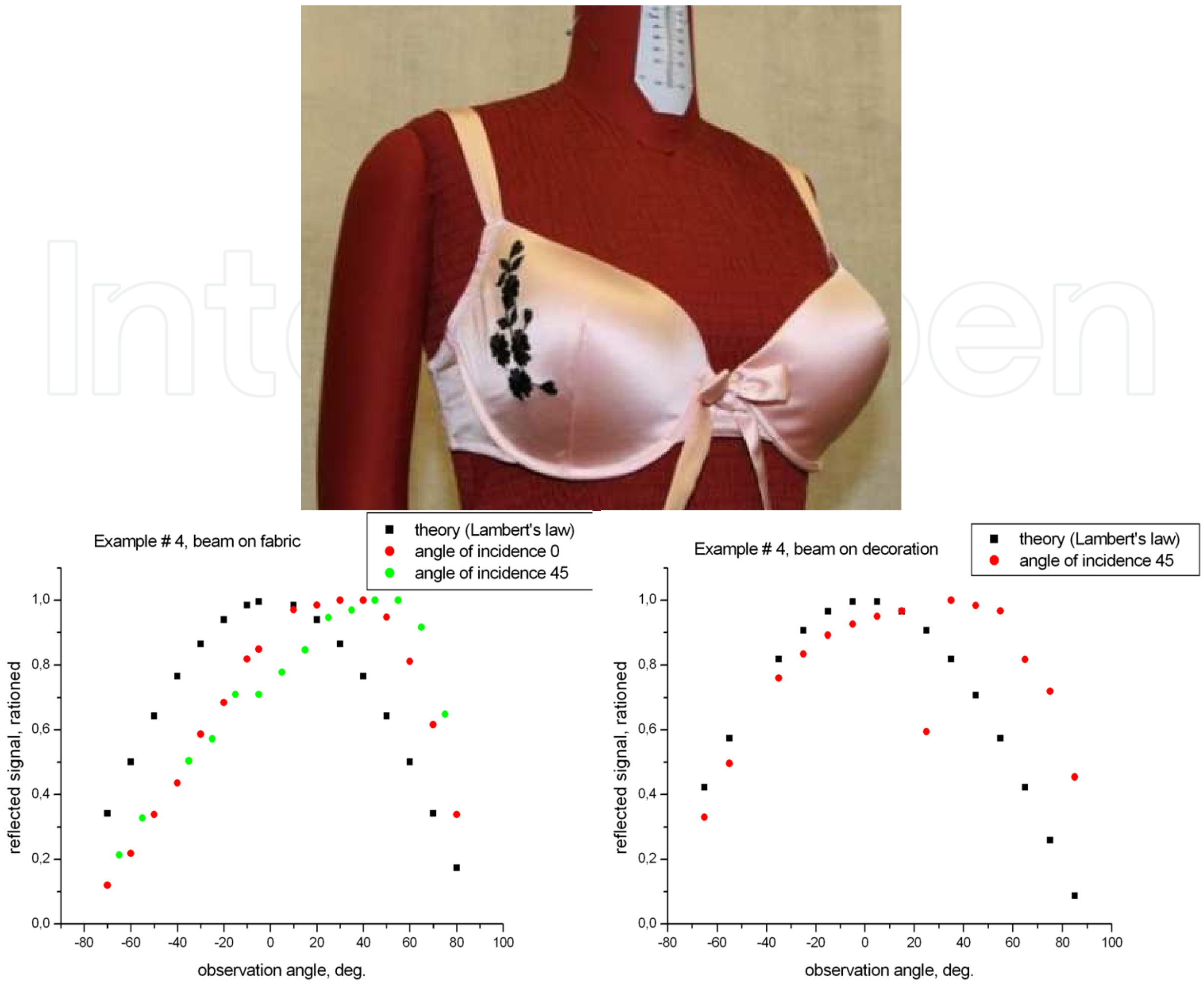


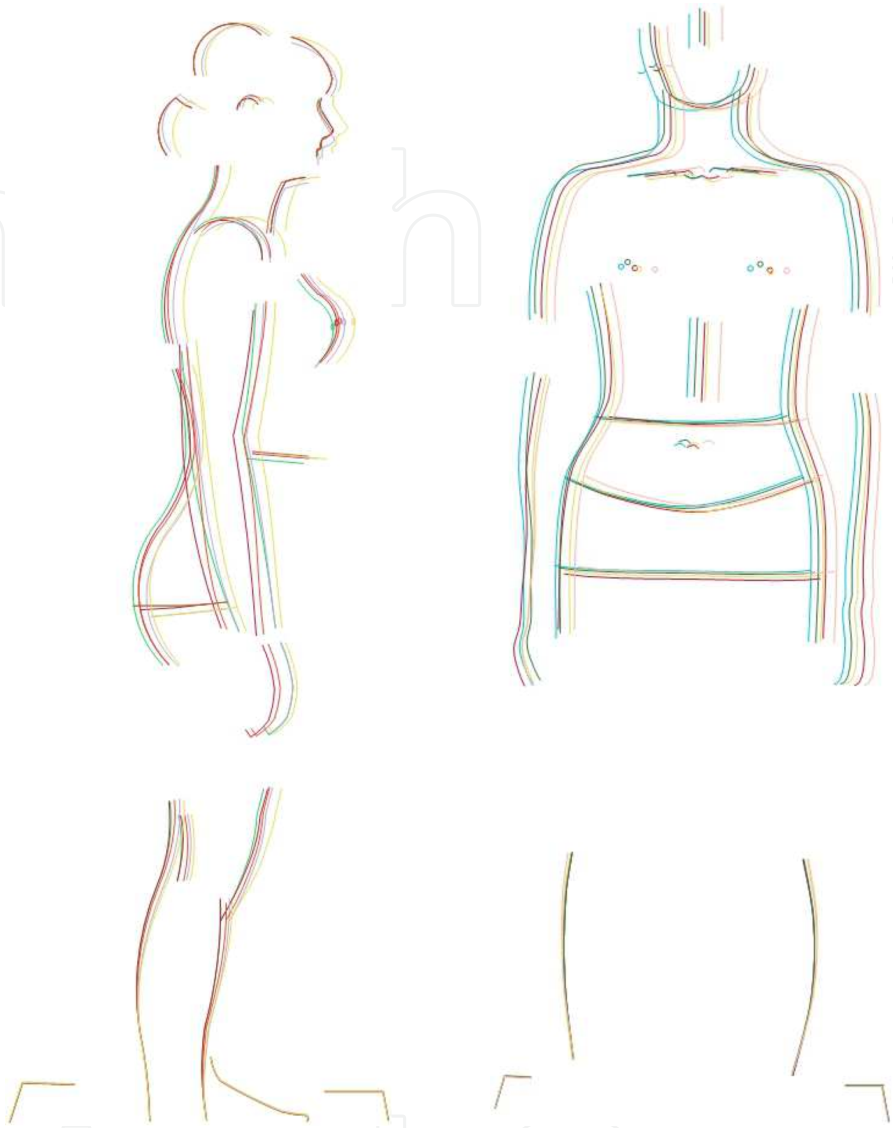
Fig. 7. An example of the results of the reflectivity study experiment: If the beam falls on a decorative element deviations from the diffuse division can be observed, this can be due to the brightness of the fabric. In this case there are significant changes in the division and a fall of the signal almost to the zero level has been observed (40 degree angle).

As a result of the research it can be concluded that smooth, but not bright underwear, without any decorative elements, has to be chosen for scanning. Underwear with decorative elements that can reflect or break the ray of light – crystals, glass particles, and pearls – should be used under no circumstances.

An analysis of the oscillations of the human body in rest state has been performed and the significance of these oscillations for 3D anthropometrical measurements have been studied (Fig.8.).

The experiment has been performed for three different postures of a person: back view, side view and front view. Since the front and back view analysis did not show any differences, the result of the analysis has been reflected for the side view and front view only. Photographing has been performed in two cycles.

In the first cycle differences in the posture have been evaluated photographing the person in one and the same posture every three seconds, for each posture. Afterwards the changes in the posture were analysed. The analysis of the front view and back view postures show little change in the posture. A person can oscillate in the range from 3 to 12 mm.



(a) (b)

Fig. 8. Change of the posture (analysis of five sequential positions): a) side view, b) front view

The side view oscillations are greater – those can vary in the range from 9 to 21 millimetres. Such a difference can be explained by the fact that ankles are more likely to move back and forth than sideways. The results of the analysis show that the volume of oscillations increases the higher the person is from the ground. In this case not only oscillations, but small changes in the positioning of the body and posture have been observed.

In the second photo analysis cycle posture changes were evaluated sequentially stepping off the platform and changing the position of the feet and the body by 90º as it is in scanning devices with change of posture. The range of the oscillations of the front and back views is from 10 to 40 millimetres, in its turn the side view oscillation range is from 11 to 51 millimetres while the feet and the ankles remain in a fixed position. Such oscillations are characterized not only by the change of posture, but also by the change of the stand and corpus position (EN ISO 15536-1; EN ISO 15536-2). The changes can affect the scanning process causing inaccuracies in the data (Gomes, 2009; Hsueh, 1997; Luhmann, 2006).

3D scanning has several advantages comparing to manual measurements – it is fast, sequential, and has a higher precision level. Using 3D scanning, no professional knowledge is needed to acquire the measurements – most of the systems generate the measures of the human body self-dependently (EN ISO 20685; EN ISO 7250). What makes 3D scanning so attractive is the fact that is a non-contact method, but it also has disadvantages – most of the systems cannot determine hidden areas (armpits, chin, etc.), as well as vague scanning contours. The latter one is mainly affected by the oscillations of the body in time. Therefore the scanning time should be shortened as much as possible.

6. Virtual environment and virtual reality

Clothing purchasing via catalogues, e-commerce, made to measure, etc. – all these innovations are evidence of manner how people likes to shop (Protopsaltou, 2002; Sayem, 2009). So the research and development of garment CAD/CAM systems are related to this preference – general tendency is to make 3D system for garment creation and virtual usage before real production. That is why we can assert for pretty sure – it will be possible to obtain, purchase, try on to our virtual avatar, checking ease and designing properties to self-chosen or self-designed garment in e-system.

One of the most telling examples of e-commerce is a system called Fits.me (with the same Internet address) created in Estonia. Fits.me is a virtual fitting room for online clothing retailers. It has brought together competences from diverse fields ranging from apparel design and anthropometrics to IT, robotics and engineering. The system allows evaluating the external looks of a model. The user can visualize a sketch of a human with the selected garment. 4 shirt models with different fittings form men and 1 model for women. At present the system works better for the male auditory, nevertheless the developers have promised to improve the system very soon.

There are several attempts to create virtual fashion show, a model in motion, a virtual twin and to try to fit the fashion garments for demonstration purposes, as well as the chosen garment on an Internet store, and at present there are already systems with the option to create movement imitating models of a person. For instance the 3D designing system 3D MAX Studio, Maya and other similar systems, have created templates to materialize the model. These systems are not connected to a direct usage in the garment production industry, nevertheless the result, although very simplified, is very similar to a virtual fashion show.

The creation of a virtual image of a person can be performed in two ways – a digitalized pattern created by an artist, a real scanned human body. By creating the human body manually it can seem lifeless and unreal, especially the facial trail, but the scanned image reflects the human proportions more realistic. Nevertheless the implementation of a virtual twin has to be performed following mathematical calculations, with the help of dynamic anthropometry and the use of appropriate computer software. To reflect the movements of a human body, a realistic reproduction of the operation of its muscles, joints and bonds is necessary. It can turn out to be very difficult if using a scanned human body reproduction one of the scanning imperfections appears – the hidden regions. Besides, the special pose of the human body necessary for scanning changes the external characteristics of the body and makes it inadequate for the natural posture. Human Solutions GmbH, one of the world's leading laser scanner producers, solves this problem by scanning people in a free, stately, unconstrained posture, detaching the extremities form each other and from the torso with the help of calculations afterwards. This method can have drawbacks in cases when due to the specific weight of the soft tissues the extremities of the person not only fit close to each other and the torso but are so close that they misshape each other.

The creation of such a realistic reproduction of the human body allows developing services available in the e-environment. For instance in the spring of 2011 the company Human Solutions (Germany) presented a virtual mirror that reflects the scanned virtual twin of a person which can be used to fit the chosen garment and evaluate the set. Although there are different e-commerce catalogues available in the computer environment, this type of fitting is a novelty and is expected to be a great success since the bothersome and exhausting garment fitting process is excluded. Ditto Vidya Human Solutions in cooperation with Assyst 3D have developed an innovative 3D system, that not only allows virtual "sewing", fitting and evaluation of a garment, but also define the technological placement of seam ease allowances, the pocket spread and even evaluate the functionality of button snap.

7. Conclusions

There is high level of pattern making systems. Modern computer aided designing software provides the possibility to avoid small operations and manual work, to raise precision, productivity and organize information flow. The usage of garment designing systems excludes the time consuming manual preparation of patterns, creation of layouts and relocation of written information. The computer systems are meant for the execution of every single process and the integration of all processes into one joint flow, for the organization of logistics and the mobility of work tasks. Computer systems allow making two dimensional as well as three dimensional product illustrations and visualizations. It is possible to create computer aided garment constructions, as well as gradations, and create a virtual first pattern of the model - such computer aided operations significantly decrease the time consumption and cost necessary to design a product. The costs of the product itself can be calculated with the help of the product management systems following the development parameters, the layout of patterns, textile expenditure, model complexity and specification, as well as previous experience of the company stored in a data base.

Although computer systems significantly facilitate the development of a product, the knowledge and skill of the user are still very important. One of the most important garment creation stages is constructing. Constructing is the reproduction of a spatial model (clothing) on a plane (construction); this transformation has to be reflexive when joining the parts of the construction a garment is originated. The creation of the drafts of the construction is the most complicated and responsible stage of garment designing, because a non-existent complicated spatial shape product surface layout has to be created (drawn). One of the most topical problems in garment designing has always been the search of garment designing methods scientifically reasoned, precise and as little as possible time and labour consuming. Several factors depend on a precise development of garment surface layout – material expenditure, garment set quality, labour intensity level, the aesthetical and hygienic characteristics of the finished product.

The specialists in the different fields are interested in reproducing of human figure in a virtual environment: designers, what uses information of ergonomics (engineering, interior design), animation creators, and also medicine and apparel designers. There is a chain of problems in the production of clothes which is related to the features of the figure of a customer to get maximally conformable clothes. It is very important to have exact human body measurements without significant mistakes for garment construction. The traditional mass production ever decreases the volumes of series, the production becomes more elastic and the choice of goods expands; the wear time decreases. Along with the serial production, individual production becomes more and more popular. The current economic situation shifts the search for labour more and more to the East, but the creation of individually oriented products could make it possible to maintain working places and production units in Europe. People will be willing to pay more for this type of clothing and receive it in a possibly short term. Thereby the promotion of individualized production is affected by social and economic aspects.

The research of scientists regarding the improvement and development of 3D garment designing is directed into different directions:

The development of mass customization process schemes;

The development of a virtual twin;

The study of coherence and definition of projection ease allowances;

The improvement of fabric visualization means.

The garment production companies mostly support the development of the company and the introduction of CAD/CAM systems, since these ensure a higher product quality, higher productivity, humanization of the working process, a more elastic production process and process control. Nevertheless the distribution and introduction of computerized systems in companies of all levels (small and large) can be a problem because of the system costs as well as the incompetence of the employees.

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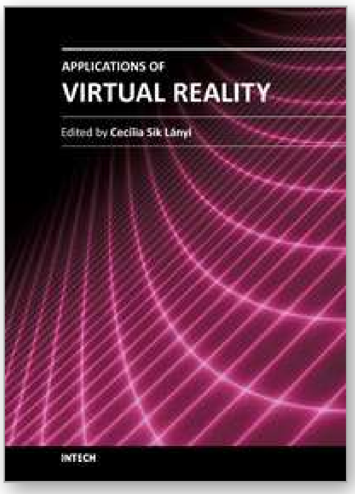

Applications of Virtual Reality

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Information Technology is growing rapidly. With the birth of high-resolution graphics, high-speed computing and user interaction devices Virtual Reality has emerged as a major new technology in the mid 90es, last century. Virtual Reality technology is currently used in a broad range of applications. The best known are games, movies, simulations, therapy. From a manufacturing standpoint, there are some attractive applications including training, education, collaborative work and learning. This book provides an up-to-date discussion of the current research in Virtual Reality and its applications. It describes the current Virtual Reality state-of-the-art and points out many areas where there is still work to be done. We have chosen certain areas to cover in this book, which we believe will have potential significant impact on Virtual Reality and its applications. This book provides a definitive resource for wide variety of people including academicians, designers, developers, educators, engineers, practitioners, researchers, and graduate students.