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EVROPSKÁ UNIE
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
OP Vzdělávání pro konkurenceschopnost
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Computer simulations of garments

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PROJEKT OPTIS PRO FT, reg. č.: CZ.1.07/2.2.00/28.0312 JE SPOLUFINANCOVÁN EVROPSKÝM SOCIÁLNÍM FONDEM
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Julian Alps


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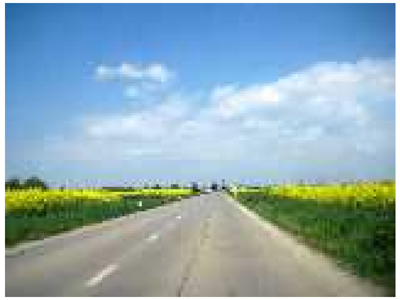
MARIBOR




HUNGARY
15 Miles
15 Kilometers
N
Mačkovci
Murska Sobota
Gornja Radgona
Lendava
Dravograd
Ravne
Maribor
Mura R.
Ljutomer
Slovenska Bistrica
Ptuj
Ormož
Kidričevo
Triglav 2,863 m
Jesenice
Grintavec 2,558 m
Velenje
Drava R.
Soča R.
Sava R.
Kranj
Savinja R.
Tolmin
Kamnik
Celje
Rogaška Slatina
ITALY
CROATIA
Škofja Loka
Ljubljana
Radeče
Sevnica
Krapina R.
Idrija
46° N
Nova Gorica
Vrhnika
Višnja Gora
Krško
Sava R.
Logatec
Brežice
Trebnje
Velike Lašče
Ribnica
Novo Mesto
Postojna
Sežana
Dolenja Vas
Pivka
Gulf of Triest
Kočevje
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Piran
Vinica
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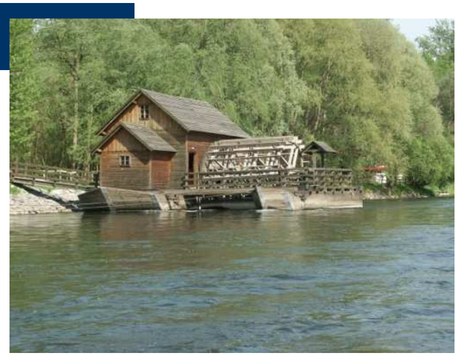
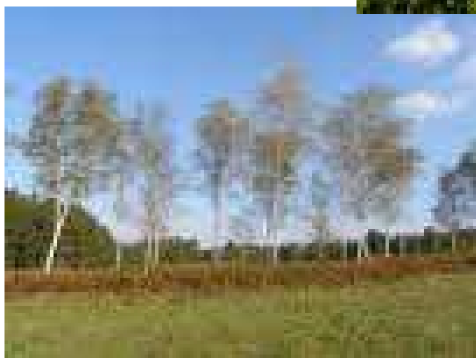




Universities in Slovenia

University of Ljubljana (http://www.uni-lj.si)

Faculty of Natural Sciences and Engineering-Textile deparment

Study directions:

- Graphic and Media Technology
- Graphic and Interactive Communication
- Textile and Clothing Production
- Planning Textiles and Clothing
- Textile and Fashion Design

Universities in Slovenia

University of Maribor (http://www.um.si)

Faculty of Mechanical engineering-Textile department

Universities in Slovenia

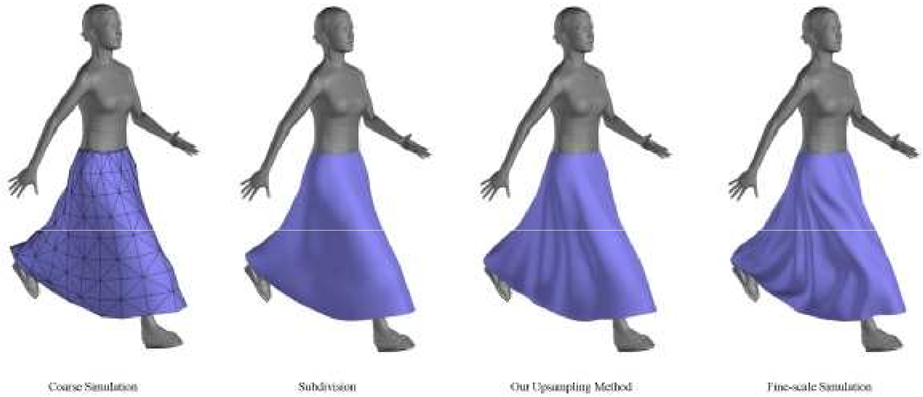
University of Primorska (www.upr.si)

ACADEMY OF DESIGN

Study directions:

- Textile and clothing design
- Interior design
- Visual comunication

University of Nova gorica (*www.ung.si/)*



INTRODUCTION TO VIRTUAL SIMULATION OF GARMNET

Does have the virtual presentation of garment THE FUTURE?

Requirements of clothing industry- nowadays

- Rrequirements of clothing industry
  - Fast responding on social changes
  - New fashion tendency
  - Short time for development of clothing
  - Low development cost

- The world globalisation allows that design of clothing and production process take place in different parts of the world.

- The “mass production” is no longer suitable for today’s modern computerized environment

Some of the problems related to classical garment production:

- The 40-50 days long sampling cycle

The traditional proceses of making garments is done in 2D (basic pattern , following by the pattern modeling and graduation process and finally the clothing prototype in order to validate it (3D work) is created.

- Theprototaypes are almost never accepted at the first trial
- The dress doesn’t fit to the human body.
- The high expenses development process
- bad communication between the buyer, the merchandiser and the supplier

Outline of lecture

- Introduction to virtual simulation of clothing
- Virtual prototyping of clothing
  - Computer simulation of fabric behaviour
  - Virtual models:
    parametric and scanned human body
- Application of Virtual prototyping of garments

Virtual simulation in general

The first accurate clothes simulation applications appeared in 1990s.

They integrated numerous computer technologies that included clothes simulations and were focused mostly on modelling, animation of human body motion, interaction between body and clothes as well as its response.

Computer animation of garments has become more and more interdisciplinary and now uses techniques are from different areas such as art, robotics or cinema.

Garment simulation

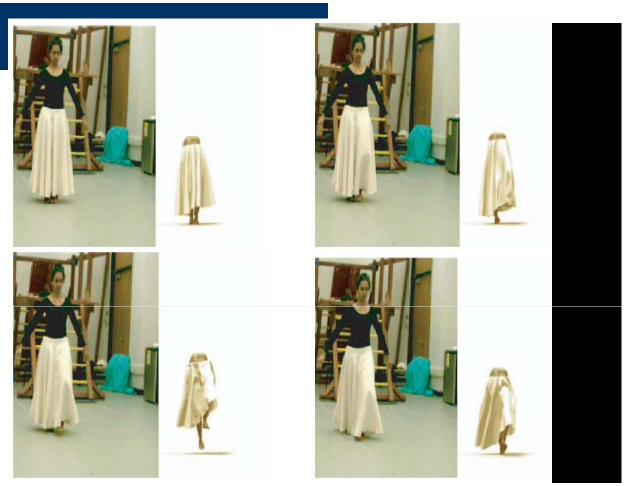
●Garment simulation on the human body has been a challenging issue in computer graphics for a long time.

● The development of garment simulation in a virtual world is going in two areas:

1. ANIMATION OF GARMENT BEHAVIUOR and

2. ATTEMPTS THE REALISTIC GARMENT SIMULATION

Animation of garment behaviuor



On the beginning, animators have used only models with consideration for the physical laws, which drive the real world.

These methods have become unable to present **even the simplest realistic effects of fabric behavior** in the processes of garment development.

Methods for animation the realistic fabrics behavior (wrinkling, folds, drape) and garment behavior during wearing **are suitable for new generation of movies an computer games and so on..**

Application areas for garment simulations

Garment behaviour simulation has many potential application areas such as

- entertainment industry, (the entertainment industry requires fast, convenient and effcient tools for designing garments that look realistic enough
- CAD/CAM systems, (CAD/ CAM tools and interactive online stores make use of garment design and simulation systems)
- e-commerce, (e-shoping)
- textile industry (fashion designers wish to see the appearance of a garment on a virtual mannequin before the garment is manufactured)
- protoyping a new textile products (garments, seats…..)

Computer aided tools for designing and simulation of garments

- 2D (do not allow the fitting of a garment on a mannequin)

- 2D/3D (the user draws the 2D pattern of the garment parts and the system triangulates these patterns and converts them into physically-based models)

Computer systems for 2D/3D virtual simulation/prototyping of clothing

-Browzwear -
*www.**browzwear**.com/*

(VStitcher™, VStyler™ and VViewer™, are recognized as commercial applications on the market for 3D visualization and design of garments and materials)

- OptiTex -
http://www.optitex.com/

(OptiTex ™ 3D , Pattern Design System (PDS) OptiTex , OptiTex Runway are the applications for 3D visualization and design of garments and

materials)

Computer systems for 2D/3D virtual simulation of clothing

- Lectra (http://www.lectra.com/

It covers the fields: Fashion, Foodwear, leather goods, Automotive and Composites and industrial fabrics)

(*Modaris 3D Fit, - for design and products engineering)*

-Assyst (http://www.human-solutions.com/)

-Fashion and interiors products

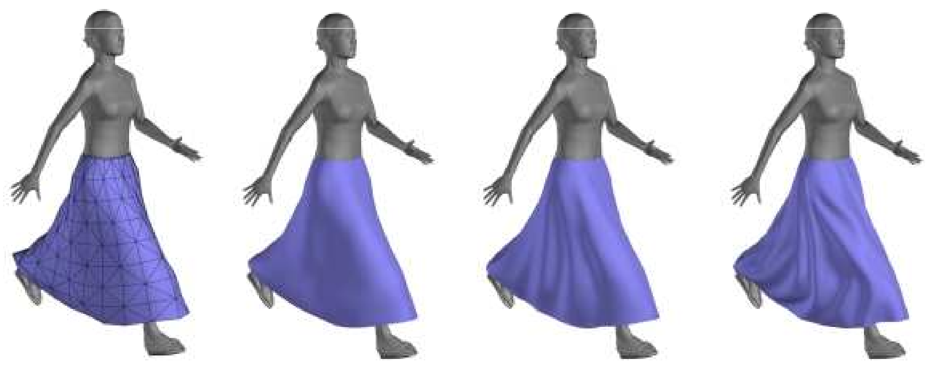
Computer systems for 2D/3D virtual simulation/prototyping of clothing

Gerber (http://www.gerbertechnology.com/)

The basic issues to consider when modeling the garment in a virtual environmental are:

● **Geometrical representation**

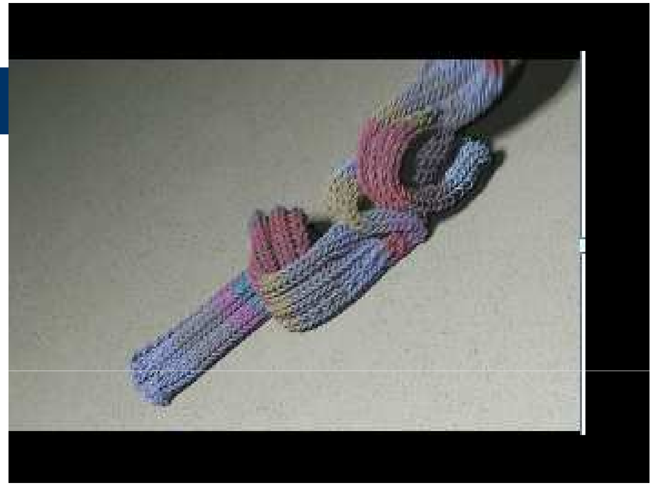
(geometrical representation, is about the accurate representation of the shape of the cloth)



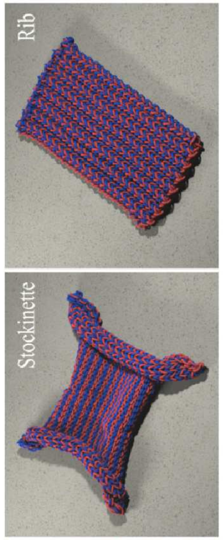
● **Behavior of cloths** (shows the various properties of the garment's material such as stress-strain curves)

PRESENTS MANY UNKNOWNS (open research area)

The basic issues to consider when modeling the garment in a virtual environmental are:



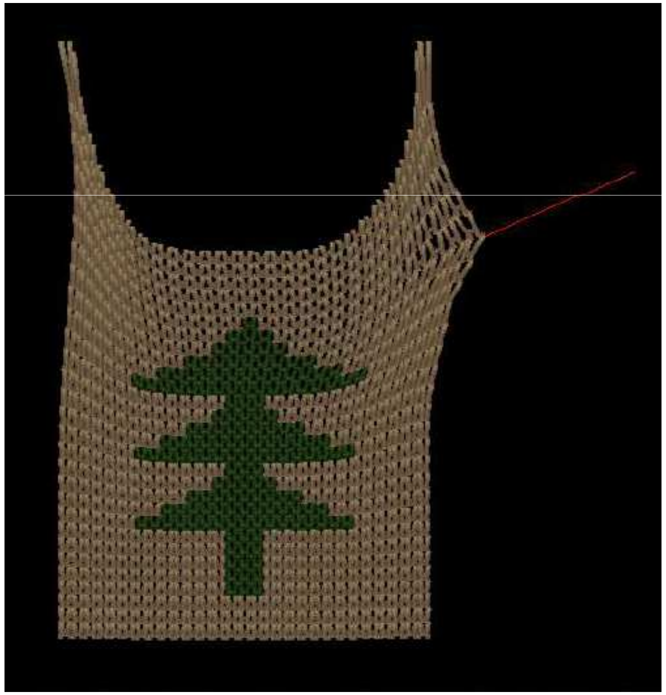
- **Interaction with the environment** (deals with how the cloth behaves under environmental conditions such as gravity, wind or collisions with rigid objects.

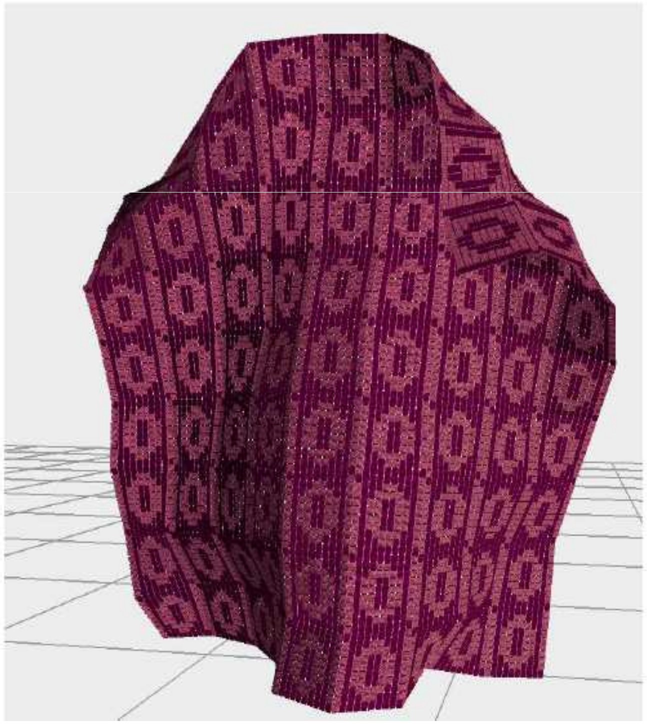


- **Rendering of fabric surface** (is an open-research area, which involves the visualization of fabrics)

  The visual appearance of fabric is crucial when real appearance of garment is required in a virtual environmental

Graphic presentation of fabric structure





Techniques and methods for computer simulation

Computer simulation of garment is the result of a large combination of techniques and methods:

- **Physics- based models** for define mechanical properties of fabrics. (nonlinearity and large deformation at any place in the cloth, such as folds and wrinkles).

Physics-based models show their potential into real-life simulations of cloth shapes. The geometrical substrate is enriched with information derived from fabric properties and dynamic laws.

- **Collision detection** (Geometrical contacts between body and cloth and cloth and cloth.
- **Computational methods** (computation speed and efficiency).

Physics-based models

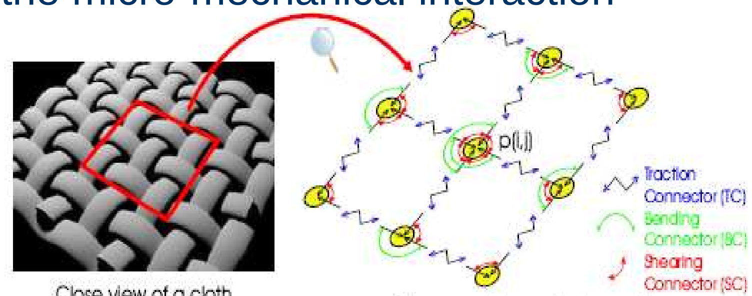
- Particle system
- Finite element
- Spring –Mass models
- Models Based on Elasticity Theory
- Combination of models

Physics-based model- **Particle system**

Authors Donald Hause and David Breen

Their model is based on the observation that cloth is best described as a mechanism of interacting mechanical parts rather than a continuous substance, and

derives its macro-scale dynamics properties from the micro-mechanical interaction between threads.



Close view of a cloth
Corresponding particle model

The cloth is represented by a set of particles.

The energies of each particle are defined.

The final equilibrium shape of the cloth occurs at the minimum energy of the whole particle system. Energy function were derived using the Kawabata data.

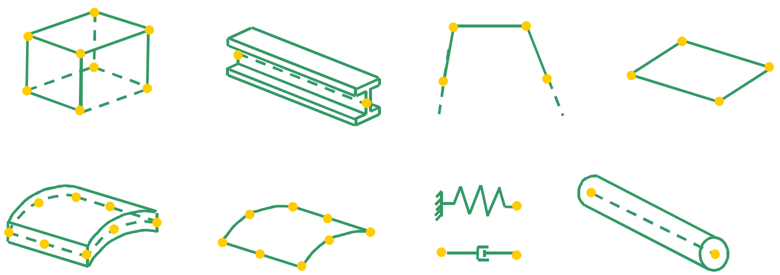
The model produces only draped configurations without motion and its original implementation was slow and inefficient.

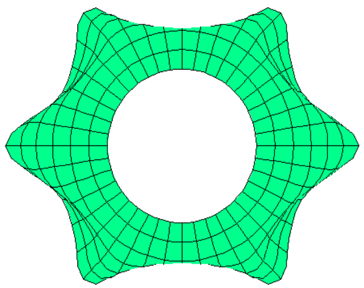
Physics-based model-Finite element

Finite element method (FEM) methods belong to the numerical analysis, which is based on the use of matrix algebra. Any design is discretised on appropriate finite elements.

The nonlinear elasticity problem is reduced to a linear, planar one in each step.

In contrast to mass-spring models, which deal with regular quadrilateral meshes, this method works independent of the mesh topology.





Physics-based model- Models Based on Elasticity

Authors : **Feynman**

He simulates some mechanical properties of cloth by defning a set of energy functions over a 2D grid of 3D points.

The total energy of this cloth model contains tensile strain, bending and gravity terms.

He assumes that cloth is a continuous flexible material and derived his energy functions from the theory of elastic shells.

Techniques and methods for computer simulation

- Physics- based models
- Collision detection
- Computational methods

Cloth Self Collision and Response.mp4

Collision Handling

- Garments interact with the body or with other garment panels. The shape and the movement of the body affect on the garments movement.

- In order to obtain realistic simulation of garment panels, collision handling must be achieved in an accurate and efficient way.

Collision handling consists of two phases:

- ***Collision detection:*** *Checking the geometrical contacts be*tween the objects. (fabric to fabric, fabric to body)

- ***Collision response:*** *Correcting the velocities and positions of the colliding* objects by applying constraints or forces.

VIRTUAL PROTOTYPING OF CLOTHING

Virtual prototyping of garment

Virtual prototyping is a technique in the process of garment development that involves:

- application of computer aided design intended for garments development and
- virtual prototyping of them.

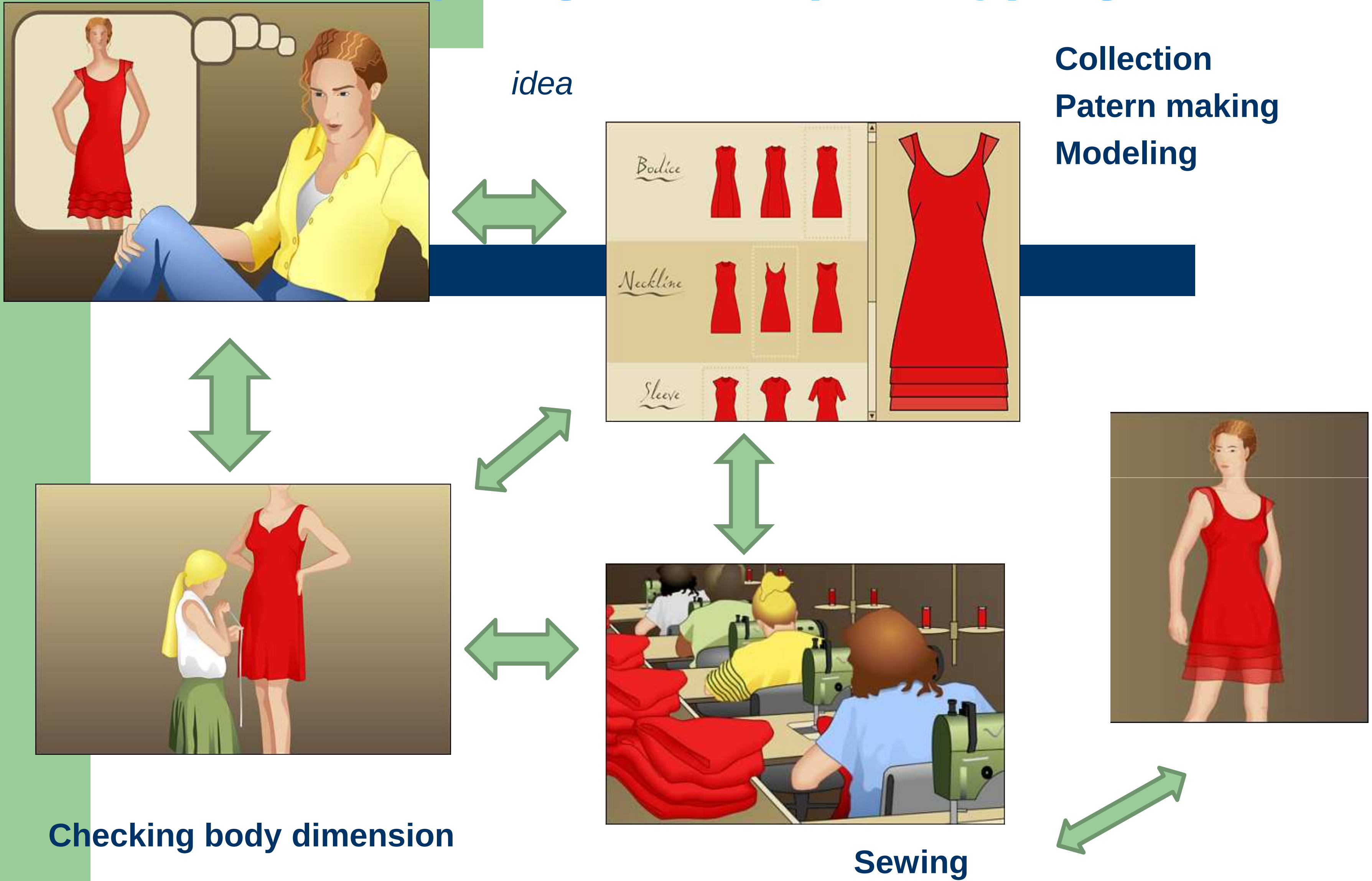
It has been recently introduced to clothing industry, become a topic of increasing interest of both computer graphics and clothing industry

Whay it becams important?

Virtual prototyping of garments provides high potential for :

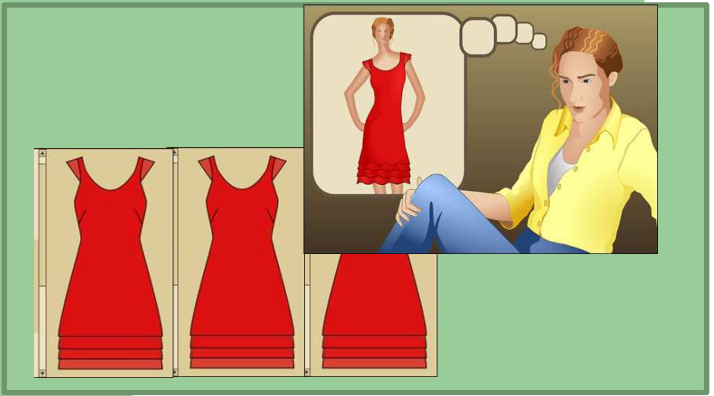
- design,
- product development and
- marketing processes.

The classical way of garment prototyping

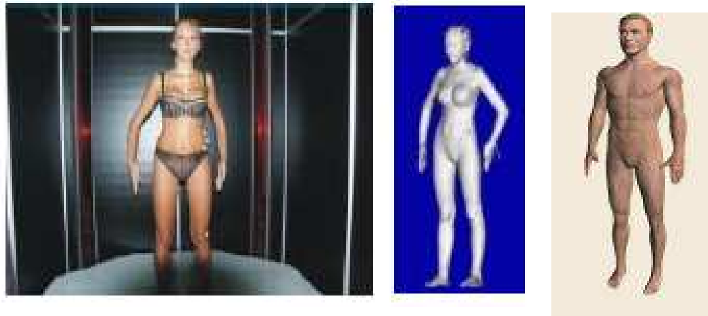


- **long time consumption**
- **unnecessary material consumption in the process of prototyping**

Prototyping the clothes in a virtual environmental

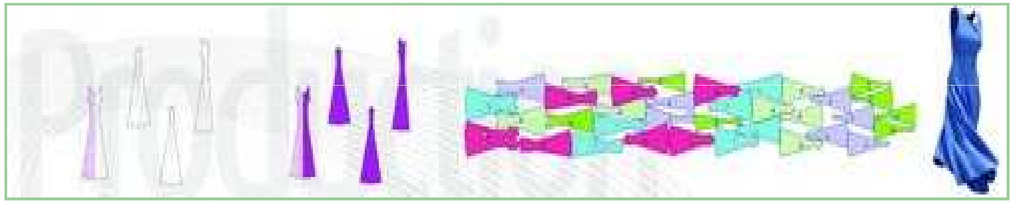


Design idea

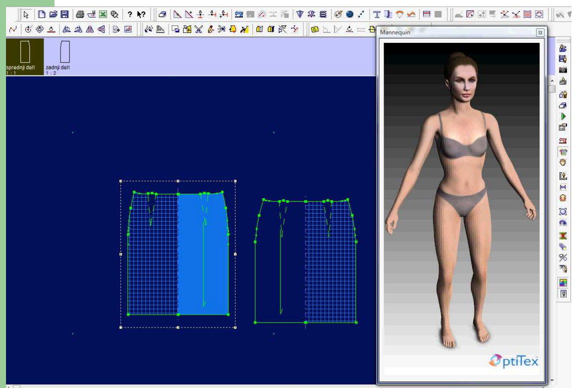


1. Full body scan or parametric model

2. Cloth and fabric definition



3. Pattern and marker making



3. Virtual stiching

4. Cloth simulation

Virtual prototyping of garment

Fit a garment on the body model is an important factor to produced: comfortable, functional and well fitted garments.

Within the process of virtual prototyping clothes are still open questions ?

Todays the central focus of researches in this area is based on:

1. on development **of the efficient mechanical simulation models of fabric**, which can accurately reproduce the specific mechanical properties of textiles.

2. The other aspect of the researches focuses on modelling of virtual humans to assure representation of the exact human body figure needed for virtual prototyping

Computer simulation of fabric behaviour

Fabric behavior simulation ???

- Computer modeling behavior of a fabric is still a very **demanding** task when constructing a proper physical based model.

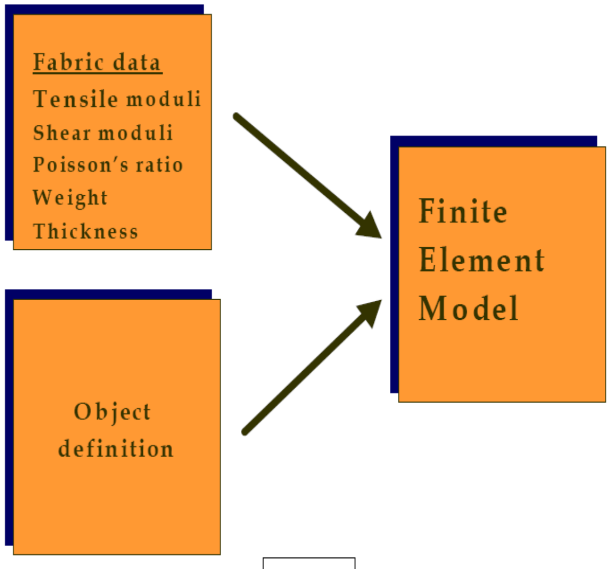
- Fabric and other textile materials are **non-homogeneous materials with nonlinear properties,** which are significant at low loading also.

- **Low deformation and large displacement** are also characteristic , therefore, there behavior is very unpredictable.

Application: Simulation of “real” fabric behavior

Draping behavior according to Cusik drape meter

Physical based model was created using FINITE ELEMENT METHOD



Drapeability

The drapability of the fabrics is one of the most significant properties which characterize the shape of producing cloths.

It is one of the most important aesthetic concept characteristics.

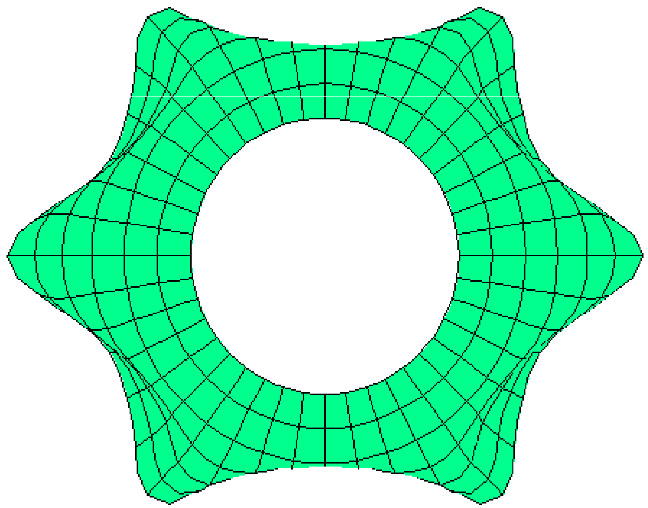
Tablecloth's drape

Curtain's drape

Drape on mannequin

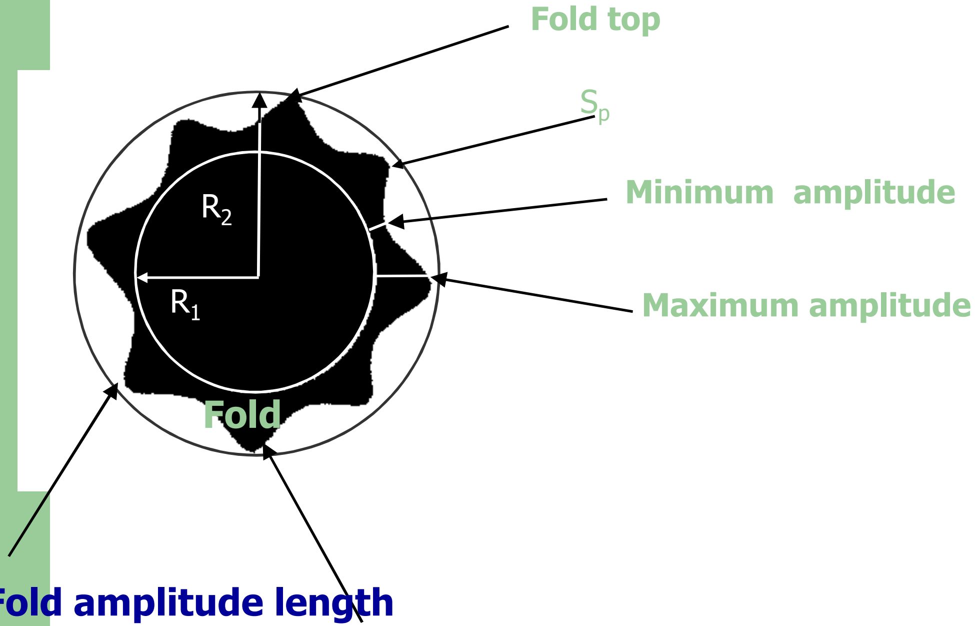
Drapeability parameters

drape coefficient,
number of folds,
their depth,
evenness,



Drape coeffient

representing ratio between sample surface when laid horizontally and the same surface when draped.



- Sp is the surface of rectangular projection
- of draped sample surface, in mm2,

R1 is horizontal plate radius, in mm,

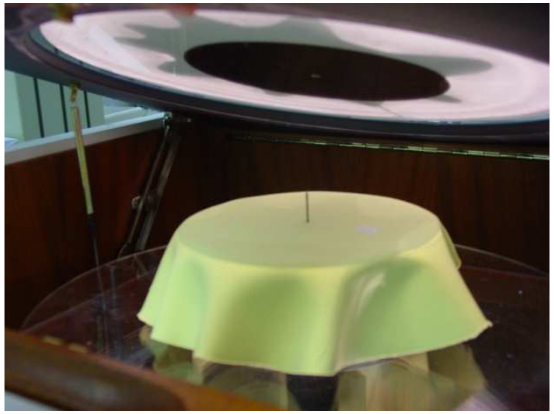
- R2 is non-deformed sample surface radius, in mm

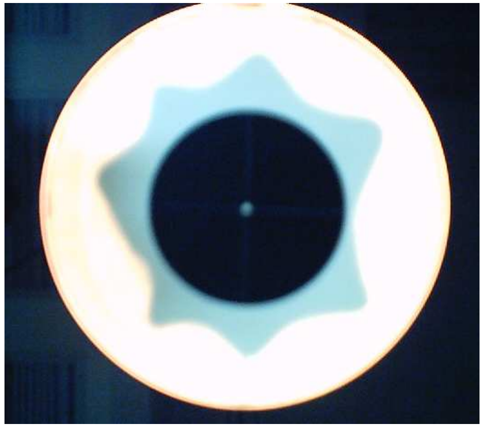
It is calculated using the following

$$CD = \frac{S_p - \pi R_1^2}{\pi R_2^2 - \pi R_1^2} 100$$

Measurement equipment:

Cusick drape meter with Drape Analyser





Data preparation for fabric simulation

DETERMINATION OF REOLOGICAL PARAMETERS OF FABRIC →
- Young modulus
- Shear modulus
- Poisson ratio

MODELING OF FABRIC →
- Geometrical model
- Numerical model

SIMULATION AND NUMERICAL ANALYSIS (USING ABAQUS program) →
- The drape

EXPERIMENTAL MEASURING (USING CUSIK DRAPE METER) → **COMPARISON BETWEEN RESULTS OF NUMERICAL ANALYSIS AND EXPERIMENTAL MEASURING**

Reological parameters of fabric

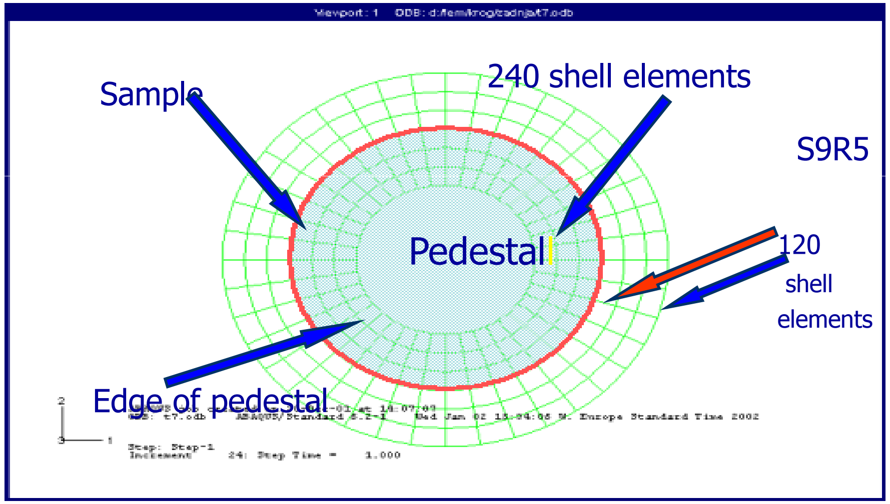
Young modulus
Shear modulus
Poisson ratio

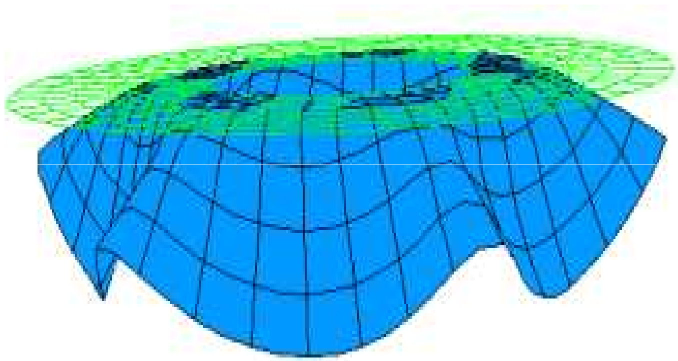
E_o = 14,98 Nmm^{-2}
E_v = 1,45 Nmm^{-2}
G_o = 0,108 Nmm^{-2}
G_v = 0,091 Nmm^{-2}
ν = 0,22

Suppositions:

Homogeneous
Orthotropic
Linearity by low loading

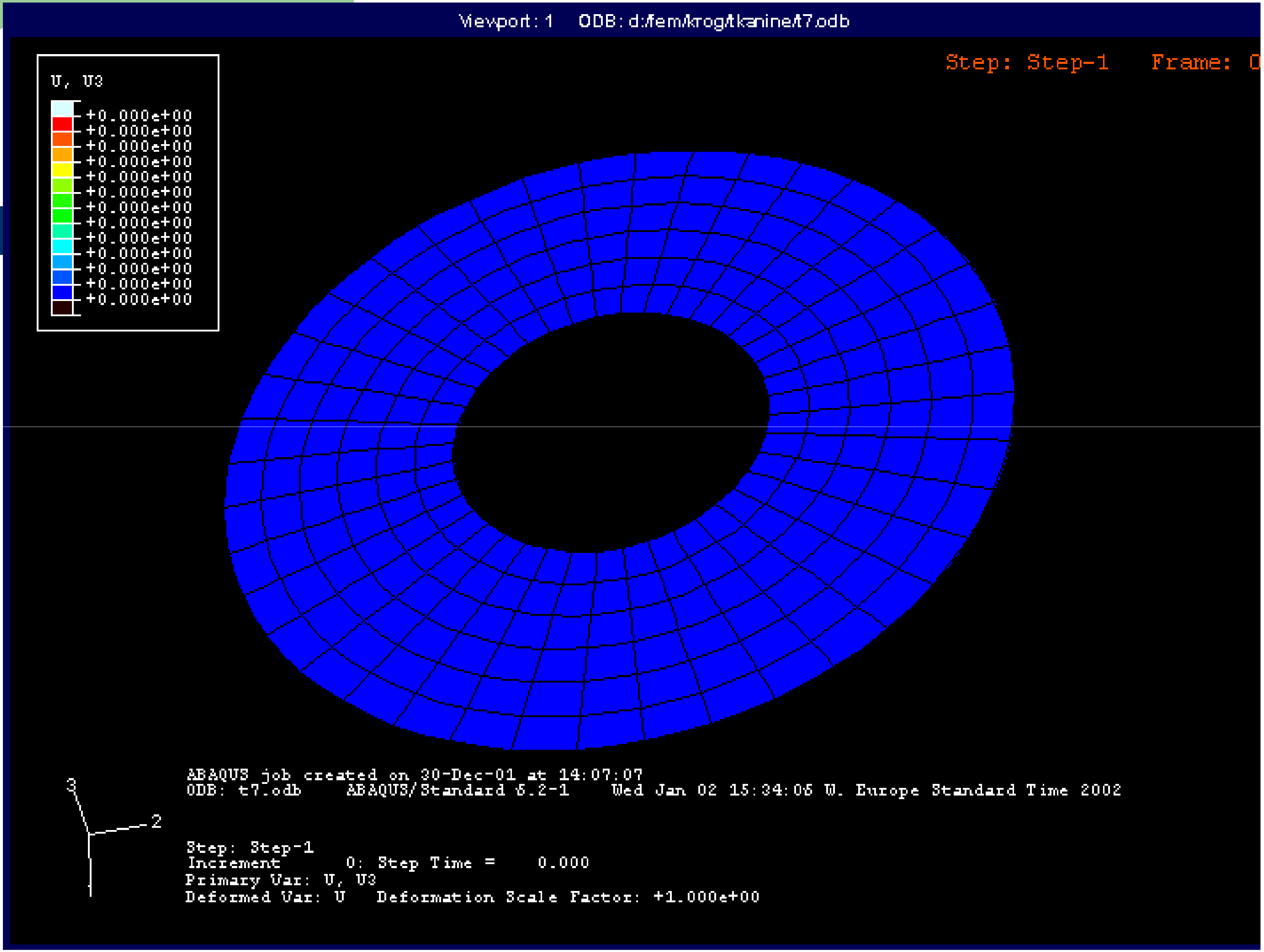
Application: Simulation of fabric drape





Numerical simulation of drapability

Numerical model


Viewport: 1 ODB: d:/fem/krog/tkanine/t7.odb
Step: Step-1 Frame: 0
U, U3
+0.000e+00
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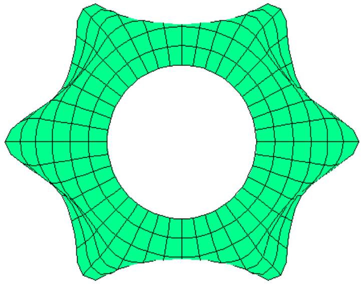
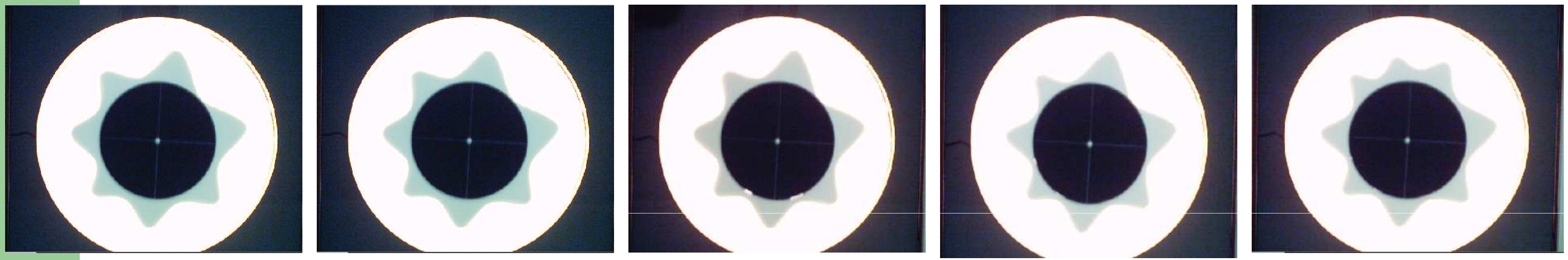
ABAQUS job created on 30-Dec-01 at 14:07:07
ODB: t7.odb ABAQUS/Standard 6.2-1 Wed Jan 02 15:34:06 W. Europe Standard Time 2002
Step: Step-1
Increment 0: Step Time = 0.000
Primary Var: U, U3
Deformed Var: U Deformation Scale Factor: +1.000e+00
3
2

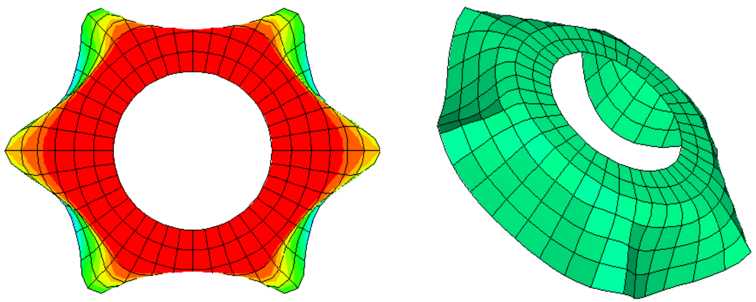
Drape simulation of fabric





Merjeni / izračunani parametri (Cusik drape meter)	
Št. gub	7
Max.poves / mm	59,90
Min. poves / mm	35,71
Globina gube / mm	45,70
Max.amplituda gube / mm	138,30
Min. amplituda gube / mm	94,80

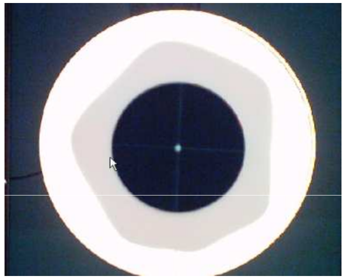
(Cusik drape meter)



Numerical simulation with FEM

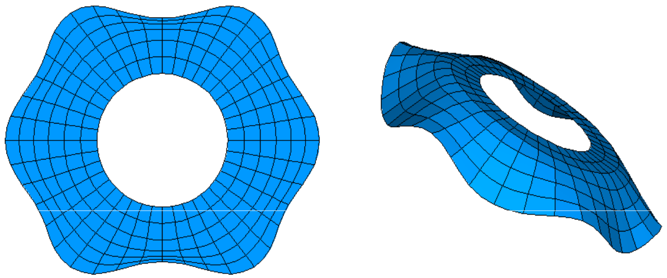
Izračunani parametri z MKE	
Št. gub	6
Max.poves / mm	59,9
Min. poves / mm	35,8
Globina gube / mm	35,53
Max.amplituda gube / mm	148,34
Min. amplituda gube / mm	112,81

Drape simulation of fabric



Experiment

Non Symetric



Numerical simulation

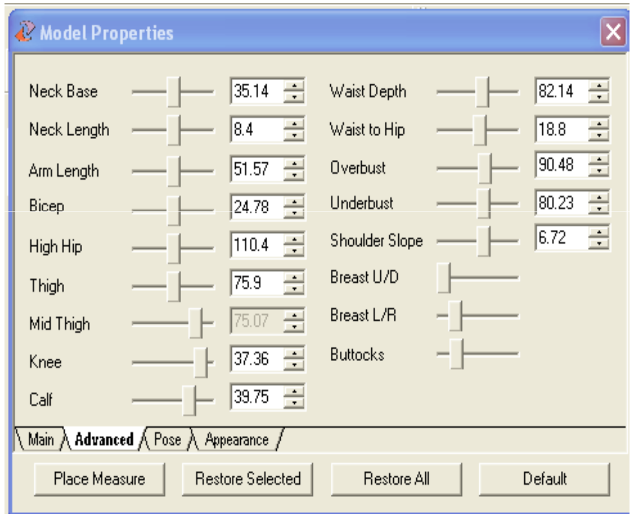
Symetric

Fused panels are inhomogeneous all over their surfaces, and anisotropic with non-linear properties.

A numerical model cannot take into account either local inhomogeneities, nor anisotropic character of the material.

Virtual models: parametric and scanned human body

Parametric model of human body

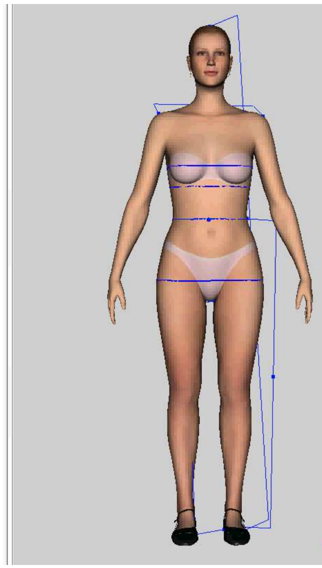


Parametric body (Optitex)

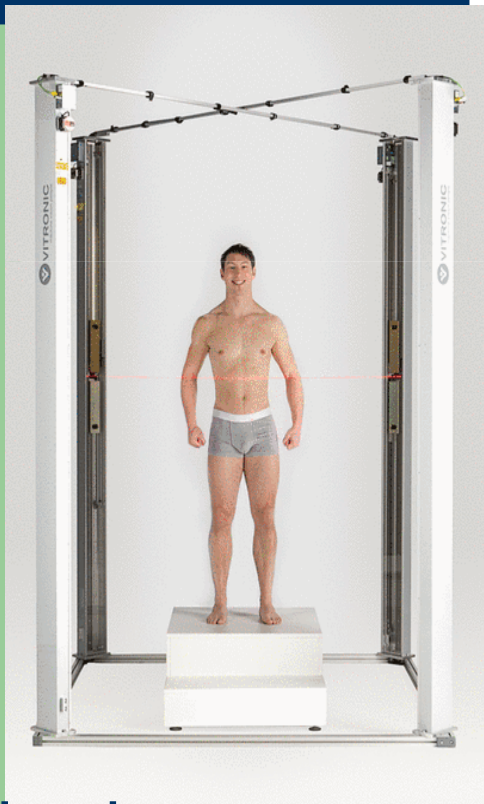
Body measurments

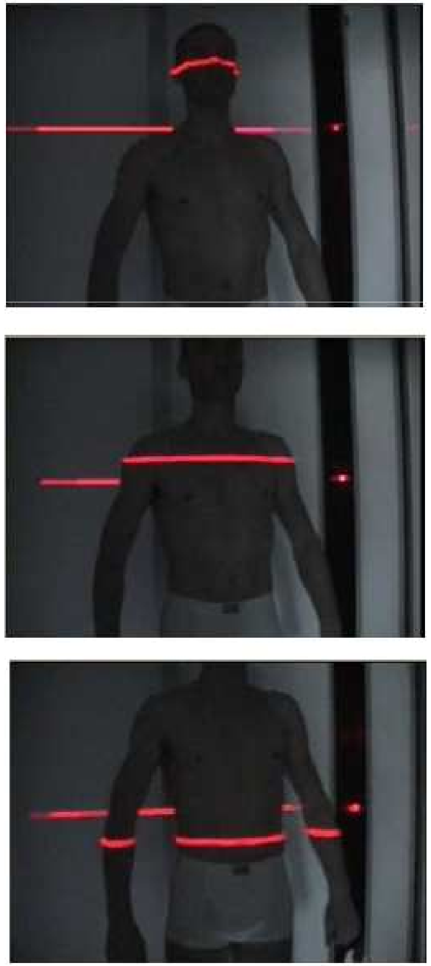
By hand

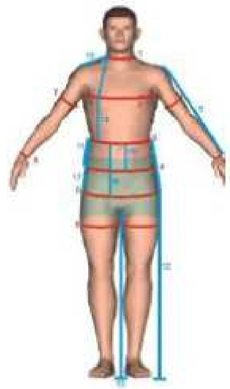
By scanner



Scanned model of human body







3D body scanner
Vitus Smart.

TECHNOLOGY AVAILABLE

Company	*Scanner type*	*Web site*
Cyberware	WBX, WB4	http://www.cyberware.com
Hamamatsu	Body line scanner	http://www.hamamatsu.com
Hamano Engineering	VOXELAN	http://www.voxelan.co.jp
[TC]^2	2T4, 3T6	http://www.tc2.com
Human solutions	Vitus Pro, Vitus Smart	http://www.human-solutions.de
Telmat	SYMCAD 3D Virtual Model	http://www.symcad.com
Wicks & Wilson	Triform BodyScan	http://www.wwl.co.uk

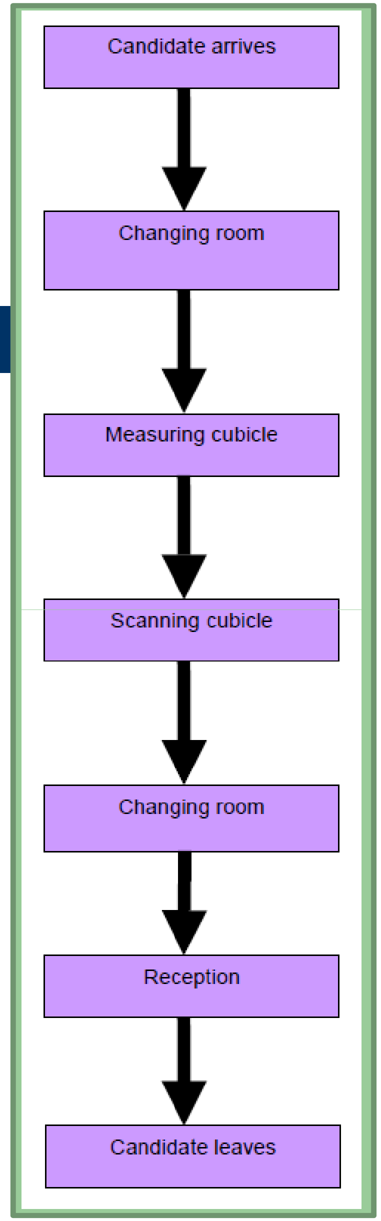
TECHNICAL DATA

System	*Boot size* (WxDxH metres)	*Measure size* (WxDxH metres)	*Colour*	*Resolution* x,y,z (mm)	*Projection system*
Cyberware WB4	3.6x3.0x2.9	1.2x1.2x2.0	Yes	0.5, 2, 5	Laser, class 1
Hamamatsu Body line	1.6x1.7x2.4	0.9x0.5x2.0	no	1, 7.5, 5	Infrared light emitting diodes LED
Hamano Voxelan			No	3.4, 3.4, 3.4	Two vertical laser lines
[TC]^2 3T6	3.3x5.9x2.4	1.1x1.1x2.0	No	1, 2.5, 2,5	Structured light
Human solutions Vitus smart	2.2x2.2x2.8	1.0x1.0x2.1	Optional	1, 2, 1	Laser, class 1
Telmat Symcad	3.9x1.6x2.4		No	No	Light, structured light
Wicks & Wilson Triform Body scanner	2.5x1.5x2.4	0.75x0.75x2.0	yes	1.5, 1.5, 1.5	Structured light

Mobile scenner

Scanliner

Vitus smart scanner has been completely integrated into a full mobile an independent large truck



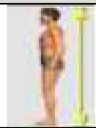
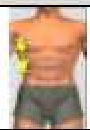
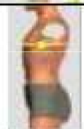
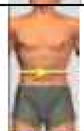
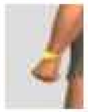
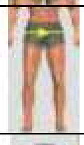
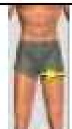
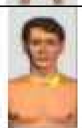
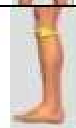
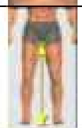
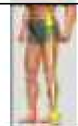
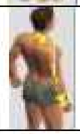
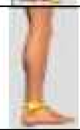
Flow chart of the data collection process- Overview

Scanned model of human body

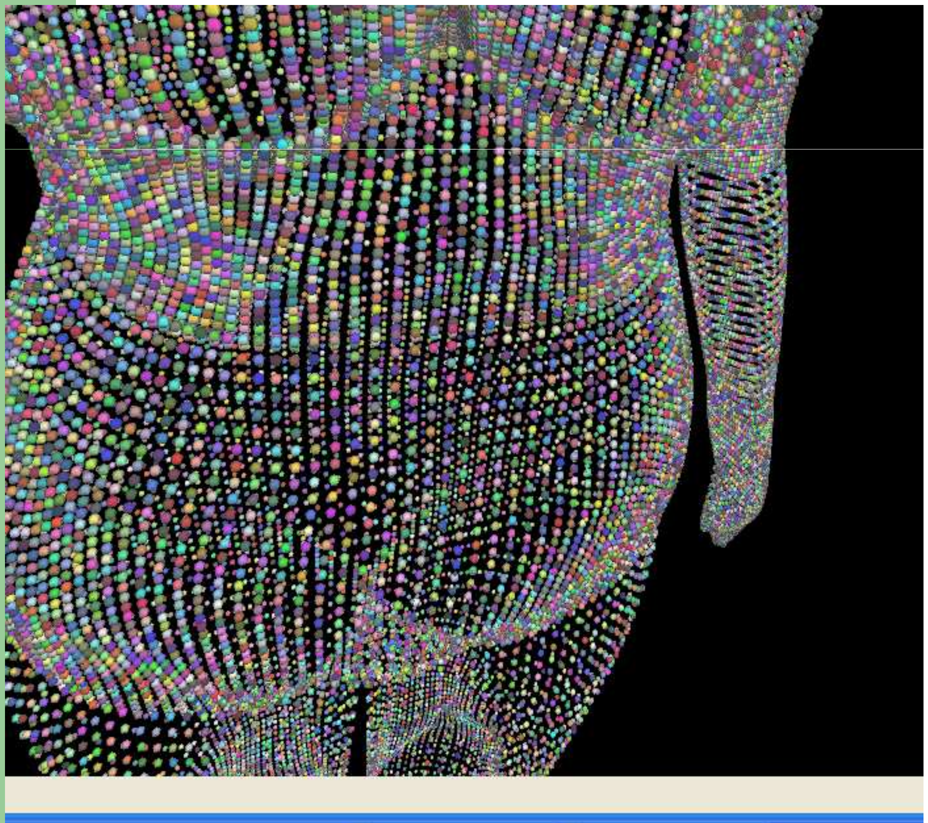
http://www.breuckmann.com/

Artec™ Eva 3D Scanner is similar to a video camera which captures in 3D. The scanner captures up to 16 frames per second. These frames are aligned automatically in real-time, which make scanning easy and fast. This is especially important for the creation of special effects, medical and biomechanical research. Because of the high quality, Eva's textured models can be used in such industries as CG/Animation, forensics and medicine

Body measures resulted from 3D body scanning

Body measure	Ski jumper measure (cm)	Measuring position	Body measure	Ski jumper measure (cm)	Measuring position
Body high	172,9		Length armpit-waist	19,6	
Chest circumference	89,1		Hip depth	22,2	
Waist circumference	64,7		Wrist circumference	15,3	
Hip circumference	93,1		High thigh circumference	52,1	
Neck circumference	39,8		Knee circumference	36,4 cm	
Length crotch-floor	75,7		Length waist-floor	110,2	
Hand length (7. neck vertebra – wrist)	82,8		Ankle circumference	28,4	

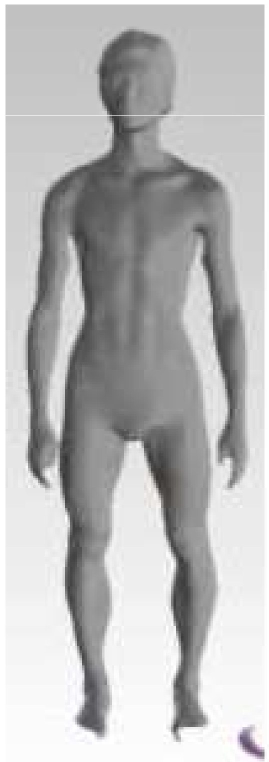
Reconstruction the scanned body



- 3D body scanner Vitus Smart.
- Cloud point: up to 600.000 points.
- Body measures: ScanWorx programme package.

Reconstruction the scanned body

3D scanner cannot produce sufficient scan data and lead to defect body model.



Reconstruction the scanned body

●Reconstruction of the 3D body model was realized by different computer programmes:

● **<u>Programme ATOS</u>**.

Used tools

Thin Mesh - Number of polygons was reduced from about 660 000 to 150 000 triangles .

Then the mesh was repaired and holes were filled with the tools Repairing Mesh, Regularize Mesh, Eliminate Mesh Errors, Relax Mesh and Fill Holes.

Several operations were repeated in order to reduce mesh errors.

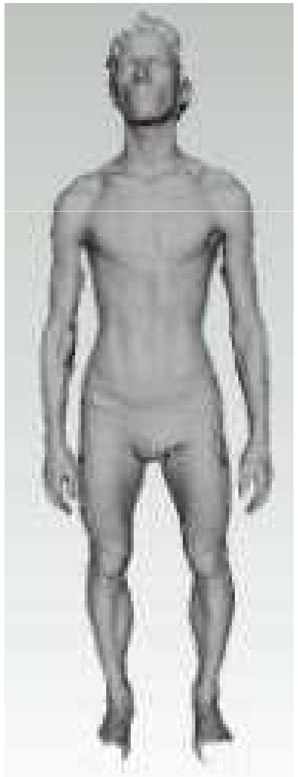
Reconstruction the scanned body

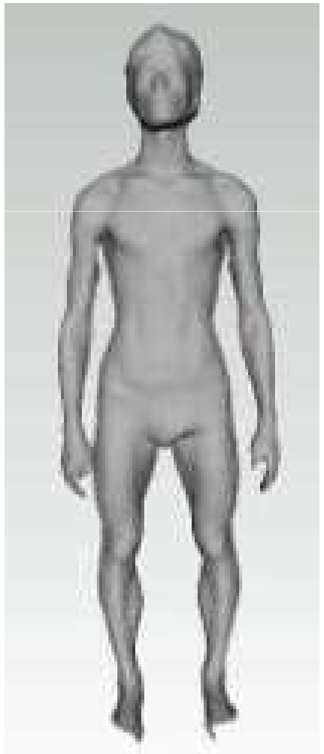
MeshLab programme was used next. Mesh imported from ATOS was still not watertight and totally uniform.

Therefore, a tool Surface reconstruction: Poisson was used.

This tool makes from more partly overlapped meshes one uniform average mesh.

There are less details included, but we got properly mesh for further work.

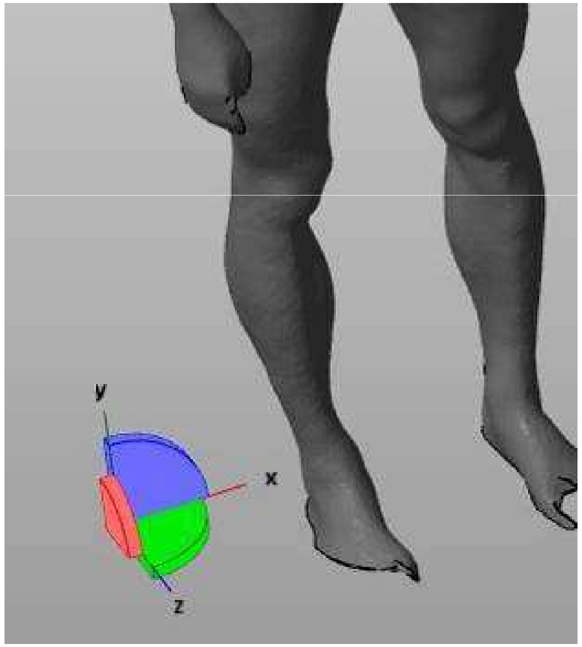




Reconstruction the scanned body

Rhinoceros programme was used after that. The whole object was scaled and properly rotated.

Programme NetFabb Basic was used for the final test and view of the model



Reconstruction the scanned body

Programme **NetFabb Basic** was used for the final test and view of the model.

This **was the last step** before importation of the scanned 3D body model into the OptiTex programme for clothes simulation

APPLICATION OF GARMENT SIMULATION - VIRTUAL PROTOTYPING OF GARMENTS

Applications:

Virtual prototyping:

1. **Women jacket and skirt**

2. **Jumpsuit for ski jumpers**

Prototyping of womens garment

Real prototype and jacket

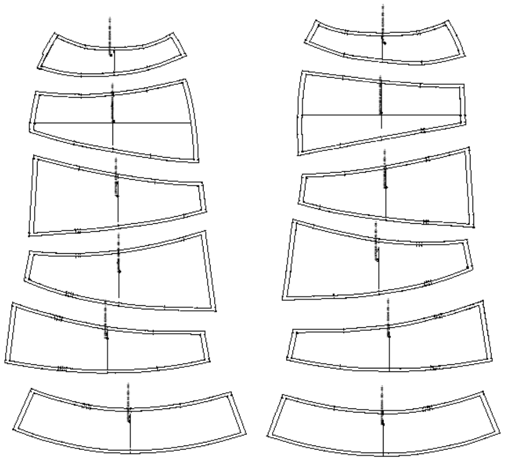
Garment design and fabric selection

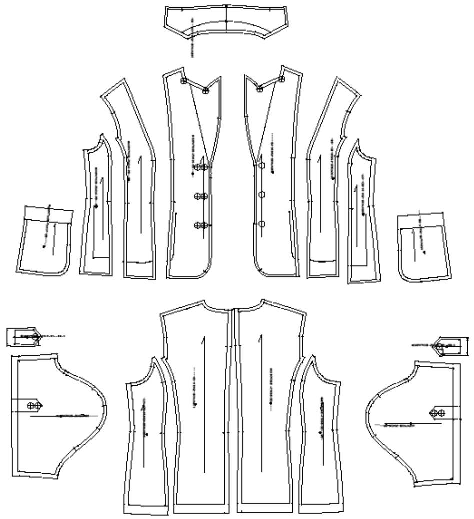
Fashion sketch

- Fabrics, suitable for upper garments.
- Different natural fibres (cotton, linen) and mixtures (linen/PA).
- Fusing was performed in all models using the same type of adhesive interlinings and Mayer fusing machine.

CAD preparation of pattern using the program OptiTex PDS

- program OptiTex PDS





CAD preparation of pattern using the program OptiTex PDS

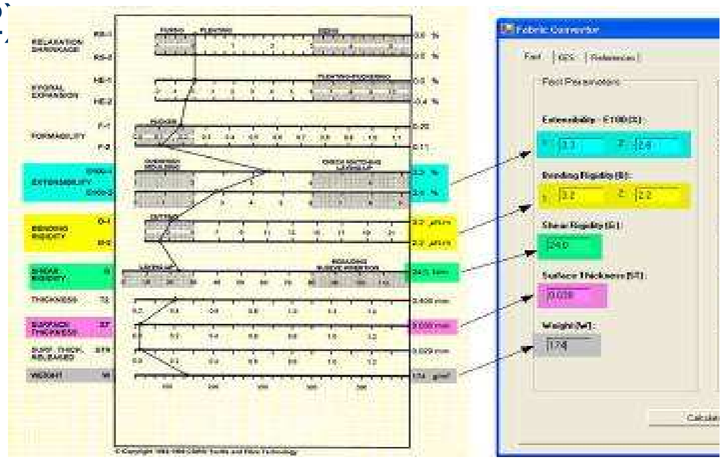
1. Construction the based pattern
2. Modeling
3. Pattern preparation for 3D simulation

Fabric properties definition of pattern

- the fused and non fused part of pattern were chosen
- the fabric properties for virtual simulation of prototype based on FAST measurements.

The following properties were taken into account for fused and non fused pattern

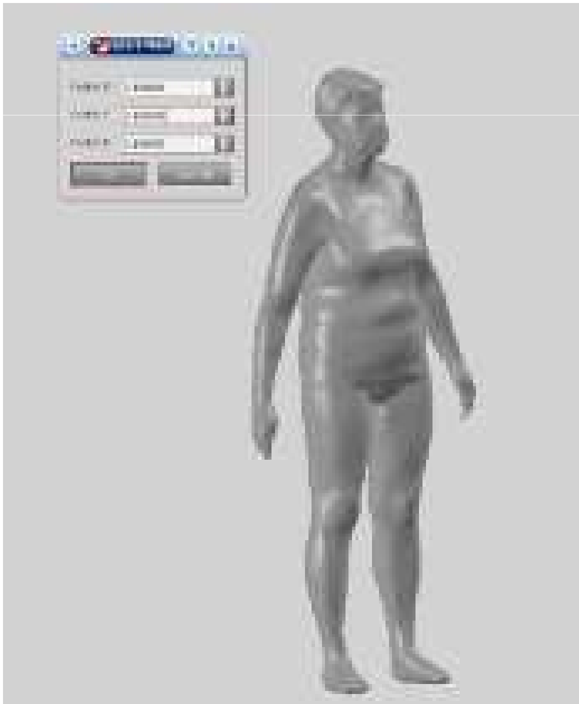
- Extension in a warp (E100-1) and weft direction(E100-2),
- Bending rigidity in a warp (B1) and weft direction (B2)
- Shear rigidity(G),
- Fabric thickness(ST) in
- Fabric weight (W).



Preparation the virtual body models

- parametric and scanned virtual body was used

Parametric body (40 different body measurement)



Scanned model

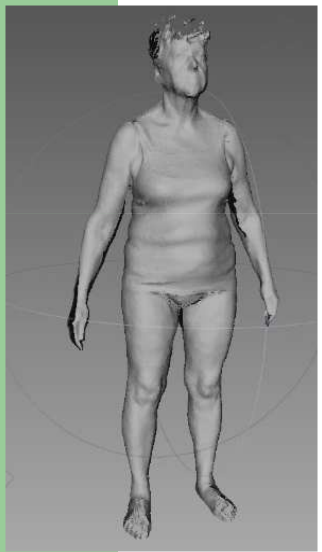
The reconstruction process of scanned body model

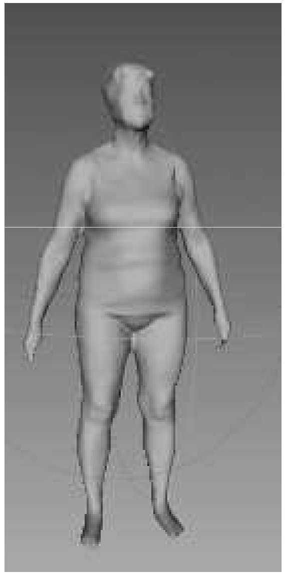
Virtual body - scanned real person

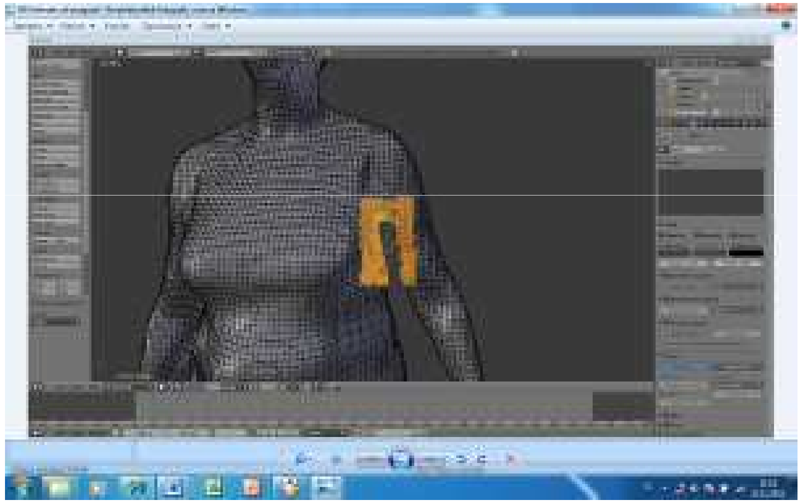
- body measures obtained by the scanner

- Graphical programs for reconstruction the scanned body models
  - *ATOS* for reconstruction the 3D body models
  - Program *MeshLab* (tool *Poisson*)
  - Program *Blender*
  - Zoom the 3D body and import into *OptiTex PDS 3D Creator*

The reconstruction process of scanned body model





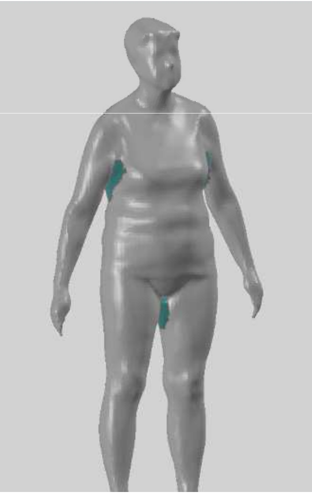


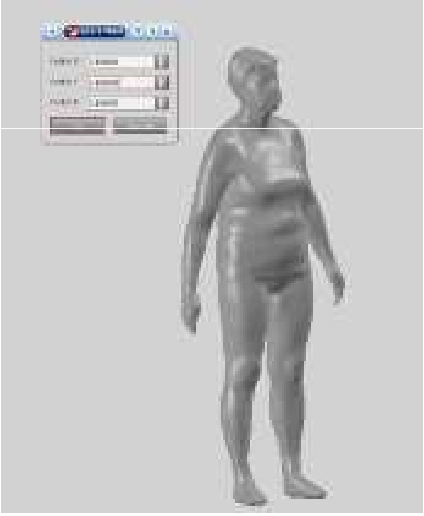
Program Blender

Program *ATOS*

program *MeshLab*

The reconstruction process of scanned body model





Programme **NetFabb Basic**

The simulation of prototype on parametric and scaned body (skirt and jacket)

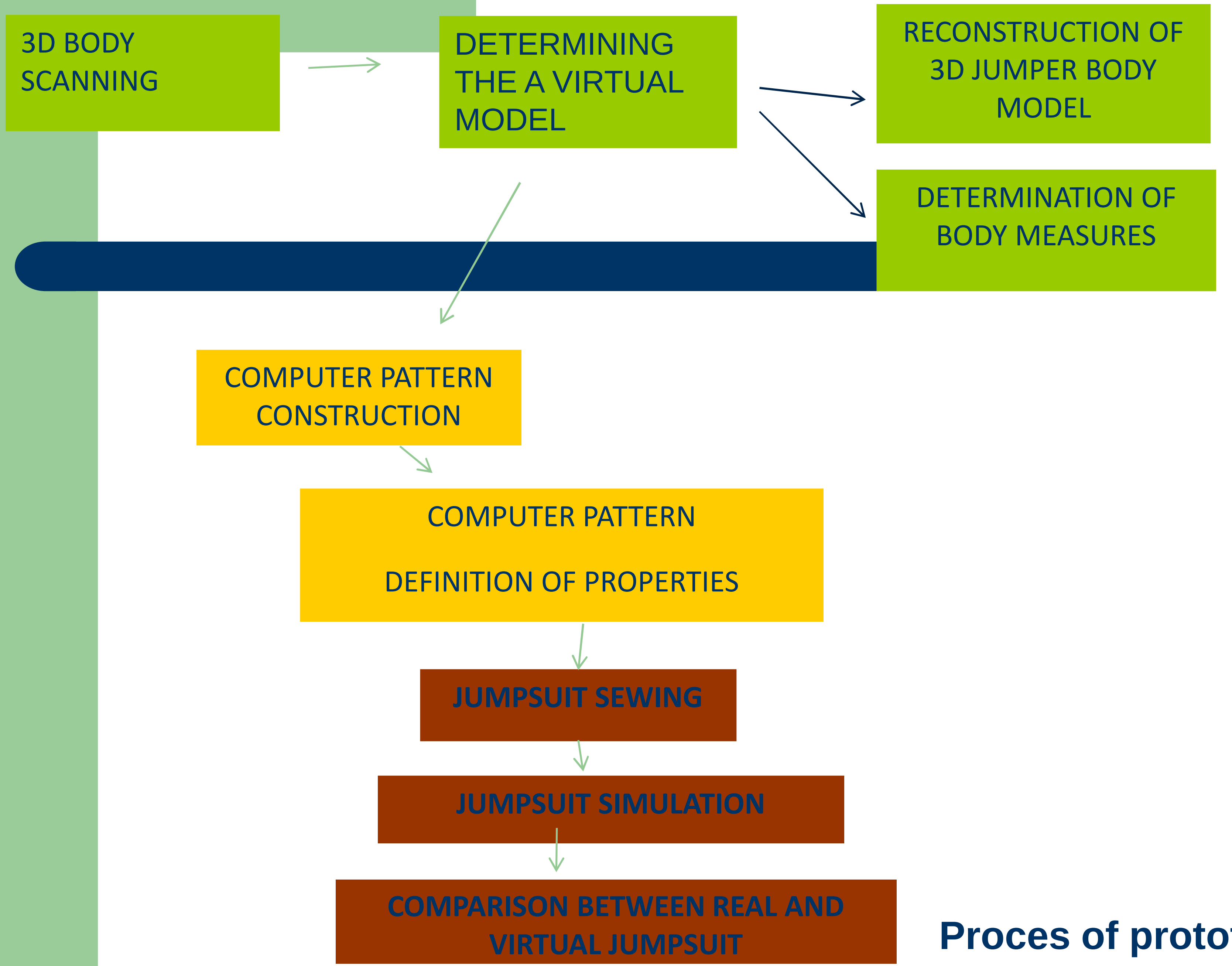
Prototyping of jumpsuit for ski jumpers

Virtual and clasical way of virtual prototyping will be presented

Profesional Jumpsuit

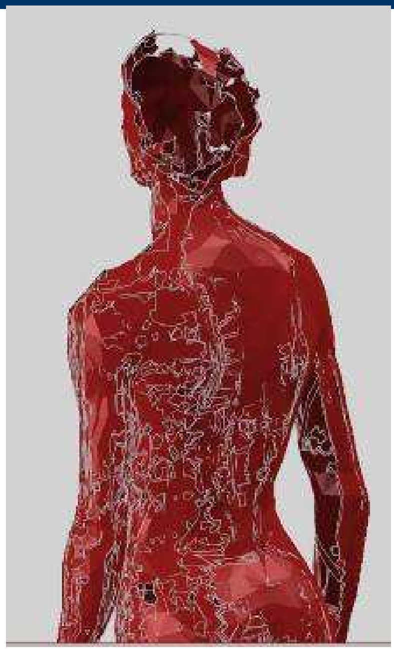
Prototype Jumpsuit

Virtual prototping of **JUMPSUIT FOR SKI JUMPERS**



Proces of prototyping

Scanned body model



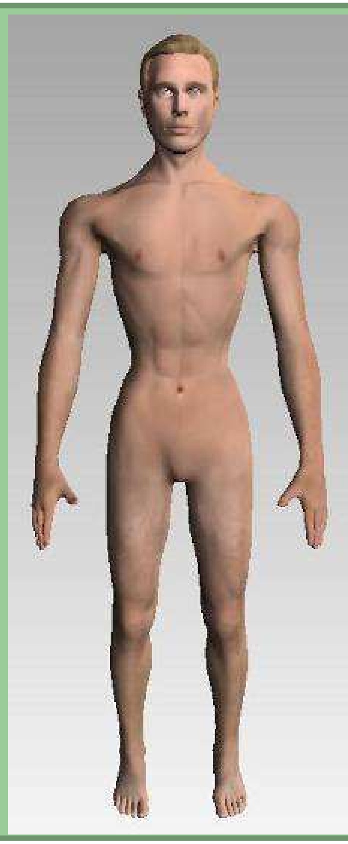
Programs used:

- Atos
- Blender
- Rhino 4
- Netfabb
- MeshLab

Reconstruction of 3D body scan models

Parametric body models vs scanned body

MERE [SLOVENSKO]	*MERE [ANGLESKO]*	*MERE SKAKALCA*	*PRIKAZ MERJENJA*
Dolžina levega rokava od 7. vratnega vretenca	arm lenght to neck back left	82,1 cm	
Dolžina desnega rokava od 7. vratnega vretenca	arm lenght to neck back right	82,8 cm	
Dolžina levega rokava	arm lenght left	60,7 cm	
Dolžina desnega rokava	arm lenght right	61,0 cm	
Dolžina leve nadlahtnice	upper arm lenght left	34,6 cm	



Scope of body measurement and preparation the parametric model

Materials of Ski-jumper suit

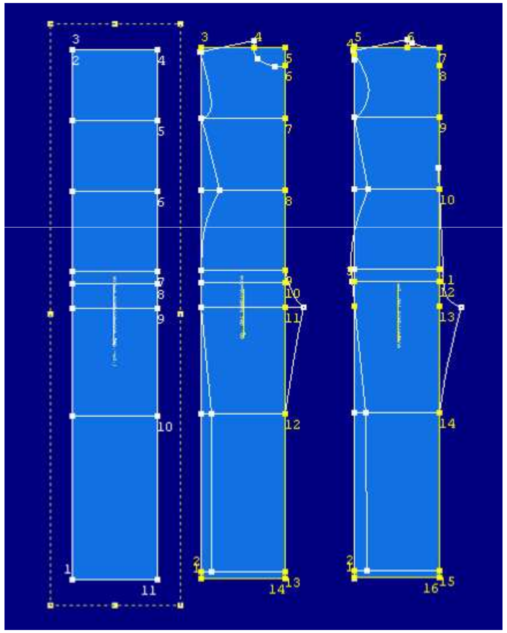
- Five-layer laminated fabric consisting of:
  - first layer: outer fabric,
  - second layer: foam,
  - third layer: elastic membrane,
  - fourth layer: foam,
  - fifth layer: lining fabric.

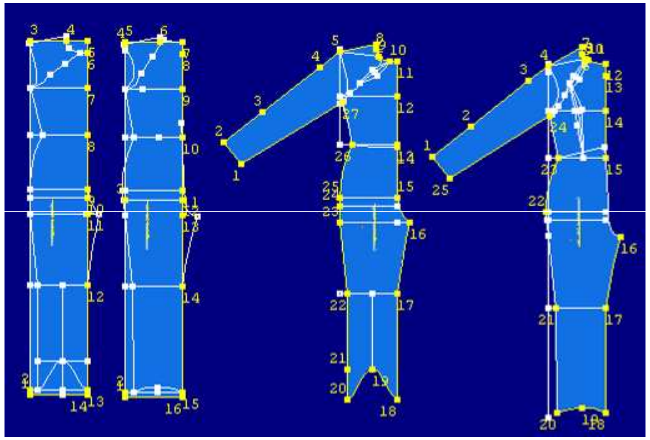
Fabric properties neccesery for computer record of fabric

Properties	Measured value			OptiTex parameters		
	Unit	Course d.	Wale d.	Unit	Course d.	Wale d.
Extension at load of 98,1 Nm^{-1} / E 100	%	9.6	10.9	gcm^{-2}	400.641	352.858
Bending rigidity / B	µN·m	44.8	54.5	dyn*cm	4965	
Shear rigidity / G	Nm^{-1}	199		dyn*cm	1990	
Surface thickness / ST	mm	0.035		cm	0.0035	
Mass per unit area / W	gm^{-2}	601		gm^{-2}	601	

Mechanical properties of the laminated fabric measured by **FAST** measuring system and converted properties for jumpsuit simulation using **OptiTex** programme

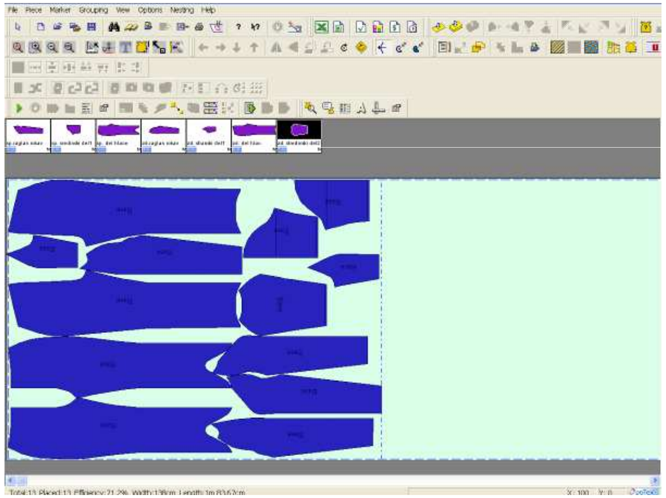
Construction of pattern





Pattern Design System (PDS) OptiTex were used for base construction and modelling of pattern.

Marker preparation



Computer made marker

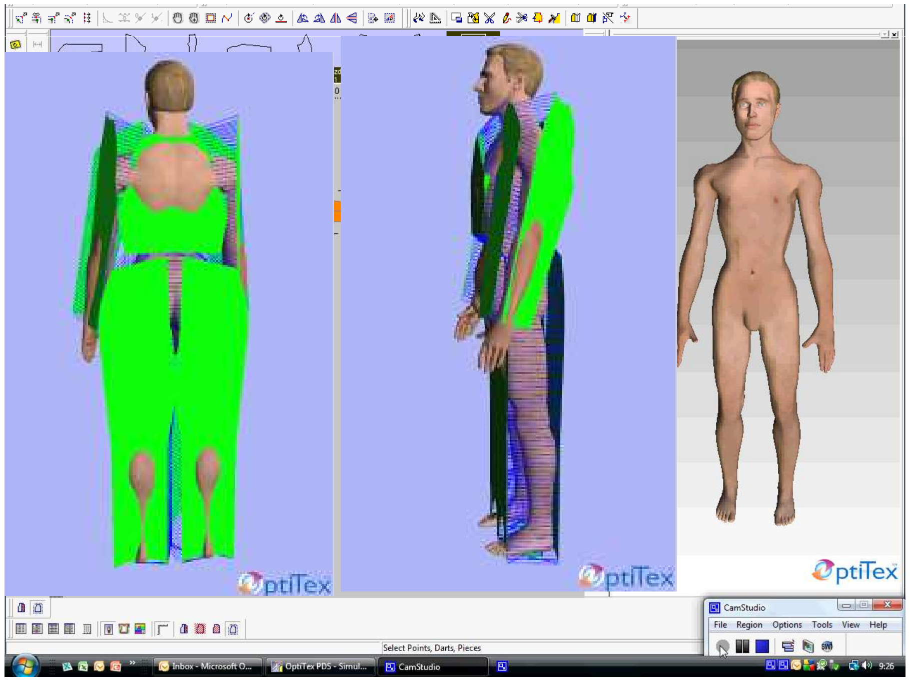
were done by *Pattern Design System (PDS) OptiTex*

Hand made marker

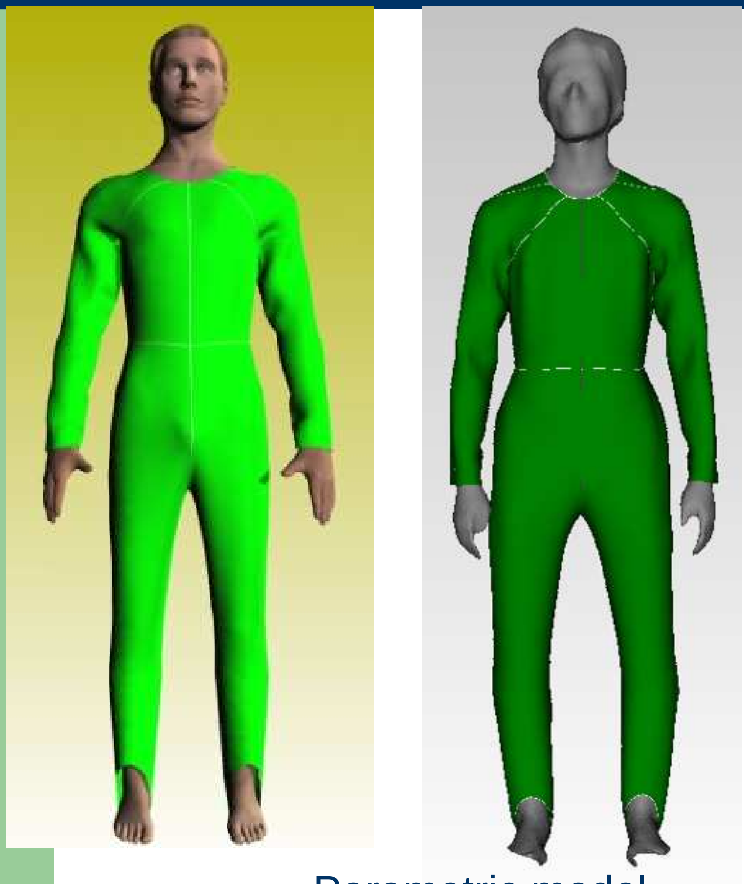
Sewing process

Real sewing

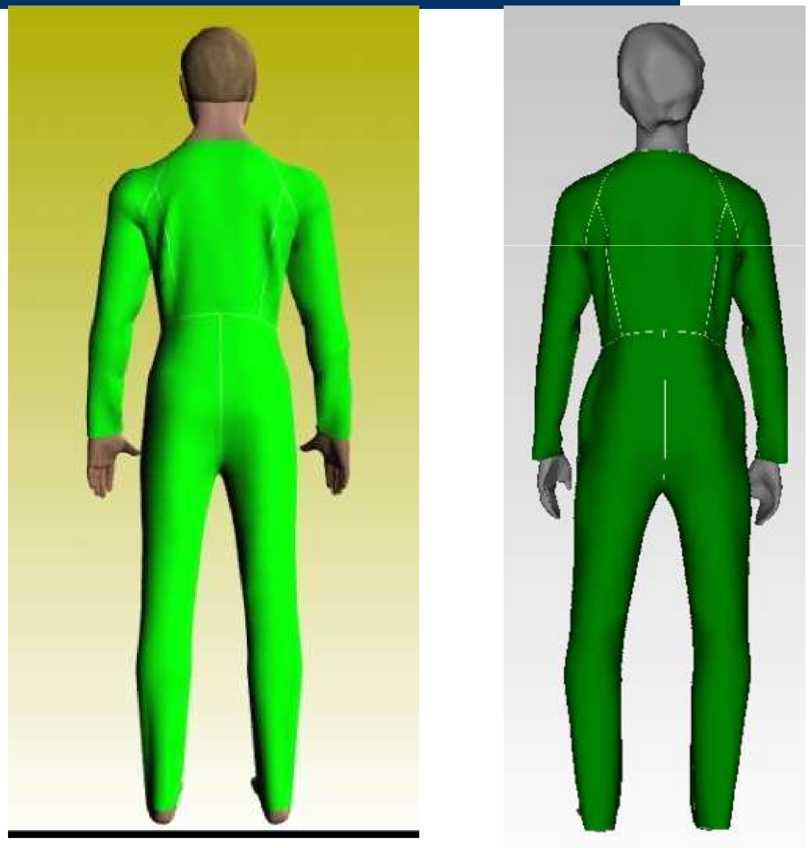
Virtual sewing



Comparison between virtual and real dress – FRONT viewu



Parametric model



Scaned model

3D virtual prototyping of women's garments

- Accurate and fast process for development of fashionable and sports garments.
- Sportswear for professional purposes.
- Example: competitive ski-jumper suit.
- Realistic simulation of garment behaviour.
- Accurate 3D body model.

Advantages of virtual prototyping

Advantages of 3D prototyping in comparison to conventional

- The 3D virtual prototyping process carry out one person
- The development process of clothing is faster and effective
- The possibilities the changing of garment prototypes are unlimited.
- Tele-work and fast data transfer
- Accurate and fast process for development of fashionable and sports garments.
- Accurate 3D body model
- Help us shorten the time of garment developing processes
- savings the cost of development
- the deliver of products are quickly

Liminitation of virtual prototyping

Limitation of 3D virtual prototyping process of garment

- **Simulation problems** by pretending garment construction.
- Virtual draping of fabrics **dose not reach the appearance of real draping of fabric.**
- **Complicated transfer the scanned body** into program package for garment construction.
- **Very powerful and expensive computer equipment** is needed.

The research possibilities on the field of development 3D virtual prototyping of garment.

- **to extend data bases** of mechanical properties of textiles materials according to kind and purpose, raw material weight and yarn density.
- **to improve the computer models for fabrics** and other textiles material.
- **to design the different parametric human bodies** focusing on various types of body shapes and ages groups.
- **High-level interaction** and testing of fit and drape of a garmen

????

Do you remember the questions that I made at the beginning of class?

Does have the virtual presentation of garment THE FUTURE?

What is your opinion?

Discussion is open!!

I would like to thank you for invitation to cooperation in project OPTIS

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ