IMPACT OF TEXTILE MATERIALS' PARAMETERS ON BEHAVIOUR/TENSION LOADS OF VIRTUAL GARMENTS USING SITTING POSTURE BODY MODELS

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Outline

- Introduction and motivation
- Garment virtual prototyping
- Garment simulation systems
- Application areas of sitting 3D body model posture
- Experimental part
- Results with discussion
- Conclusion

Introduction

- The complexity of today’s garment industry has led to unit advanced computer-aided (CAD) technologies and 3D graphic software.
- Benefits of garment simulation systems:
  - reducing real garment’s prototypes production and the amount of manufacturing waste,
  - assuring fast response to fashion trends,
  - assist designers’ creativities,
  - serving costumers‘ needs and increase their satisfaction percentage.

Garments virtual prototyping

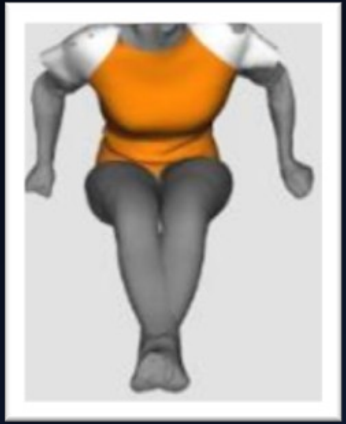
- Recognized and widely used technique applied in majority of modern industries, including textile/clothing industry.
- Application fields:
  - garment production considering individuals‘ body characteristics and requirements for garment style and functionality,
  - simulating accurate garment’s fit appearance on three dimensional body models.

Garment simulation systems

- Researcher are focusing to reproduce accurate fabric's and consequently garment's fit appearance and drape behaviour on three dimensional body models in a standing posture with standard body shape characteristics.

- Existing 3D body shapes are adaptable for normal body posture.

- No research to other human body postures for example (sitting positions) was done.



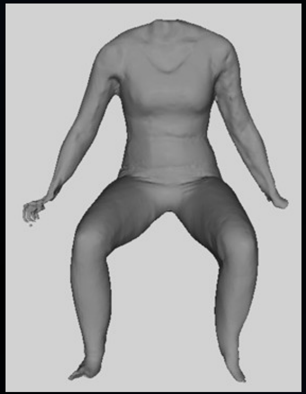
Applicationa areas of sitting 3D body model posture

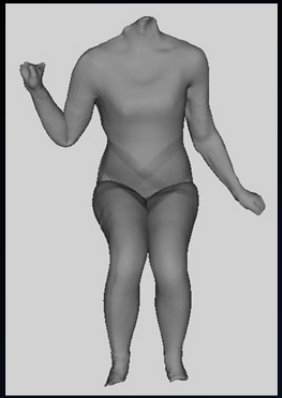
- People with limited body abilities are active in sports and in other social activities.
- Sports garments have to be engineered not only for the assurance of aesthetic and protective functions, but also to provide comfort, while performing sports activities.
- Paraplegics have special garments needs, because of physical limitations (body shapes, mobility or movability),
- therefore it is necessary perform the special garment constructions.
- The garment fit to the body of paraplegics people also depend on fabric ‘s properties (extensibility, bending , rigidity etc.)

Experimental part

The aims of study were:

- Virtual prototyping of garments for the upper body to the sitting 3D body model in three different postures was performed.
- Fitting of the sport shirt was investigated from aspects depending on the mechanical properties of fabrics, garment pattern construction and body posture.
- The focuse was on extensibility of used material
- Developing the garment for the upper body sitting posture in terms of ergonomic requirements of garments.
- The focuse was on extensibility of used material

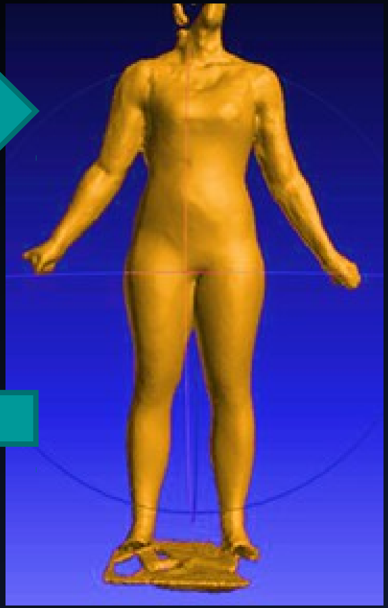




Scanning and surface reconstruction

- The test person was scanned in a standing posture using a conventional body scanner GOM Atos II 400.
- Several individual scans from different heights and angles were observed and combined into one independent mesh, using the software Atos V6.0.2.
- An optimal digital surface description of a test’s person’s body was established trough noise reduction - cleansing and removing those points which did not correspond to the body surface, such as the unnecessary digital data of the mesh at the armpits and the ground.
- Observed mesh has contained holes, which were repaired manually by using different graphic programs such as MeshLab and its tool “Poisson” and Blender for smoothing the remaining irregularities on the meshed surface by using its tool “Sculpt Mode-Smooth”.

GOM Atos II 3D optical scanner

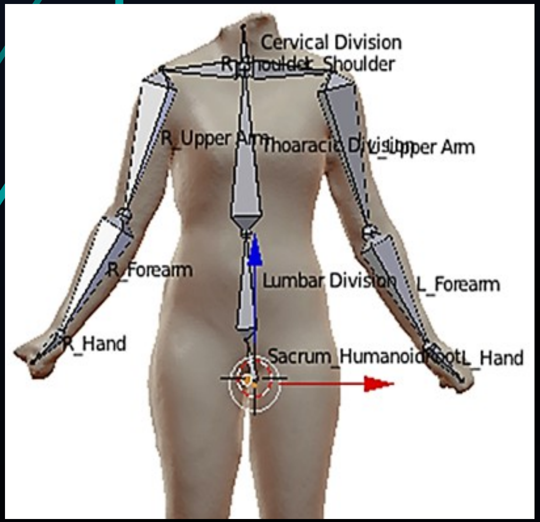


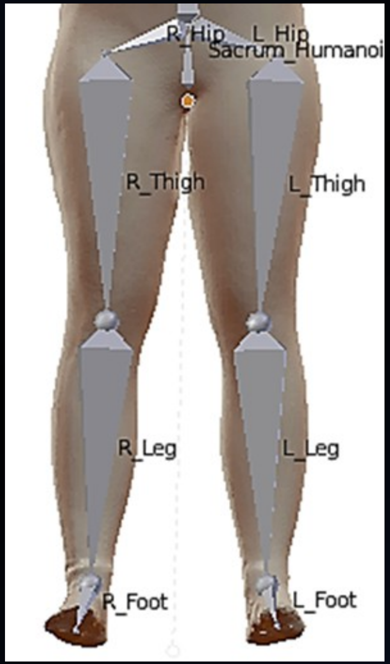
Combined individual scans in a global coordinate system with irregularities

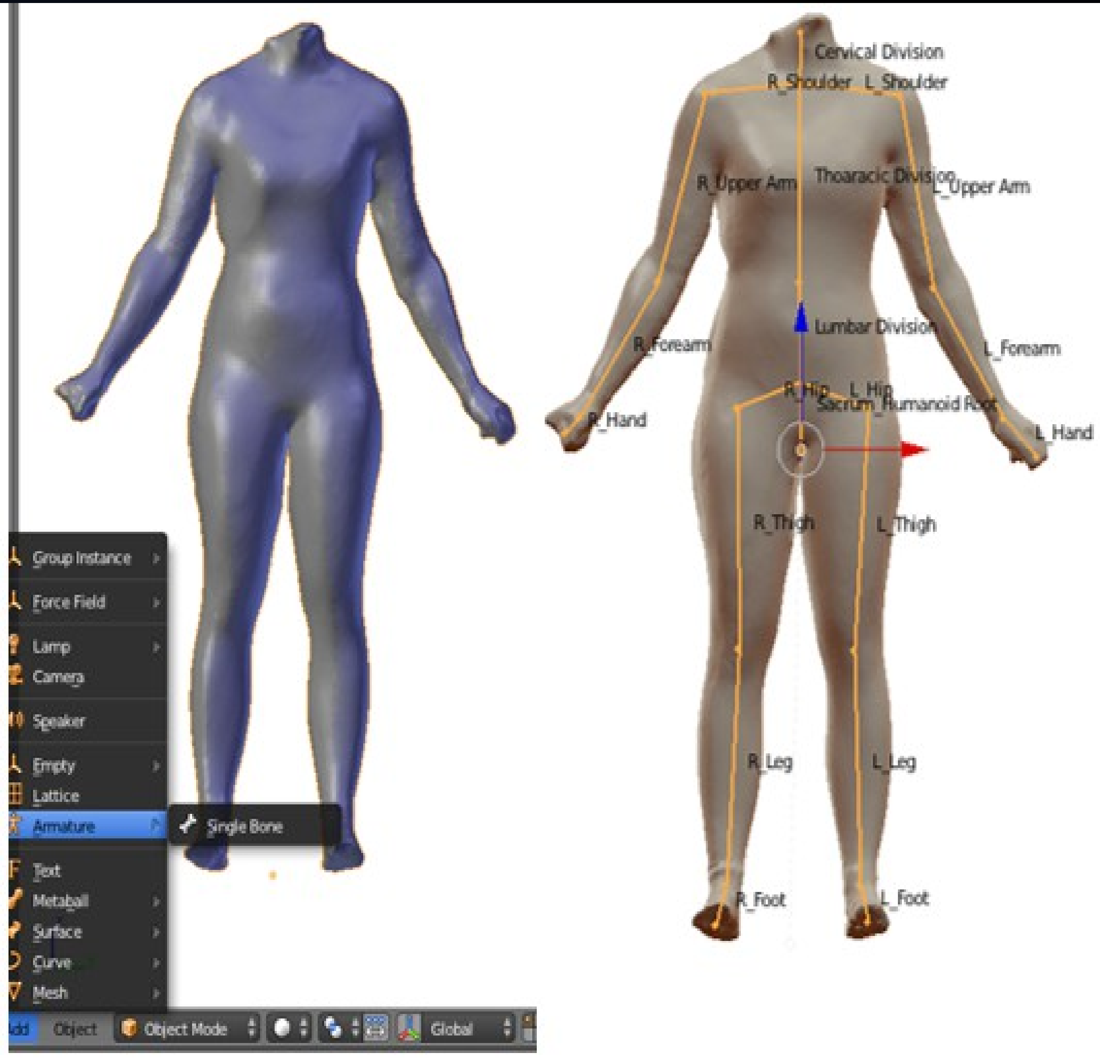
Final waterthight 3D surface

Kinematic skeleton construction

- The “Armature Modifier” was used to construct a hierarchical skeleton of 20 bones and 15 joints, (see Figure right).
- The skeleton construction continued from the shoulder and upper limbs at the left and right sides and completed at the lower limb for the left and right sides.



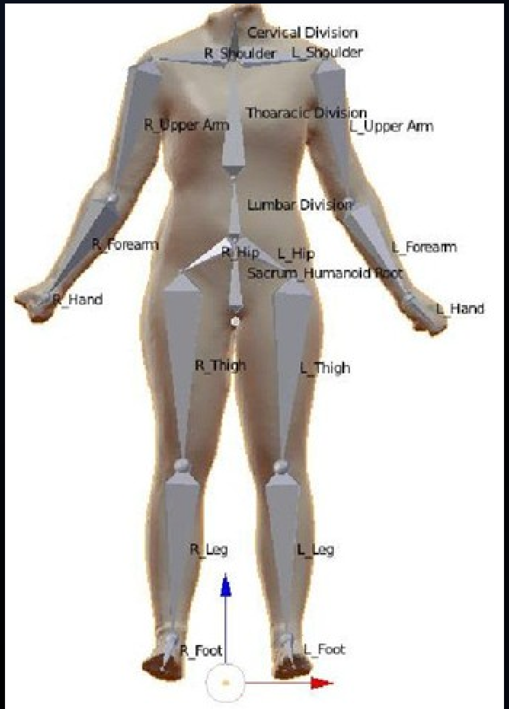


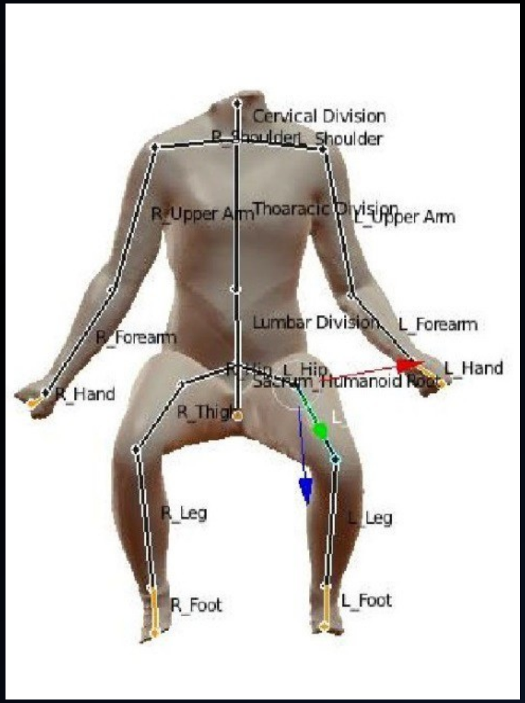


3D body model posture adaptation

Achieved 3D body models, ready for posture adaptation, can be completely adapted to the desired position/posture required for virtual garment prototyping.

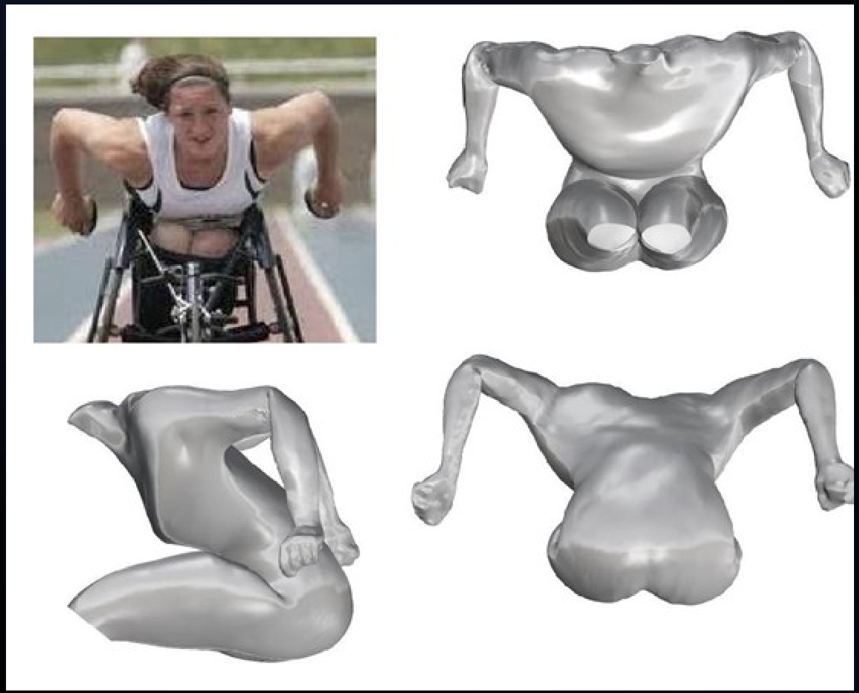
Blender 2.68 is open-source 3D graphic software.



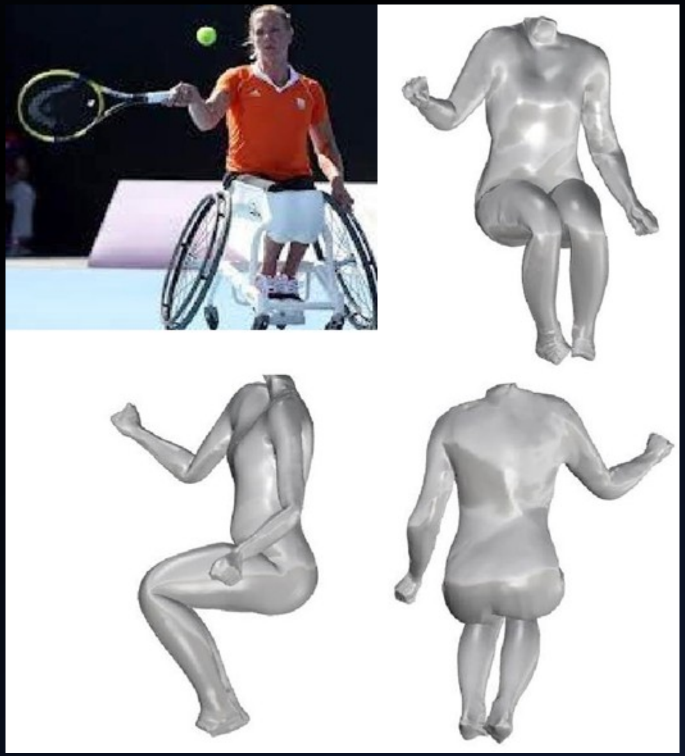


3D body model posture adaptation

- To images of people with paraplegia state, occupying positions while playing sports games.



Adapted 3D body model posture to a wheelchair-racer



Adapted 3D body model to a wheelchair tennis player

Materials

- Basic fabric characteristic

Fabric type	Raw material	Knitwear density		Fabric weight, gm^{-2}
		Wales	Courses	
S1	85 % PA 6 15 % Dorlastan	22	80	50
S2	73% PA 6 27 % Lycra	22	156	95

- Single-jersey knitted fabrics were used.
- The knitted fabrics' mechanical parameters (extensibility, bending rigidity, shear rigidity, compression) were determined by using the FAST measuring system.

The elastic components for the production of the knitted fabrics were Dorlastan and Lycra. Therefore, they can be characterised as highly elastic knitted fabrics.

Mechanical properties of knitted fabrics

- The knitted fabrics' mechanical parameters (extensibility, bending rigidity, shear rigidity, compression) were determined by using the FAST measuring system.

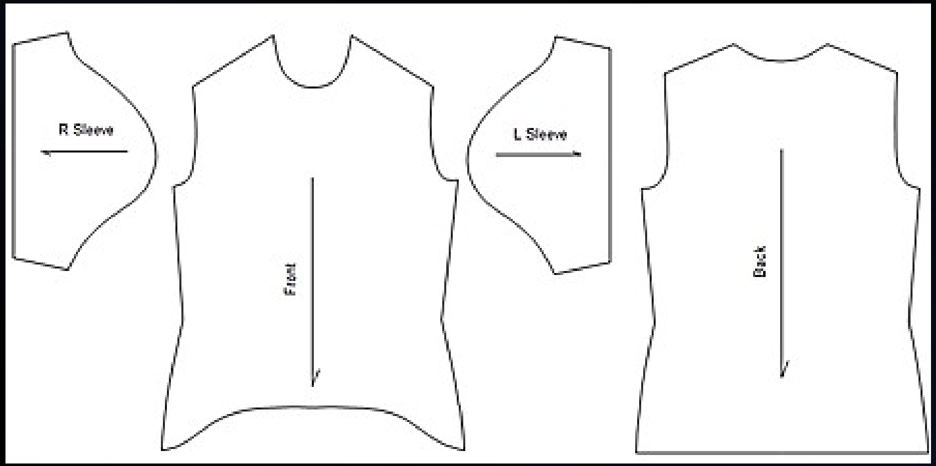
Measurements	Direction	Units	Knitted fabric notation	
			S1	S2
Bending rigidity	Wales	μNm	0.3	1.6
	Courses	μNm	0.6	1.2
Shear rigidity		Nm^{-1}	17	46
Surface thickness		mm	0.054	0.047
Surface mass		gm^{-2}	50	95

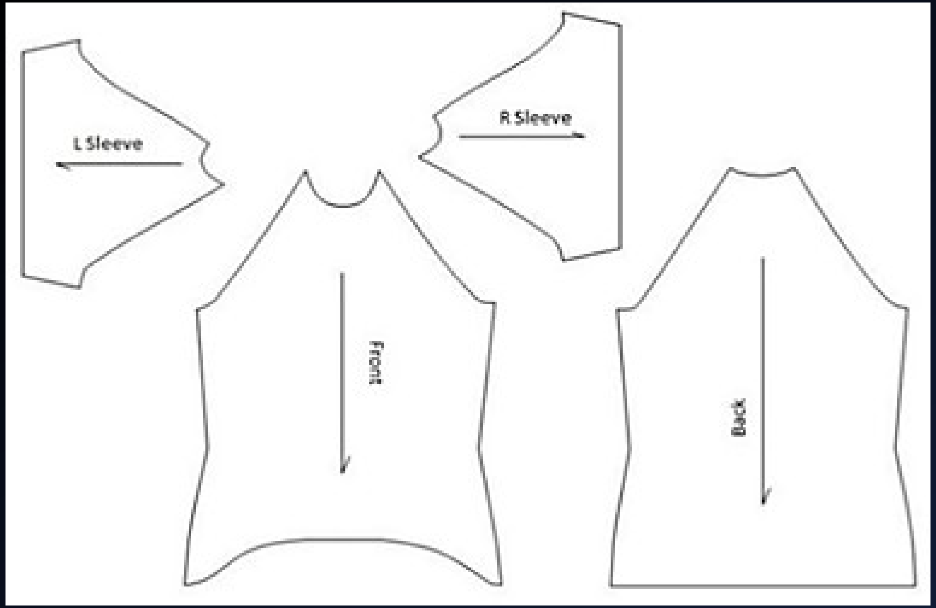
- Extensibility was between 20 % to 23 % in both direction, separately

Pattern design

- Sport shirt pattern design was performed using a construction system M. Muller & Sohn and the OptiTex PDS software.

- An additional sport shirt with raglan sleeve was designed in order to determine the influence of garment construction in conjunction with fabrics' mechanical characteristics on garment's fit appearance.



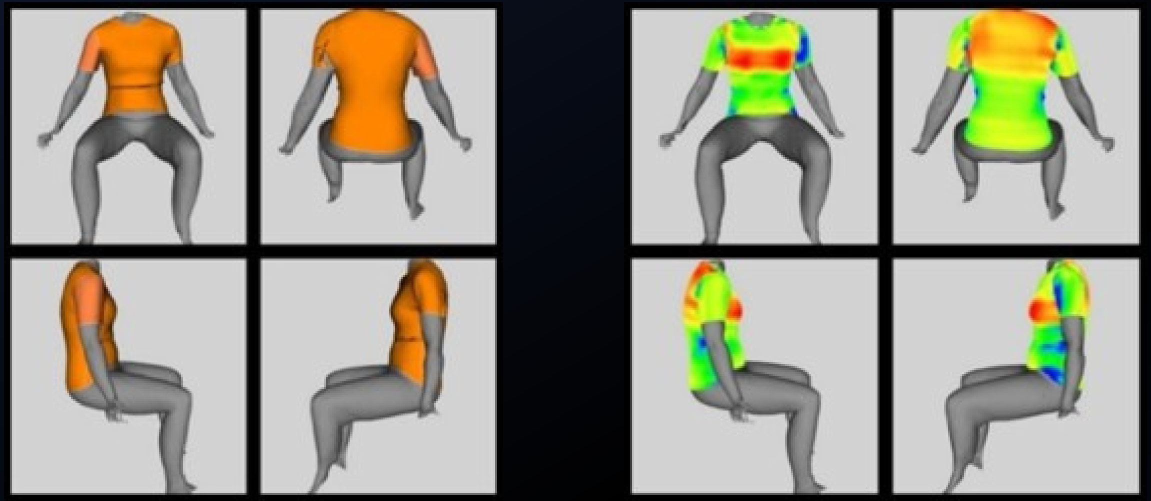


Adaptive garment pattern construction for a seated 3D body model.

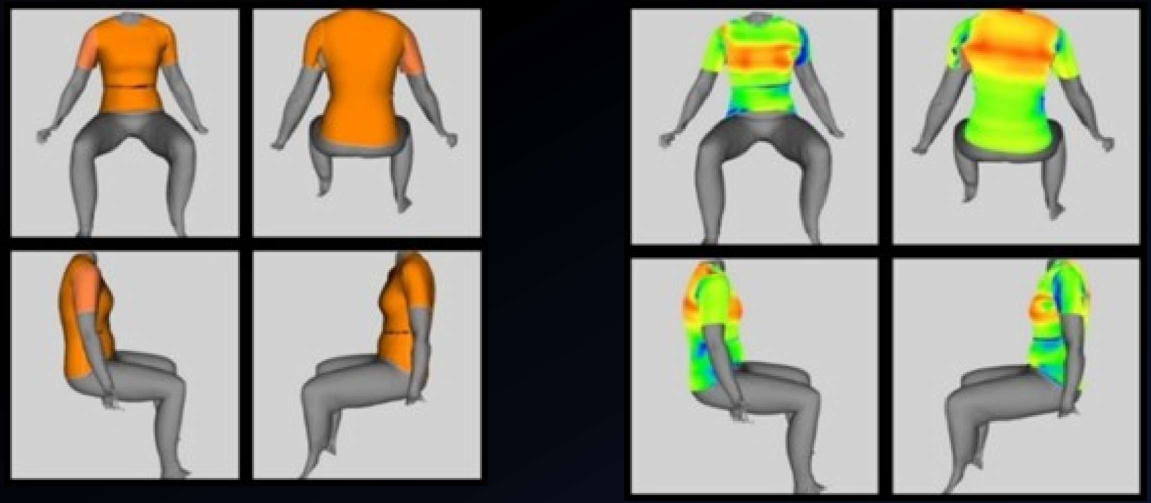
Results with discussion – influence of knitted fabric properties

Fitting of the sport shirts using different mechanical properties of the knitted fabrics S1 and S2 on a 3D body model in a standard sitting posture- M1-3D.

Knitted fabric S1



Knitted fabric S2



At position M1, the highest values of tension and stretch deformations were obtained with fabric type S2 in y-direction.

Slightly larger tension and stretch deformations appeared in x-direction with fabric type S1.

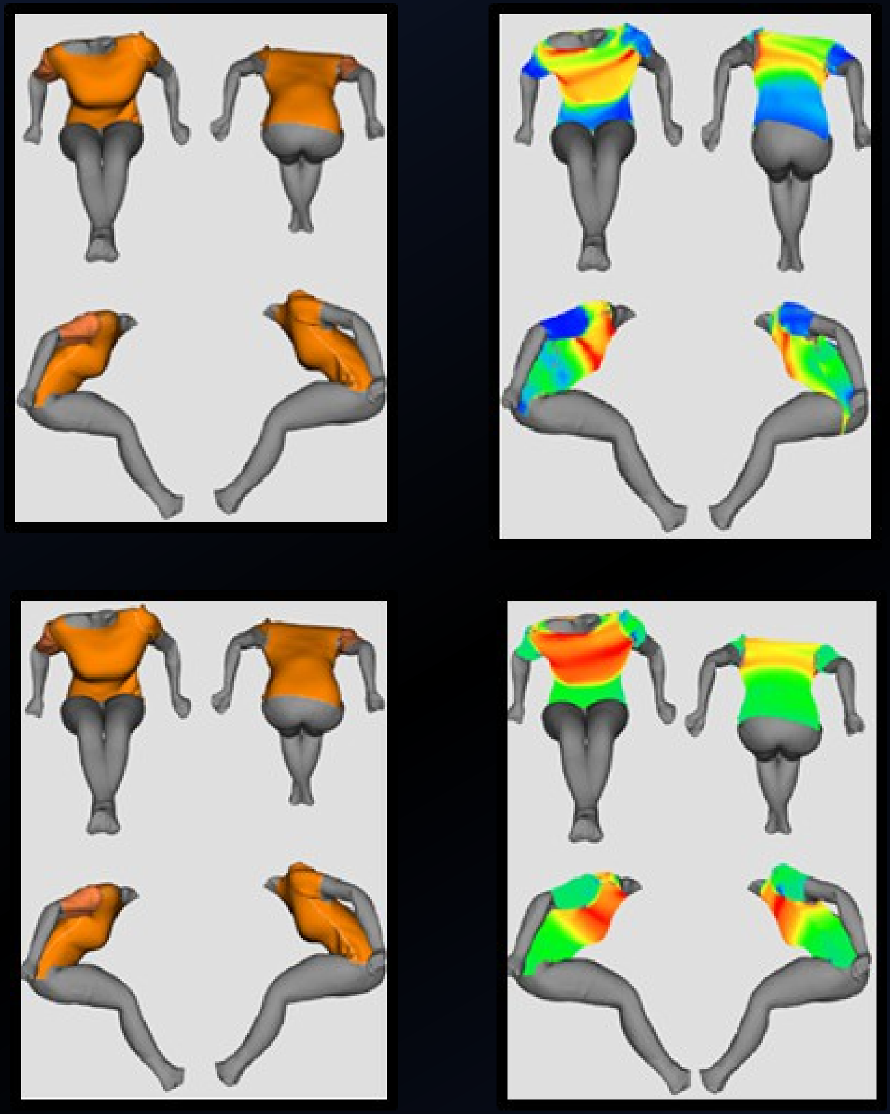
Higher values in y-direction can be explained by the highest values of bending and share rigidity and the higher knitwear density in course direction of fabric type S2.

Results with discussion - influence of knitted fabric properties

Fitting of the sport shirt using different mechanical properties of the knitted fabrics S1 and S2 to wheelchair racer- M3-3D

Knitted fabric S1

Knitted fabric S2



Observed were similar relations of tension and stretch deformations in x- and y-directions for both fabric types, whose values increases by changing 3D body model postures.

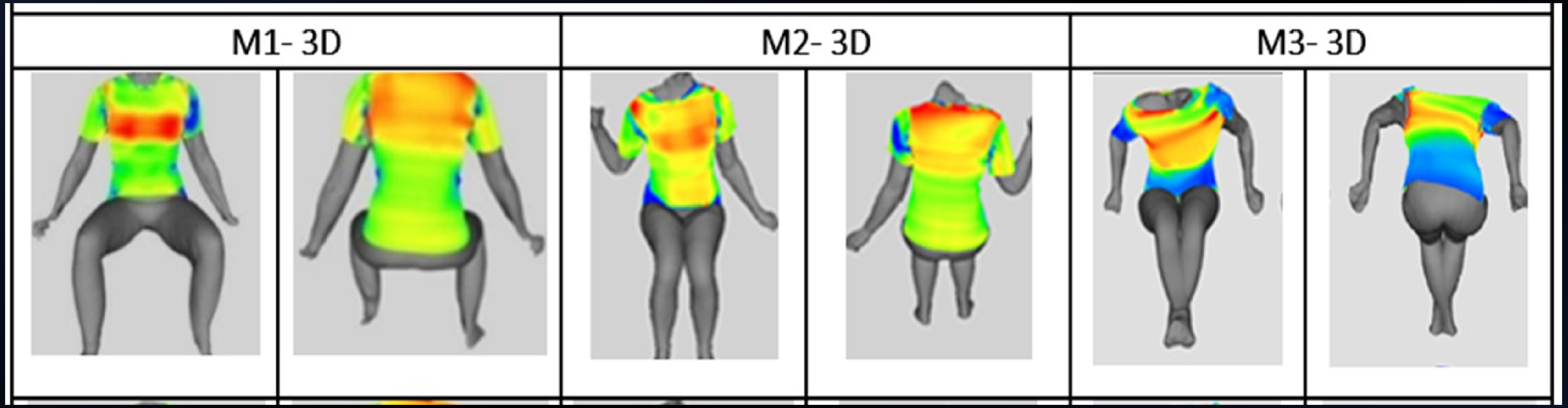
In both cases, the highest values of tension and stretch deformations in x-direction were observed with fabric type S1.

The highest values of tension and stretch deformations appeared in y-direction with fabric type S2, which could be repeatedly explained by higher values of bending and share rigidity and the higher knitwear density in course direction.

Results with discussion- influence of body positions

Fitting of the sport shirt using different mechanical properties of the knitted fabrics S1 and S2 to wheelchair racer- M3-3D

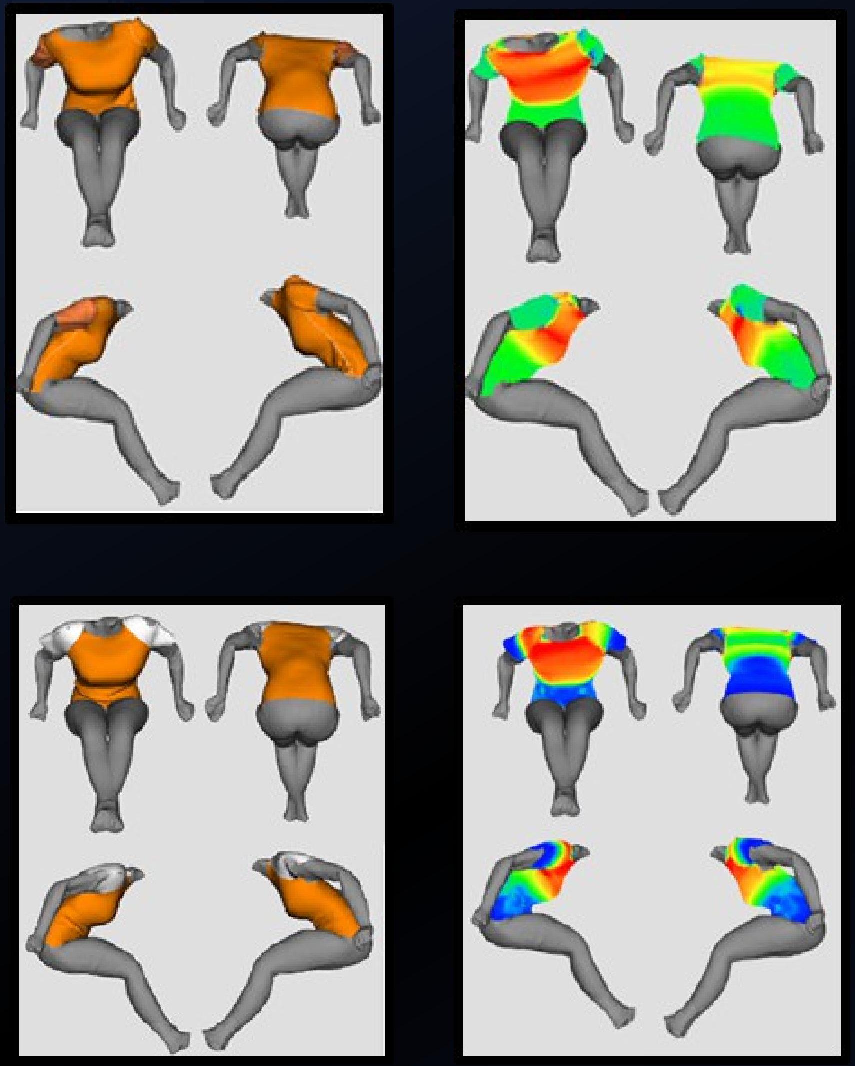
Knitted fabric S1



It is evident, that the highest tension and stretch deformation values were observed after simulating garment's fit appearance to the body model posture M3, where the body is exposed to higher physical efforts, or otherwise, higher inclinations of body segments.

Results with discussion – influence of garment construction

Knitted fabric S2



- It is necessary to consider that less satisfactory results of garment’s fitting have increased under 3D body model’s posture complexity and pattern constructions.
- The sport shirt pattern with raglan sleeve was designed in order to estimate how garment pattern construction in relation with fabric’s mechanical characteristics influences on garment fit.
- Moreover with raglan sleeves is less tension of shirt on the armpits area.

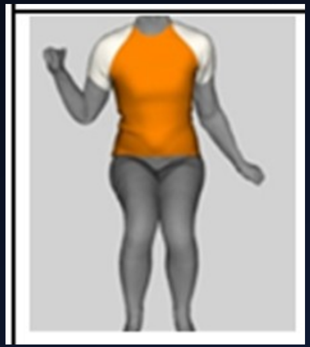
Results with discussion

Tension and stretch deformation at the sport shirt with **the basic pattern- P1**

KNITTED FABRIC NOTATION		3D body model in different postures		
		M1- 3D	M2- 3D	M3- 3D
	MAXIMAL TENSION AND STRETCH DEFORMATION AT THE SPORT SHIRT- P1			
S1	Tension x (Nm^{-1})	14,89	15,15	18,11
	Tension y (Nm^{-1})	35,19	36,93	58,04
	Stretch x (%)	8,9	9,06	11,21
	Stretch y (%)	21,05	22,21	35,92
S2	Tension x (Nm^{-1})	11,89	13,7	13,05
	Tension y (Nm^{-1})	36,18	37,13	45,81
	Stretch x (%)	7,34	8,48	8,07
	Stretch y (%)	22,39	22,85	28,35

Tension and stretch deformation at the sport shirt with **raglan sleeve pattern- P2**

KNITTED FABRIC NOTATION		3D body model in different postures	
		M1-3D	M2-3D
S1	MAXIMAL TENSION AND STRETCH DEFORMATION AT THE SPORT SHIRT- P2		
	Tension x (Nm^{-1})	10,97	11,93
	Tension y (Nm^{-1})	25,25	53,24
	Stretch x (%)	6,78	7,38
	Stretch y (%)	15,62	32,94
S2	Tension x (Nm^{-1})	11,59	13,13
	Tension y (Nm^{-1})	27,25	53,36
	Stretch x (%)	7,16	7,80
	Stretch y (%)	16,86	31,91



Conclusions

- Importance of fabrics’ characteristics for reliable garment prototyping and visualisation was studied using two types of knitted fabrics with different structural and physical/mechanical properties.

- For the purpose of virtual garment prototyping and visualisation we have developed standing and sitting posture 3D body models.

- By using the tension maps we can analyse the impact of textile materials' parameters on behaviour/tension loads of virtual garments using sitting posture body models.

- There can be seen some obvious differences in tension maps of both garments on 3D body models in different postures.

- They are caused by the differences in structural and physical/mechanical properties of applied knitted fabrics, but also by garment pattern construction and 3D body model complexity.

Thank you very much for your attention!