

## 3D BODY DATAS INTEGRATION IN FUNCTIONAL WEAR UNDER BRACE

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**Abstract:** Scoliosis is a spinal deformity that most commonly appears in girls and makes itself apparent at puberty during the early teenage years, but it affects approximately 12 million people worldwide. Living with scoliosis can be especially difficult for children, particularly when a brace is required to stop its progression. The brace is 5 mm thick plastic armour that is to be worn 24 hours a day. To wearing it cause not just physical hardship but psyche trouble as well. Currently, the underwear that is worn by children under the brace is the commercially available materials and tailoring forms determined. Our goal is the unique design of pant, bra and t-shirt patterns with least seam and we use a special raw material. Wearing it under the brace will be improved the children physiological conditions and comfort. We use 3D scanned body model to make measurement and to do t-shirt construction.

**Keywords:** Scoliosis, brace, underwear

### 1. Introduction

Garment is an important part of the underwear. The comfort and good hygiene is largely determined by the material of underwear, technological development, the method of production. However, there are situations in life when an illness is part of the patient's medical aids /brace/ to be worn every day. In this case, even more important thing is the underwear. The dressing is difficult, because a 5 mm thick plastic "armor" to wear on one side of the body, pressure on the other side is not touching the body. Where the body and the plastic plates meet, it often happens that rubbed the skin, which cause pain and discomfort.

We tested different kind of textiles t-shirt in a climate chamber in 3 different temperature and 3 kind of body moving like sitting, walking and running. The t-shirts construction made of in special way, because we used a 3D scanned mannequin with and without brace to measure the model. In pattern we didn't use seam in the pressure points of the brace.

### 2. Brace create

Material of brace is made from 180 degrees thermoplastic plastic. The brace material must be hard and rigid. The brace is made of high thermoplastic plastic after sampling of the body is made of plaster.

Physiotherapist adjusts for sampling the child's posture.

Orthopedic technician create of the plaster molds to determine the basis pressure points, and free places left /Figure 1/. [1]



Figure 1. Cheneau brace

### 3. T-shirt construction

The points of the curve of mannequin could be determined with conventional image processing methods; however the surface curves were approximated with trigonometric regression, sections of Fourier series [2]. It is possible to measure and based on it could be make the construction. The figure 2 shows the mannequin measure points, and the t-shirt construction. The construction designed to take into account the pressure points in the brace.

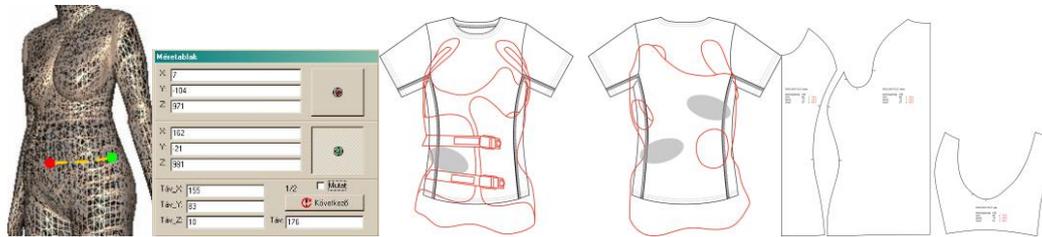


Figure 2. Body measurement from virtual mannequin and t-shirt construction

### 4. Selection aspects of suitable textiles

We are looking for intelligent and functional textiles, which are due to their composition, or finishing result, suitable for protecting the health quality of life.

Our basic requirements from textiles:

- Good air permeability
- Antibacterial
- Moisture-wicking
- Good abrasion resistance
- Washable
- Good to be processed.

In our study, we tried to find new developed, commercially available material parameters which are under test conditions, which are the physiological needs of customers in the best match.

We tested 3 kinds of textiles brace in:

1. „Traditional” 97% cotton 3% elasthan type knitted material
2. „Outlast” PCM 66% cotton, 28% viscose, 6% elasthan knitted material
3. „Coolmax” 100% PES antibacterial finished knitted material

We are detailed functional properties of no. 2 and no. 3 textiles.

#### 4.1 PCM thermal control material

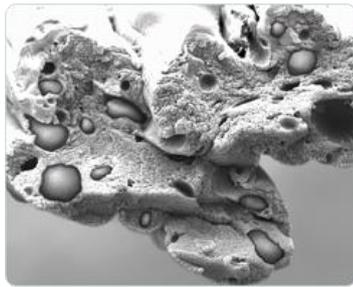
At the textiles also used special particles in the liquid-crystalline materials, changes in the physical state of the unusual phenomena can be observed /Figure 3/ [3]:

- The melting of solid phases at the first one for liquid, dense, confusing, "liquid crystal" state,
- Followed by further heating the isotropic liquid and gaseous materials.

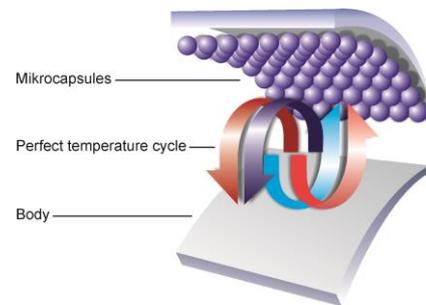
A "normal" liquids isotropic property of the liquid-crystalline state, however, the material coming from different directions and respond differently influences ("anisotropic" phase). The "Phase Change Material," the phrase in English PCM-agent spread after phase-alternating phase-changing, state-set exchange properties. The PCM-s ability to absorb a significant amount of heat energy, temporarily stored and then adapting to the changes in the environment of this latent heat is utilized. If temperatures in the range of their physical state change request:

- Solid phase near liquid state is cooling,
- Liquid cooling states of matter has an external effect, e.g. heat loss. The PCM is stopped before the melting point of the heating cycle. [3]

That Outlast technology, the company was first developed for astronauts the basic materials of everyday life can be used in many fields, especially for clothing. The figure 4 [3] is shown the Outlast technology physiological effect.



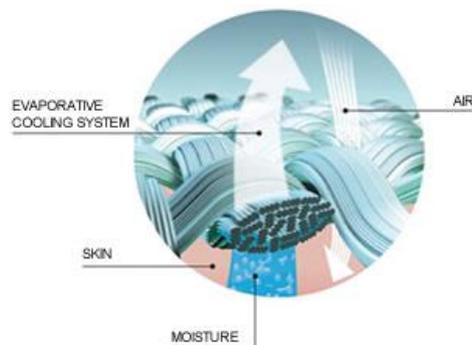
**Figure 3.** Capsules in viscose fibre [3]



**Figure 4.** The Outlast technology [3]

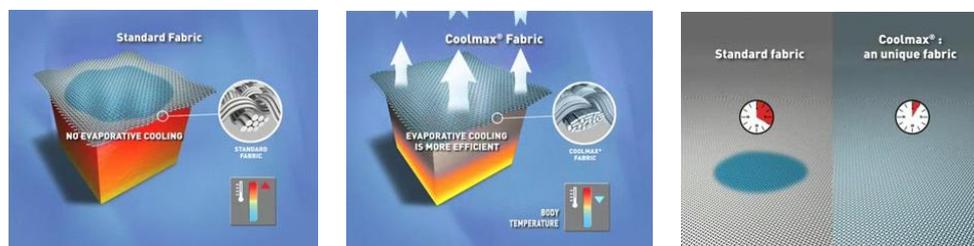
#### 4.2 Coolmax antibacterial material

COOLMAX fabric with a specially designed polyester fiber made from elemental that wicks away perspiration from the body, and through the material quickly evaporates, so the clothing wearer comfort improvement. Figure 5 has shown 4 and 6-channel fibers develop. The increased fiber surface due to the tissue surface of the water quickly evaporates. [4]



**Figure 5.** Coolmax textile evaporate system [4]

It can be seen in figure 6 comparison of the traditional cotton and the coolmax textile evaporate system.



**Figure 6.** Coolmax and a traditional cotton evaporate system [4]

### 5. Test t-shirt under brace in climate chamber

*Measuring and conditions in climat chamber:*

- 22°C; 25°C; 28°C; 32°C
- „RH” relative air humidity: 50%
- „V” airflow: 0,5m/s

*Measurement intervals:*

- 15 min preparation
- 20 min sitting
- 20 min walking 2,5 km/h
- 15 min sitting
- 5 min running 3,5 km/h

*Brace:*

1. Original brace
2. Brace with hole: we make some holes to brace special points mainly that parts which are not pressing point effect to the body. The holes measure depends on the part of the brace, the distance

between holes could be different. We made so many tests how big is the optimal hole measure and hole distance. Our tests: 3 point bending tests and air permeability.

### 5.1 Measuring with MSR 12 system

Modular Signal Recorder MSR 12 system is a portable signal instrument for measuring, displaying and recording a range of physical parameters.

It is able to record and store over 100 physical parameters.

We measured 3 parameters: temperature, humidity, and ECG. It can be seen in figure 7.

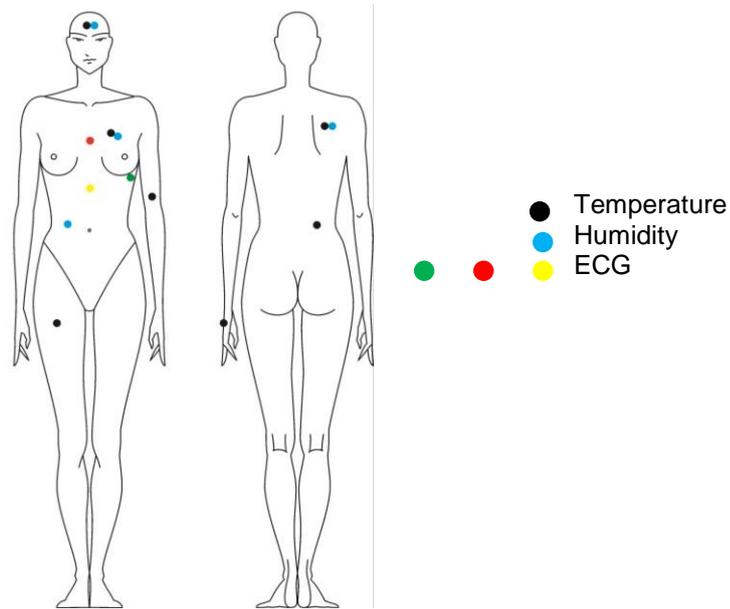


Figure 7. Measuring points on the body

### 5.2 T-shirt moisture change in different temperature

We tested person's and clothing data:

- The naked man's body mass
- The T-shirt's mass
- The bra mass
- The trousers mass
- The pant mass
- The socks mass
- The shoes mass

The 1-2. diagram shows the t-shirt moisture change in scale of body mass. In 22 °C there was just a little change, the all t-shirt mass was almost similar in this temperature. It can be seen that the t-shirt moisture decrease every temperature in brace with hole except Coolmax. The smallest moisture permeability was in Coolmax, but all wet let in the skin surface which is cause very uncomfortable feeling.

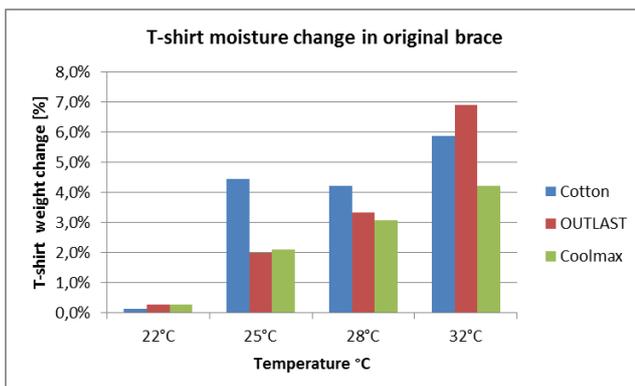


Diagram 1. T-shirt moisture change in original brace

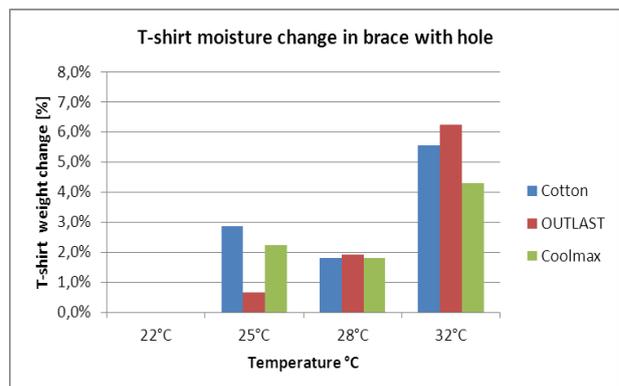


Diagram 2. T-shirt moisture change in brace with hole

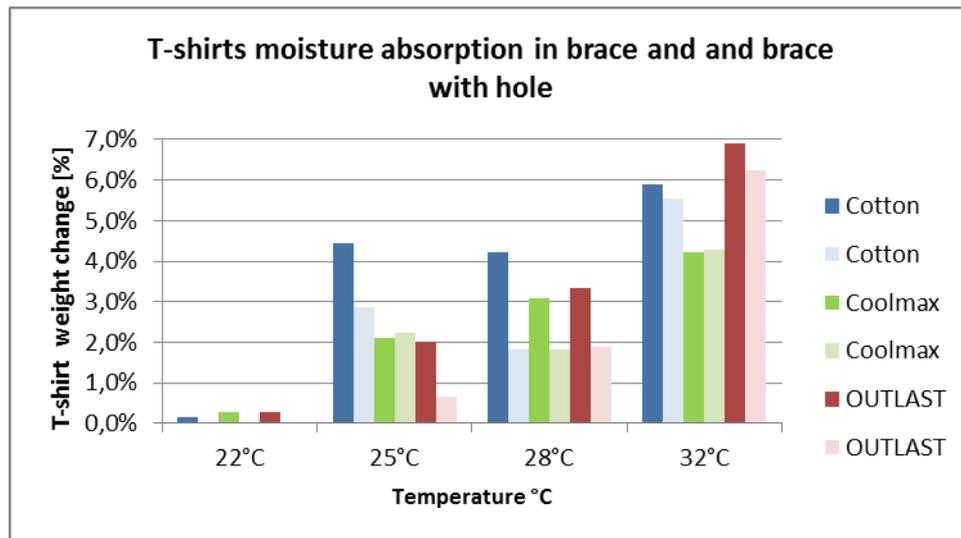


Diagram 3. T-shirts moisture absorption in normal brace, and brace with hole

It can be seen in diagram 3 the different t-shirts moisture absorption in original brace /dark colors/ and brace with hole /light colors/. In 22 °C there was very small change moisture absorption, that we don't test in brace with hole. The biggest change between normal and holed brace were in cotton and Outlast t-shirt.

The feeling in the t-shirts is a very important information beside the measured datas. The test person's opinion the best material is the OUTLAST. The subjective dates determination we used, based on Ergonomics of the thermal environment – Assessment of the influence of the thermal environment using subjective judgment scales (ISO 10551:1995) [5].

*Person's feeling and activity before the test:*

- Last night: How many hours did you sleep? good/bed
- Last meal: When/what did you eat? [8]
- Arrive: foot/with bicycle/with motor bicycle/with bus/with car/ with train.
- Resting before the test: How many hours/minutes?
- General feeling before the test: Describe with few words ho do you feel.

*Person's feeling under and after the test*

Based on the standard there were so many question about environments and feelings [5].

## 6. Conclusion

In this research we want to test an other developed cooling and humidity control PCM material, and continue the bra and pant construction with helping of Sylvie 3D system. Based on subjective and objective results we give to children further testing the best T-shirt, bra and pant.

## References

- [1] Marlok, F.: *A CHÉNEAU-KORZETT* Available from [http://www.gerincferdules.hu/images/stories/Fizio\\_cikk\\_korzett.pdf](http://www.gerincferdules.hu/images/stories/Fizio_cikk_korzett.pdf) Accessed: 2012-03-02
- [2] Tamás, P.: *3D Dress Design* (PhD thesis in Hungarian), Budapest University of Technology and Economics, Budapest, 2008.
- [3] [www.outlast.com](http://www.outlast.com) Accessed: 2012-03-02
- [4] [www.advancedfibers.eu](http://www.advancedfibers.eu) Accessed: 2012-03-02
- [5] Ergonomics of the thermal environment – Assessment of the influence of the thermal environment using subjective judgment scales (ISO 10551:1995)

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