Araştırma Makalesi
(Research Article)

TJFDM, 2019, 1 (1): 27-34

Serkan BOZ[1]
Orcid : 0000-0002-8949-4611

Özlem KURTOĞLU NECEF[2]
Orcid : 0000-0001-8384-9402

Arzu ŞEN KILIÇ[3]
Orcid : 0000-0002-2856-4196

Ziynet ÖNDOĞAN[4]
Orcid : 0000-0002-8597-2727

[1]Lecturer PhD, Ege University, Emel Akın Vocational High School, Izmir-Turkey
[2]Lecturer PhD, Ege University, Emel Akın Vocational High School, Izmir-Turkey
[3]Asst.of Prof.Dr., Ege University, Faculty of Fashion and Design, Izmir-Turkey
[4]Prof.Dr., Ege University, Faculty of Fashion and Design, Izmir-Turkey

Sorumlu Yazar (Corresponding Author):
Serkan BOZ
serkan.boz@ege.edu.tr

The Usage of 3D Technologies in Assessment of Body Fitting of Clothing

Giysilerin Vücuda Uyumunun Değerlendirilmesinde 3B Teknolojilerin Kullanımı

Alınış (Received): 21.10.2019 **Kabul Tarihi** (Accepted): 20.11.2019

ABSTRACT
The use of 3 dimensional (3D) technologies in the pre-production preparation process enables apparel manufacturers to produce quality products at a low cost in a short time and increases their ability to compete in the World economy. In this study, the usability of 3D technologies in the apparel sector during the pre-production preparation period was investigated. The fit evaluation of garment was done on virtual manikin. A 3D printer is used for creating the 3D scaled garment samples.

ÖZ
3 boyutlu (3B) teknolojilerin üretim öncesi hazırlık sürecinde kullanılması hazır giyim üreticilerinin kısa zamanda, düşük maliyetle kaliteli üretim yapmalarını sağlayarak, Dünya pazarında rekabet edebilme yeteneklerini arttırmaktadır. Gerçekleştirilen çalışmada, hazır giyim sektöründe üretim öncesi hazırlık döneminde 3B teknolojilerin kullanılabilirliği araştırılmıştır. Giysinin vücuda uyumu sanal manken üzerinde değerlendirilmiştir. 3B ölçeklendirilmiş numunelerin üretimi sırasında 3 boyutlu yazıcı kullanılmıştır.

Key Words:
Pattern preparing, 3D virtual manikin, 3D printing, 3D virtual garment simulation, Body fitting

Anahtar Sözcükler:
Kalıp hazırlama, 3B sanal manken, 3B yazıcı, 3B sanal giydirme, Vücut uyumu

How to cite: Boz, S., Necef, Kurtoğlu, Ö., Şen, Kılıç, A. and Öndoğan, Z. (2019). The Usage of 3D Technologies in Assessment of Body Fitting of Clothing, TJFM., 1 (1): 27-34

Kaynak Gösterimi: Boz, S., Necef, Kurtoğlu, Ö., Şen, Kılıç, A. ve Öndoğan, Z. (2019). Giysilerin Vücuda Uyumunun Değerlendirilmesinde 3B Teknolojilerin Kullanımı, TJFDM., 1 (1): 27-34

1. INTRODUCTION

Innovations in technology enable the development of new products and use of new production methods in many industrial areas. 3D technologies such as 3D garment dressing simulation, 3D printing and etc. have many different uses are considered to be one of today's most important technologies.

The garment dressing simulation is a process which transforms multiple 2D garment patterns into a 3D configuration that follows the surface of the human body and enables visualization of the draping effect of the garment. The 3D garment dressing simulation is a process to create a virtual garment onto a digital human model to verify the style and fit of a designed pattern before the garment is actually made. A robust simulation system should include the key functions that perform fabric modeling, sewing scheme, accurate and fast collision detection/response, and size stability maintenance. The dimensional stability of a garment pattern is an important constraint that needs to be imposed to ensure the created garment has a size complying with the original design of the pattern (Zhong and Xu, 2009). Using the 2D/3D CAD system for the preparation of garment construction, a 2D pattern was developed for the purpose of computer grading for selected sets of sizes according to different figures and statures (Mahnic and Petrak, 2013).

3D printing, called additive manufacturing is a process of making a 3D solid object of virtually any shape from a digital computer model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes (Fonda, 2013).

3D printing employs an additive manufacturing process whereby products are built on a layer by layer basis, through a series of cross-sectional slices (Berman, 2012). These objects are created from a digital file containing 3D data extruded by printer (Valtas and Sun; 2016).

In former times, it has mostly been used for pre-production (rapid prototyping) due to material and production costs as well as mechanical deficiencies. In recent years, however, production processes were included more and more (rapid manufacturing) due to better and less expensive 3D printers and corresponding materials (Spahiu et al, 2016)

Objects that produced using a 3D printer can be used anywhere throughout the product life cycle, from pre-production (i.e. Rapid prototyping) to full-scale production (i.e. Rapid manufacturing), in addition to tooling applications and post-production customization. Today this technology is extensively used in jeweler, footwear, industrial design, architecture, engineering and construction, automotive, aerospace, dental and medical industries, education, geographic information systems, civil engineering, fashion and for many other professional applications, while new fields are added to this list every year [Fonda, 2013] (Kalva, 2015).

3-D printing has undergone a three-phase evolution process. In phase one, architects, artists, and product designers used 3-D printing technology to make prototypes or mockups of new designs (Berman, 2012).

This research was aimed to test the usability of 3D technologies during the pre-production preparation period in the apparel sector. For this purpose, a top and legging were sewn and fitting to the body by using 2D and 3D integrated virtual dressing system. In addition, visual inspection of these garments was performed by using 3D printer.

2. MATERIAL AND METHOD

2.1. Material

In this study, two garments were manufactured both in traditional methods and using 3D printing technology in garment industry. Optitex 2D & 3D Integrated Pattern Design Software was used for designing garments, preparing patterns and getting fit on virtual garment simulation. Prototype sample garments fabrics details were given below; Table 1.

Table 1. Fabric properties
Çizelge 1. *Kumaş özellikleri*

Fabric Code	Fabric Construction	Material Type	Mass per Unit Area (g/m^2)	Fabric Thickness (mm)
Fabric (A)	Single Jersey	%93 PA %7 Ea	290	0,84
Fabric (B)	Double Layered Single Jersey	%87 PA %10 Ea %3 PUR	288	0,85

Front and back views of the top and legging are concerned in Figures 1.

Figure 1. Technical drawings of prototype samples
Resim 1. *Prototip örneklerinin teknik çizimleri*

In this context 3D printer Zortrax M200 which was shown in Figure 2., was used for manufacturing 3D printed of the scaled garments.

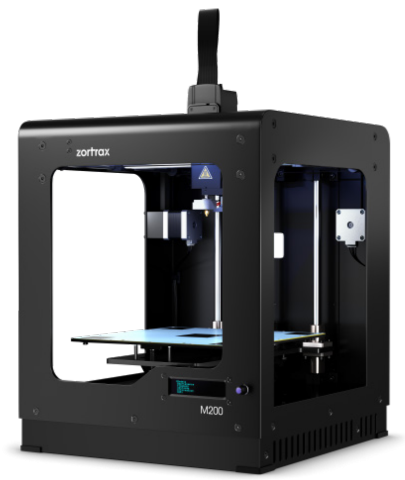


Figure 2. Zortrax M200 3D printer
Resim 2. *Zortrax M200 3B yazıcı*

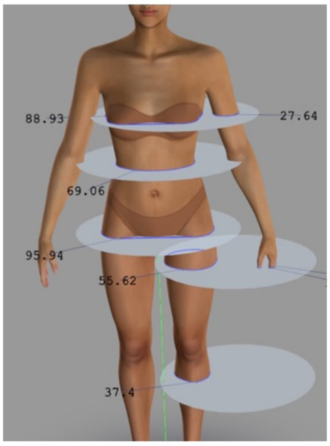
Zortrax M200 processing ABS (Acrylonitrile Butadiene Styrene) in build orientation XY.

2.2. Method

In this study, garment design, measurement settings and pattern preparing steps were carried out by using Optitex 2D Pattern Design Software. Then virtual manikin which has the following measurements (Table 2.) was prepared by using Optitex 3D Pattern Design Software.

Table 2. Measurements of virtual manikin

Çizelge 2. *Sanal manken ölçümleri*



Measurements of Manikin	Sizes (cm)
Chest width	88.93
Waist width	69.06
Hip width	95.94
Thight width	55.62
Sleeve width	27.64
Calf width	37.40

The top and the legging model files were selected, fabric properties, seam lines and the segments which will be sewed together were set. After settings, the models were worn to the virtual manikin. Garment simulation on virtual manikin that shown in Figure 3 is done and tension and stretch maps were obtained in Optitex 3D Pattern Design Software.

Figure 3. 3D garment design and simulation (CLT extension)

Resim *3.* *3B Giysi tasarımı ve simülasyonu (CLT uzantısı)*

Worn garment file converted from CLT (Cloth) extension into STL (standard stereo-lithography) extension (Figure 4.) for beginning of 3D printing process.

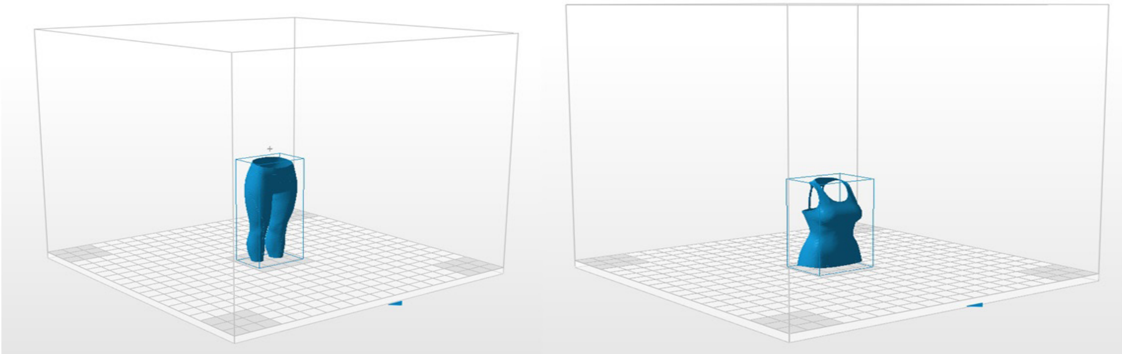


Figure 4. Z-Suite 3D Printer software screenshots

Resim 4. *Z-Suite 3B yazıcı yazılımı ekran görüntüleri*

This file was sent to the 3D printer for manufacturing the 1:10 scaled samples for visual control (Figure 5).

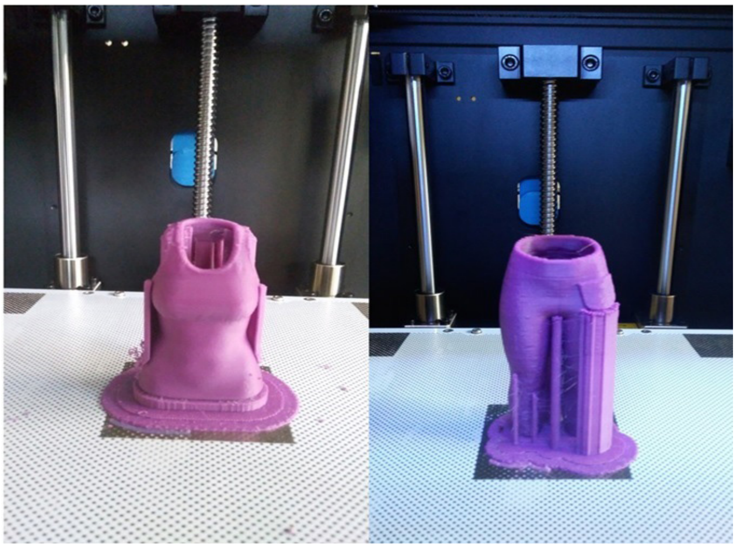


Figure 5. The scaled samples during 3D printing process

Resim 5. *3B Baskı işlemi sırasında ölçeklendirilmiş örnekler*

The scaled legging prototype sample produced in 1 hour and 53 minutes and the scaled top prototype sample in 1 hour and 14 minutes.

Front and back views of 3D printed scaled samples are concerned in Figures 6.

Figure 6. The front and back view of 3D printed scaled samples

Resim ***6.*** *3B Basılı ölçeklendirilmiş numunelerin ön ve arka görünüşü*

3. RESULTS AND DISCUSSION

During 3D garment fit evaluation on virtual manikin, tension and stretch maps, that given in Figure 7. and Figure 8., were defined. It is possible to check the garment fits by using tension and stretch maps.

The tension map have 3 different colors: blue if the garment is loose, green if the garment is perfect fit, red if the garment is too tight (Olaru et al, 2012).

It was shown that the waist line of the top sample was loose and the chest line was tight (Figure 7. and Figure 8.). For the shoulders line the pattern were loose both front and back side of the garment. Regarding the legging sample, it was shown that calfs were tight, and the waist line of the garment was loose.

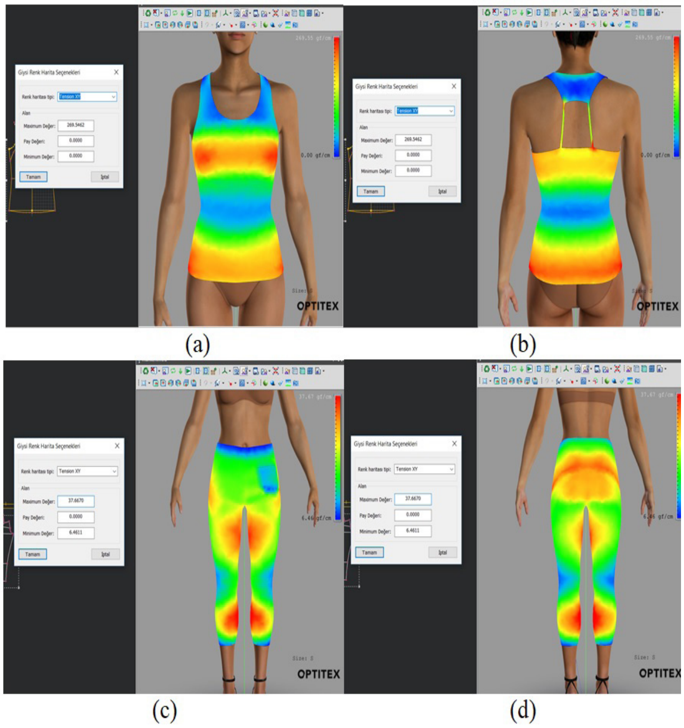


Figure 7. Tension maps of virtual garments (a) front view of top sample (b) back view of top sample (c) front view of legging (d) back view of legging.

Resim *7. Sanal giysilerin gerilme haritaları (a) üst numune ön görünüş (b) üst numune arka görünüş (c) bacak kısmı ön görünüş (d) bacak kısmı arka görünüş*

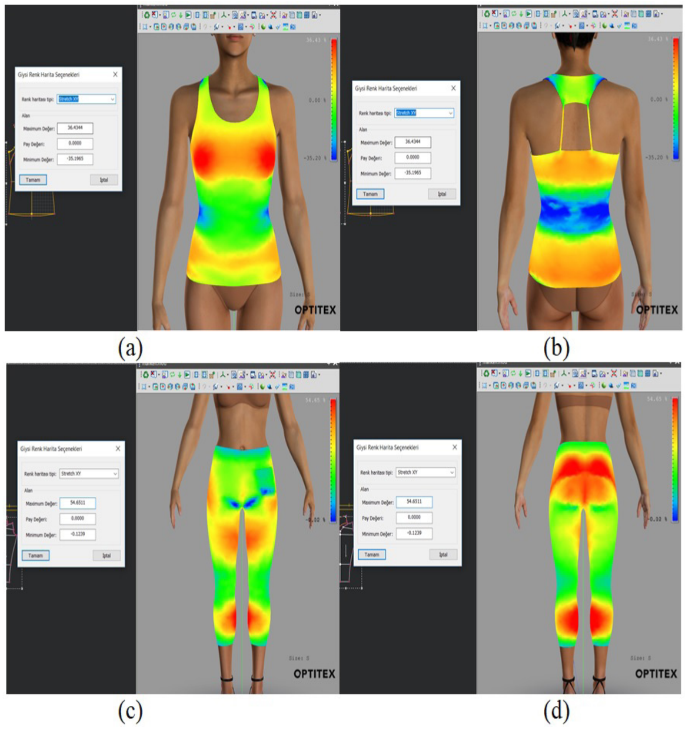


Figure 8. Stretch maps of virtual garments (a) front view of top sample (b) back view of top sample (c) front view of legging (d) back view of legging.

Resim *8. Sanal giysilerin esneme haritaları (a) üst numune ön görünüş (b) üst numune arka görünüş (c) bacak kısmı ön görünüş (d) bacak kısmı arka görünüş*

The stretch map for the front side of top sample shows that at chest line the garment is tight and the waist line is loose.

When 3D stretch maps of the legging observed the hip line area is red for legging.

Regarding to these maps, it was observed that the necessary extensions should be made in the legging pattern along the sewing line in the hip, in the upper and lower calf and in the top pattern in the chest and skirt before the sample production. Also it was observed that the front waist line of legging pattern; the waist line and shoulder line on the top pattern should be narrowed.

4. CONCLUSIONS

3D technology as a new technology used in fashion industry allows the designer to virtually realize and display a garment even when it is not produced. In the same time virtual fit of garment models over 3D body models can be assessed, and changes can be done to improve the garment fit (Spahiu et al, 2014).

In this paper, two garments were produced by using 3D printing technology in garment industry. Optitex 2D & 3D Integrated Pattern Design Software was used for preparing patterns and evaluating garment simulation.

Analyzing the tension and stretch maps it was seen that the pattern must be correct by considering red and blue areas.

After evaluating samples, Zortrax M200 3D printer was used for creating the 3D scaled garments.

As a result of the study, it was found that 3D virtual dressing systems are especially useful in the evaluation of the body fit of the sample, and the 3D printer contributes to the concrete acquisition of the sample. Manufacturing 3D scaled samples does not reflect the real time and cost but it gives an insight of visual control and stage of 3D garment printing.

In the light of the study and literature research, it is seen that 3D virtual dressing software specializes in sample preparation and evaluation of body fit in a way to provide clearer and numerical outputs. In addition to the usability of 3D printer technologies in the pre-production preparation process, it is thought that the usage areas of these technologies will differentiate in the future. With the development of technology, it is envisaged that 3D printers can be used in fashion product designs to fully meet the personal characteristics and will pave the way for mass customization applications by providing significant advantages in production and delivery stages (Chong et al, 2015). With 3D printer technology, consumers will be able to design and produce in their homes instead of buying clothes or accessories of famous brands. Thus, consumers will be able to personalize their designs according to their body shapes, sizes and preferences (Perry, 2017).

The use of 3D technologies in apparel companies; speeds up the sample production process and eliminates some process steps especially in sample garment production. Thus, time, raw material and labor saving are occurred. In this way, competitive advantage is provided in apparel companies. 3D technologies are expected to play an important role in the future of clothing fashion.

Acknowledgments

This research is one of the outputs of TUBITAK project number 5150043.

REFERENCES

Berman B, 2012. "3-D printing: The new industrial revolution", Business Horizons, pp.55,155-162.

Chong S, Chiu HL, Liao YC, Hung ST, Pan GT, 2015. "Cradle to Cradle® Design for 3D Printing", Chemical Engineering Transactions, Vol.45, pp.1668-1674.

Fonda C, 2013, "A Practical Guide to Your First 3D Print" in, Canessa, E, Fonda C, Zennaro M, "Low-Cost 3D Printing for Science", Education&Sustainable Development. ICTP-The Abdus Salam International Centre for Theoretical Physics, p.202.

Kalva RS, 2015. “3D Printing–The Future of Manufacturing (The Next Industrial Revolution)”, International Journal of Innovations in Engineering and Technology, 5(1), pp.184-190.

Mahnic M, Petrak S, 2013. “Investigation of the Fit of Computer-based Parametric Garment Prototypes” , Journal of Fiber Bioengineering and Informatics, 6:1, pp.51-61.

Olaru S, Filipescu E, Niculescu C, Salistean A, 2012. “3D Fit Garment Simulation Based on 3D Body Scanner Anthropometric Data”, 2012 April, 8th International DAAAM Baltic Conference Industrial Engineering, Tallinn, Estonia.

Perry A, 2017. “3D-Printed Apparel And 3D-Printer: Exploring Advantages, Concerns, and Purchases”; International Journal of Fashion Design, Technology and Education, www.tandfonline.com/loi/tfdt20

Spahiu T, Piperi E, Grimmelsmann N, Ehrmann A, Shehi E, 2016. “3D Printing as a New Technology for Apparel Designing and Manufacturing”, 2016 November, Aachen Dresden Denkendorf International Textile Conference, Dresden.

Spahiu T, Shehi E, Piperi E, 2014. “Advanced CAD/CAM Systems for Garment Design and Simulation”, Conference: 6th International Conference of Textile, 2014 November, Tirana, Albania

Valtas A, Sun D, 2016. “3D Printing for Garments Production: An Exploratory Study”, Journal of Fashion Technology&Textile Engineering, 4:3

Zhong Y, Xu B, 2009. “Three-Dimensional Garment Dressing Simulation”, Textile Research Journal, Vol 79(9), pp.792–803.