sciendo

DOI: 10.2478/9788367405805-031

ICAMS
The International Conference on Advanced Materials and Systems

FABRIC DATABASE FOR E-LEARNING PLATFORM IN THE FIELD OF VIRTUAL CLOTHING PROTOTYPING

ION RĂZVAN RĂDULESCU[1], EMILIA VISILEANU[1], GEORGETA POPESCU[1], CRISTINA GROSU[1], SABINA OLARU[1], XIANYI ZENG[2], COSMIN COPOT[3]

[1]*The National Research and Development Institute for Textiles and Leather (INCDTP), 16 Lucretiu Patrascanu St., 030508, Bucharest, Romania, razvan.radulescu@incdtp.ro*

[2]*ENSAIT – France, xianyi.zeng@ensait.fr*

[3]*HOGENT – Belgium, cosmin.copot@hogent.be*

Virtual clothing prototyping generates numerous benefits within the professional clothing design process. In order to become a professional, students have to train and they need adequate learning instruments. There is a lack of open-source web applications for training of students in this domain. This paper presents an e-learning platform in the field of virtual clothing prototyping and a related learning material of a fabric database, required by the e-learning platform's algorithms. This e-learning platform for training purposes simulates the fit of a garment on a 3D human avatar in four steps: selection of the avatar, selection of the fabric, selection of the garment and style. All these elements are included in four databases, namely the fabric database, the garment database, the fashion database and the 3D human model database. In order to support training of higher education students with the e-learning platform, a curriculum of learning materials was prepared and structured in relation to these four databases. The learning material on the fabric database includes valuable aspects on digitalization of a real fabric, some basic properties as well as the selection mechanism of the e-learning platform. These learning materials were conceived by an European partnership in frame of the Erasmus+ project DigitalFashion (https://digitalfashionproject.eu/).

Keywords: training, students, professionals

INTRODUCTION

Digital fashion is a field of fashion that uses 3D technologies to simulate virtual garments or to reproduce digital models of physical products, thus becoming a major contributor to a global sustainable fashion industry, by promoting innovation, reducing waste and encouraging conscious consumption. Virtual prototyping is considered as one of the main solutions to address sustainability in the early stages of the product design process, thus being part of the widely *no-waste philosophy*. Designers, pattern makers and producers can all benefit from 3D virtual prototyping to reduce the amount of generated waste (Morandi and Tonelli, 2023; Zero Waste Europe, 2023).

Virtual prototyping has the origin in early 60', when Ivan Sutherland, a computer scientist from Massachusetts Institute of Technology (MIT), pioneered the first CAD system, named Sketchpad "to make possible for a man and a computer to converse rapidly through the medium of line drawings". Sketchpad allowed users with minimal computer knowledge to create and manipulate digital drawings using a light pen and a display screen. The first digital library was obtained, under tape form, with collected pictures for possible future use (Sutherland, 1963).

https://doi.org/10.2478/9788367405805-031

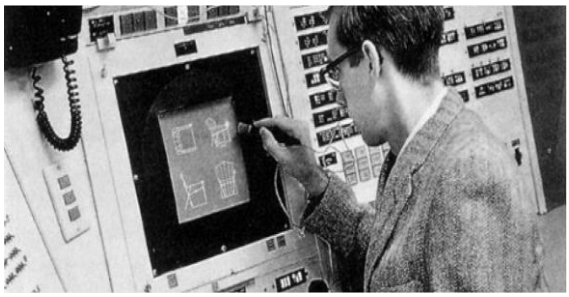

Figure 1. Sutherland using Sketchpad system (University of Minho)

Up to the present days, more and more sophisticated software solutions for 3D virtual prototyping of garments were developed. The three most powerful CAD/CAM software provider companies are: Prisma Tech, with its leading fashion software CLO, Lectra, with 50 years of industry experience and Abobe, the provider of Adobe Substance 3D toolset (Prisma Tech, Lectra, Adobe).

In a digital world, virtual prototyping represents a highly desirable work modality in the field of clothing design and is relevant for a large category of beneficiaries. Among the key beneficiaries are the higher education students, who need a series of simple and accessible digital learning instruments. Therefore, in the last few years, a series of e-learning instruments were developed in the frame of Erasmus+ projects, for correlated textile domains such as:

- Smart textiles prototypes and basic disciplines (Skills4Smartex project: http://www.skills4smartex.eu/)
- Software for design and modelling of fabric structures (OptimTex project: http://www.optimtex.eu/)
- Innovation in textile industry (Destex project: http://www.destexproject.eu/)

In order to meet the training challenges of students learning virtual prototyping of clothing, six European research and educational providers have joined expertise, for designing and implementing an e-learning platform in this domain. The e-learning platform is first of all a web application with free access on the Internet – it requires single registration (https://digitalfashiondleu.com/login). Other software solutions for virtual clothing prototyping, such as CLO 3D, Lectra Modaris or Adobe Substance 3D, are proprietary desktop applications and are quite cost-intensive. The e-learning platform of virtual prototyping developed in the frame of the Erasmus+ DigitalFashion project (www.digitalfashionproject.eu) is thus meant to meet the training needs of students in the clothing design domain.

Aside from students, the clothing industry is another major beneficiary of virtual prototyping. This advanced technology enables the development of digital garment models before physical production and fast customization according to customer preferences, thus minimizing material waste and enabling rapid design adjustments. Furthermore, factories can simulate production processes, enhancing workflow and machinery use, resulting in significant cost savings and enhanced productivity. Overall, the integration of virtual prototyping in textile manufacturing not only improves efficiency but also aligns with sustainability goals by minimizing resource consumption and waste. This is why the e-learning platform developed within the DigitalFashion project is also useful for introducing basic concepts of training for industry professionals.

The most important gain of e-learning is the technological advance reached through an interactive collaboration between higher education institutions, fashion industry specialists, software solutions suppliers and final clients which should become as “digitally compatible” as possible. To tackle this challenge, the higher education institutions have to permanently

collaborate with partners from industry and continuously incorporate into the curriculum, the digital tools used in the industry. This permanent interaction not only captivates students' curiosity and interest, but also facilitates better comprehension and knowledge retention, which will generate better employability competencies (Zhang, 2021; Conlon and Gallery, 2024; Niyogushimwa, 2023; Grosu *et al*., 2022).

THE PROJECT AND THE E-LEARNING PLATFORM

The Erasmus+ DigitalFashion project (Collaborative Online International Learning in Digital Fashion) is a Higher Education strategic partnership project for the period 2022-2025. INCDTP – Bucharest coordinates a prestigious European partnership of research and educational providers in the field of clothing design: ENSAIT – France, HOGENT – Belgium, University Maribor – Slovenia, CITEVE – Portugal and TUIASI – Romania. The project accomplished four project results (PR), which are already available on the project's website www.digitalfashionproject.eu:

PR1 – a new methodology for the clothing design training on European level, which underlined the need of virtual prototyping and 3D design, based on a survey with 35 participating clothing companies.

PR2 – four databases required for the algorithm structure of the e-learning platform: fabric database, garment database, fashion database and 3D human model database.

PR3 – the e-learning platform as web application, available at the URL: https://digitalfashiondleu.com/login

PR4 – the new curricula explaining the process of virtual prototyping based on the programmed e-learning platform – also available on the project website and on the Moodle platform www.advan2tex.eu/portal/.

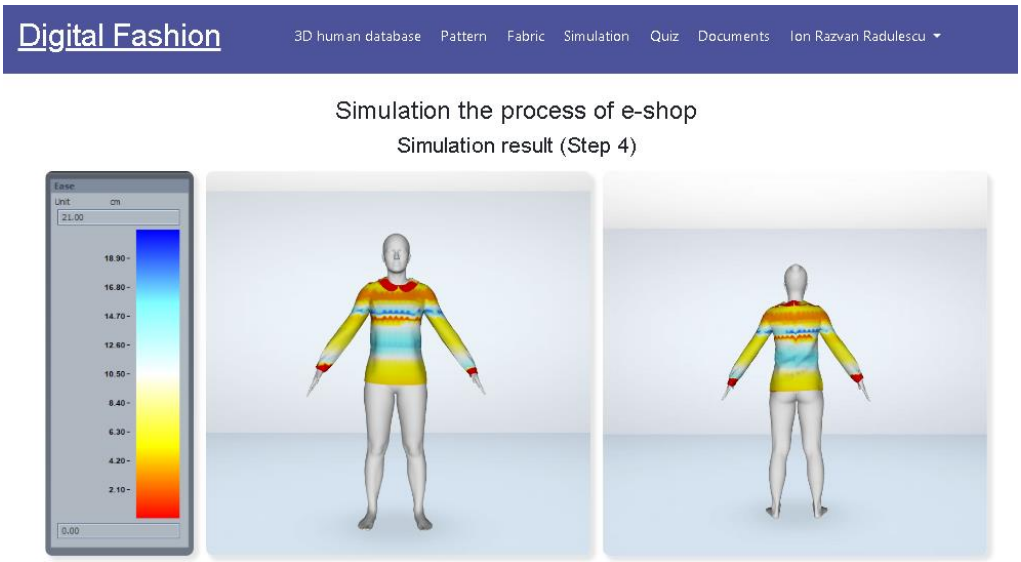

Figure 2. Print screen of the e-learning platform with simulation of the garment fit on 3D human model

The e-learning platform is programmed with algorithms that access four databases: a fabric database, a garment database, a fashion database and a 3D human model database. Figure 2 presents the fit of a blouse garment of a certain fabric on the 3D human avatar. Based on these databases a curriculum of learning materials presenting and explaining the process of virtual clothing prototyping was conceived.

FABRIC DIGITALIZATION PROCESS

The curriculum regarding the fabric database includes explanations related to fabric properties, real and digital (virtual) fabrics and transition from real to digital fabrics. The fabric database of this project consists in a structured and organized collection of types of fabrics, widely used in clothing industry and suitable for the garment models selected in the project. In the frame of the Digital Fashion Project, new representative physical samples of fabrics and garments have been collected from the project partners in order to construct a digital fabric database and then demonstrate the complete digitalization process to fashion designers. Creating a 3D digital garment requires inputs of the corresponding digital fabric properties. Digitalizing fabric technique is based on image processing and machine learning algorithm. In this project the draping image was taken using a Cusick Drape Tester, i.e. orthogonal projections of the drapes of textiles were taken using a digital camera. In addition, the drape coefficients (DC) and the number of nodes were calculated using Drape Analyser software.

From the point of user view, the prediction process for fabric technical parameters is realized by inserting the drape image of real fabric and exploiting a comprehensive digital fabric database implemented in the Lectra Modaris 3D Fit Software. The Lectra database is a large dataset of fabric properties, including the contour of fabric drape and associated drape features. The Lectra database includes 111 pictures of drape and for each digital fabric 23 properties (23 columns) are provided, including: Drape shape, Number of fabric, Average amplitude of drape, Average distance of drape, Maxim peak dimension, Minim valley dimension, Number of peaks, Weight, Commercial name or colour, Composition, Thickness, Armor, Warp/Weft Contexture, Weft Bending, Warp Bending, Drape coefficient, Nb folds, CisT, CisC, FlexT, FlexC, Color, and Patterns. One example is given in Figure 3.

Figure 3. Digitalized fabric result

THE FABRIC PROPERTIES

It is important to explore and understand the visual and mechanical properties of textile materials for an informed selection of fabric to achieve a specific look, texture, lines, and drape of the final product. By comprehending the properties of textile materials, designers can create aesthetically pleasing and functional products that meet consumers' needs and expectations. The fabrics in the database were characterized according to the following properties:

- material/ fabric composition, by their exact fibrous composition;
- material /fabric weight, in grams per square meter;
- drapability, the property of the fabric to form mobile folds under the action of its weight;
- fabric image, which shows colour, pattern, texture and finishing;
- fabric colour (according to Pantone Code/RGB code);
- construction – knitted or woven – and types of waves/knits;
- elasticity, on warp/wales - ability to stretch and then return to its original shape and size;
- thickness- the distance, in mm, between the two faces of the fabric, measured under a certain pressure;
- see through (yes/no) the propriety of the fabric to allow the passage of a ray of light;
- feel/touch (slippery, stiff, smooth, soft, little rough) a sensation when the material touches the skin.

The fabric database developed in the Digital Fashion project framework comprises a total of 49 real fabric samples (labelled F1-F49), categorized based on their intended garment use, namely Men's shirts, Men's trousers, Women's blouses, and Women's skirts. Their important fabric parameters related to the garment feel, comfort and fitting are described and the criteria for selecting a digital twin fabric (from the Lectra database) of the real fabric are outlined. Fabric database contains representative weaves and knits (Figures 4 and 5):

Code	Image	Composition (%)	Weight (gm^{-2})	Thickness (mm)
F1		100% cotton	200	0,38
F2		97% cotton, 3% elastane	115	0,22
F6		55% cotton + 45% cellofibre	103,3	0,228
F7		100% cotton	114,52	0,462
F8		100% cotton	138,54	0,292
F9		68% polyester, 29% viscose, 3% elastane	345	0,65

Figure 4.
Example of woven fabrics in the database

Code	Image	Composition (%)	Weight (gm^{-2})	Thickness (mm)
F3		100% cotton	145.8	0.48
F4		100 % cotton	210.2	0.467
F5		100 % cotton	163,86	0,674
F15		45% polyacrylonitrile, 55% ?Poly?	315,8	1,86
F45		78% polyamide, 22 elastane	238	0,536

Figure 5.
Examples of knitted fabrics in the database

THE FABRIC SELECTION ON THE E-LEARNING PLATFORM

By using the e-learning platform, users can select the real fabrics from the fabric database according to their demands. Appearance images, draping images, draping properties and mechanical properties of each fabric are provided to the user to facilitate selection of the appropriate fabric (Figure 4).

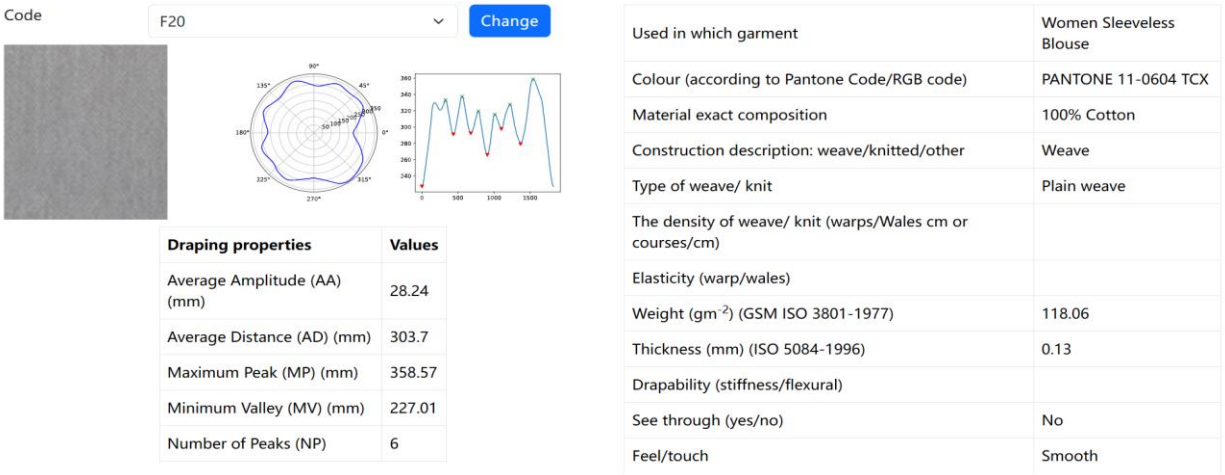

Figure 4. Fabric selection on the e-learning platform

The database includes fabric details such as raw material composition, fabric's specifications (e.g. weight, fabric identity, source and Lectra pairing number, fabric image, colour code), construction description (type of weave/knit, the density of weave/ knit, thickness, elasticity, bending and stiffness properties, visual references as transparency, drapability, feel and touch). After the user selects a real fabric, the system will recommend digital fabrics with similar performance to the user. This recommendation is based on intelligent algorithms. The idea is to cluster the existing digital fabrics (in Lectra database) into different clusters based on the similarity of their draping parameters to identify the group that is the closest to the real fabric (closest group).

CONCLUSIONS

This paper presents modern educational materials in the field of virtual clothing prototyping, meant to be used by students and professionals. The benefits of virtual garment prototyping are undeniable, while our training solution is a free web application. The educational materials developed within the Erasmus+ project DigitalFashion are going to be presented to professionals within multiplier events and to high school students within workshops. The module "Fabric database" aims to develop specific competencies related to fabric knowledge, fabric construction, and the properties of both real and digital fabrics. The entire learning material is available at URL: https://digitalfashionproject.eu/?page_id=2489.

Acknowledgement

The Erasmus+ DigitalFashion project (2021-1-RO01-KA220-HED-000031150) was funded with support from the European Commission.

REFERENCES

Adobe. *Adobe Substance 3D*. Retrieved from: https://www.adobe.com/ [Accessed May 2024].

Conlon, J. & Gallery, C. (2024). Developing Digital Skills: A Fashion Business Masterclass in Virtual 3D Prototyping with Style 3D. *International Journal of Fashion Design, Technology and Education*, 17(1), 76-85. https://doi.org/10.1080/17543266.2023.2247425

Erasmus+ Project *Destex – Advanced Textile Design Hackathons*. Retrieved from: https://destexproject.eu [Accessed May 2024]

Erasmus+ Project *OptimTex – Software Tools for Textile Creatives*. Retrieved from: http://www.optimtex.eu/ [Accessed May 2024]

Erasmus+ Project *Skills4Smartex – Smart Textiles for STEM Training*. Retrieved from: http://www.skills4smartex.eu/ [Accessed on May 2024]

Grosu, C., Rădulescu, I.R., Visileanu, E., Ionescu, I., Avadanei, M., Olaru, S., Zeng, X., Odhiambo, S., Cardoso, A. & Rudolf, A. (2022). Analysis of the Learning Requirements of Less Advantaged Groups on the Romanian Level. *Proceedings of the 9th International Conference on Advanced Materials and Systems (ICAMS 2022)*, pp. 531-536, https://doi.org/10.24264/icams-2022.VI.2

Lectra, *Lectra Fashion*, Retrieved from: https://www.lectra.com/ [Accessed May 2024]

Morandi, A. & Tonelli, C. (2023). The Impact of 3D Technology on Sustainability in Fashion Luxury Product Design: Evidences from an Exploratory Analysis. Master's Thesis, Scuola di Ingegneria Industriale e dell'Informazione, Milano

Niyogushimwa, J. (2023). The Importance of eLearning: Revolutionizing Education in the Digital Age. Retrieved from: https://elearningindustry.com/

Prisma Tech. *CLO*. Retrieved from: https://www.prisma-tech.it/ [Accessed May 2024]

Sutherland, I.E. (1963). Sketchpad, a Man-Machine Graphical Communication System. In: AFIPS '63 (Spring): Proceedings of the May 21-23, 1963, Spring Joint Computer Conference. Massachusetts Institute of Technology. https://doi.org/10.1145/1461551.1461591

University of Minho. The Very Beginning of the Digital Representation – Ivan Sutherland Sketchpad. Retrieved from: https://bimaplus.org/ [Accessed May 2024]

Zero Waste Europe (2023). A Zero Waste Vision for Fashion – Chapter 1: All We Need Is Less. Retrieved from: https://zerowasteeurope.eu/

Zhang, P. (2021). Understanding Digital Learning Behaviors: Moderating Roles of Goal Setting Behavior and Social Pressure in Large-Scale Open Online Courses. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.783610