

Personal space between physical and virtual

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Professional paper**

The fashion and textile industry has long been influenced by digitalisation. Digital tools offer innovative and sustainable approaches, with virtual prototyping reducing work processes. Fashion brands are increasingly utilising digital fashion, virtual reality and 3D animation for storytelling and collection presentation, engaging audiences through interactive experiences such as virtual shows. Digital tools are also improving personalisation in fashion industry, with virtual try-ons and augmented reality allowing customers to view garments before they buy. The next generations, who are more familiar with the digital world, are expected to make further progress, with education playing a key role in developing digital skills. Since 2022, the The Chair of Textile and Clothing Design at the University of Ljubljana has been participating in the Erasmus+ Me-You-Us project, a three-year collaboration with Designskolen Kolding (DK) and Willem de Kooning Academy (NL). The project aims to develop nine open-access educational modules on digital 3D skills in textile and clothing design, focussing on diversity, inclusion and sustainability. In the first year, the University of Ljubljana explored the synergy between manual and digital design and developed the module "Personal space between physical and virtual". The students used CLO3D to develop digital collections and physical garments, bridging the gap between virtual and real fashion.

Keywords: fashion and textile design; digital design; education; virtual prototyping; synergy between manual and digital design

Stručni rad**

Modna i tekstilna industrija dugo su pod utjecajem digitalizacije. Digitalni alati nude inovativne i održive pristupe, a virtualna izrada prototipova smanjuje radne procese. Modni brendovi sve više koriste digitalnu modu, virtualnu stvarnost i 3D animaciju za pripovijedanje i predstavljanje kolekcija, angažirajući publiku kroz interaktivna iskustva poput virtualnih revija. Digitalni alati također poboljšavaju personalizaciju u modnoj industriji, a virtualna isprobavanja i proširena stvarnost omogućuju kupcima da pregledaju odjeću prije kupnje. Očekuje se da će sljedeće generacije, koje su bolje upoznate s digitalnim svijetom, ostvariti daljnji napredak, a obrazovanje će igrati ključnu ulogu u razvoju digitalnih vještina. Od 2022. godine The Chair of Textile and Clothing Design na University of Ljubljana sudjeluje u projektu Erasmus+ Me-You-Us, trogodišnjoj suradnji s Designskolen Kolding (DK) i Willem de Kooning Academy (NL). Cilj projekta je razvoj devet obrazovnih modula otvorenog pristupa o digitalnim 3D vještinama u dizajnu tekstila i odjeće, s naglaskom na raznolikost, uključivost i održivost. U prvoj godini, University of Ljubljana istražilo je sinergiju između ručnog i digitalnog dizajna i razvilo modul „Osobni prostor između fizičkog i virtualnog“. Studenti su koristili CLO3D za razvoj digitalnih kolekcija i fizičkih odjevnih predmeta, premošćujući jaz između virtualne i stvarne mode.

Ključne riječi: modni i tekstilni dizajn; digitalni dizajn; obrazovanje; virtualna izrada prototipa; sinergija između ručnog i digitalnog dizajna

1. Introduction

Creative fashion practise has traditionally been strongly associated with specialised craft processes, materiality and skills that have relied on tactility and principles of learning by doing. However, contemporary methods of fashion design and production increasingly rely on digital ways of working. This shift involves the use of tools and technologies to enable innovative developments in the design and production of clothing. Recent technological advances are therefore blurring the lines between physical and digital practises in the fashion industry [1]. The increasing digitalisation of fashion design and production processes paved the way for the development of digital fashion, as technological advances enabled designers to create and market clothing entirely in the digital world. Digital fashion thus emerged as a response to the growing need for innovative, sustainable, and virtual self-expression in an increasingly digitalised world. There are numerous interpretations and definitions of digital fashion and the terms associated with it. The term "digital fashion" entered the fashion industry at the beginning of the 21st century [2].

The fashion industry has always been interested in technology, but a pandemic has made the need for digital design even more urgent. Brands have been forced to quickly adopt technologies that allow them to continue operating despite challenges such as shipping restrictions and limited physical interactions. Digital design is replacing traditional methods with software that allows designers to create and modify designs without physical production. The properties of fabrics are measured and digitally recreated, while avatars serve as fit models and show how the clothes will fit in real life. This digital approach also allows designers to test and experiment with materials and prints and create virtual collections. The introduction of a digital supply chain is seen as a strategy to reduce waste and increase production speed. This is a double benefit for companies looking to become more sustainable and reduce costs at the same time. Digital design is therefore becoming a key tool for the industry, allowing brands to create items quickly and remotely. Once created, 3D assets - realistic virtual objects - can be used in various scenarios, from marketing materials and virtual showrooms to enhancing e-commerce sites for customers and augmented reality experiences [3].

1.1. Sustainable and commercial benefits of digital fashion

The fashion industry is witnessing a widespread adoption of 3D design and virtual sampling, with

brands, including those in footwear and luxury, leveraging these technologies to accelerate processes, cut costs, and enhance sustainability. This shift is part of a broader digital transformation within the industry. The use of 3D design and virtual sampling has increased significantly in recent years, with brands like Macy's, Hugo Boss, and Adidas incorporating digital prototypes into their development processes. The technology has proven to be particularly successful in categories like footwear, where it helps eliminate the need for producing physical samples for every design iteration. Despite its growing popularity, the technology has not completely replaced physical samples, especially in luxury fashion where the tactile experience of materials on a real body is crucial.

In addition, some companies use virtual reality in the design process to gain a better understanding of product dimensions. The use of 3D assets in marketing and e-commerce is also on the rise, with brands considering adapting these assets for virtual environments and virtual try-ons [4]. Recent advances in augmented reality (AR) technology for trying on clothes are making them more realistic and accessible. Given the rapid pace of development, experts expect benefits for fashion brands, such as an increase in digital sales of clothing, higher conversion rates and fewer returns in e-commerce. With AR clothing try-on, digital clothing appears automatically and in real time on a person, primarily via smartphones, but also on laptops and other devices [5]. Despite the positive aspects, there are challenges, including the need for training and a cultural change in companies to fully integrate these technologies into their processes.

Fashion schools are also gradually incorporating 3D into their curricula, but the skills are still in short supply among designers. Companies introducing 3D design have had positive experiences: they have attracted new talent and realised significant time and cost savings [4].

1.2. Digital design in fashion education

Current studies on textiles and garments integrated with digital technology are not only concerned with technical aspects, but also emphasise their potential for aesthetic expression and playful experimentation. Teaching digital design in higher education institutions (HEI) goes beyond imparting technical skills and knowledge; it also plays a crucial role in fostering students' creativity. In the field of fashion, it is about cultivating innovative approaches to overcoming technical obstacles - an area where virtual prototyping proves invaluable. Furthermore, the use of virtual prototyping software also encourages imaginative

visual solutions and aesthetics. The creative potential extends to various image and design applications and offers students a wide range of opportunities to develop innovative solutions. In fashion education, digital design serves as a dynamic platform for students to explore new technologies, encourage a forward-thinking mindset and drive innovation in line with industry trends.

Higher education institutions play an important role in disseminating and raising awareness of sustainable development in fashion. In this context, it is important to emphasise digital technologies. The study by D'Itria and Vacca explores the overlap between fashion design education and sustainability and shows a strong link with digital media. The synergy between sustainability and digital innovation in higher education revolves around holistic practises, technology integration, interdisciplinary approaches and the promotion of transformative education models [6]. Transformative education, which is becoming increasingly important, promotes the change of ingrained ways of thinking and behaviour. This approach challenges individuals to rethink their existence and collectively question moral values for the benefit of our interconnected society. By encouraging us to reassess our impact, this transformative education aims to contribute to the creation of a more sustainable society [7]. In discussions that call for a re-evaluation of assumptions and values and the promotion of critical thinking and new creativity, the concept of transformative learning is therefore becoming increasingly important. It is the responsibility of higher education institutions to think ahead and rethink their approach in order to move towards transformative, socially engaged and future-orientated models of teaching and learning. These models should promote positive personal and social development [8].

In terms of the use of digital tools, HEI are increasingly integrating 3D software into their curricula to prepare students for the evolving demands of the fashion industry. The integration of 3D design tools aims to provide students with the essential skills for the digital future of fashion. In addition to 3D software, these institutions take a comprehensive approach to preparing students for the industry. The programmes cover a wide range of skills that include traditional techniques such as pattern cutting by hand as well as modern digital skills such as 3D printing, laser cutting and body scanning. Some institutions go further and offer specialised programmes that cover the entire fashion industry value chain, including material design, marketing and virtualisation.

Furthermore, the need to expose students to broader technological aspects is recognised, as seen in MBA programmes that include elements such as programming and artificial intelligence. This approach recognises the increasing importance of diverse skills that combine traditional craftsmanship with cutting-edge digital competencies to succeed in the modern fashion world [9].

2. Erasmus+ project Me-You-Us

The Chair of Textile and Fashion Design at the Faculty of Natural Sciences and Engineering, University of Ljubljana has been participating in the international Erasmus+ project Me-You-Us since September 2022. The project is a collaboration between three HEIs: Design School Kolding from Denmark, Willem de Kooning Academy from the Netherlands and the University of Ljubljana from Slovenia. At the heart of the project initiative is the realisation that digital tools offer a crucial opportunity to promote transformative change in fashion and textile design practise. It is strongly believed that digital technology can serve as a starting point for a more sustainable future in fashion. The methodology is based on improving existing teaching practices within HEIs.

By thoughtfully integrating digital tools into education, we aim to equip fashion educators and students with the knowledge and skills essential to adopting sustainable practises and promoting inclusion and diversity in the industry. The overarching goal is to develop nine course modules that demonstrate the effective use of digital tools and technologies, including 3D virtual prototyping, body scanning, artificial intelligence (AI), virtual reality (VR) and augmented reality (AR), specifically tailored to promote sustainable design in the context of artistic fashion education. The results of our three-year collaboration will consist of online resources tailored for fashion educators and students. These resources will include video tutorials, downloadable and printable teaching materials and clear descriptions of course modules, a library of examples of student work, articles and learning and teaching tools.

2.1. Introduction to Virtual Prototyping: Personal Space within Physical and Virtual

The Chair of Textile and Fashion Design at the University of Ljubljana is developing three modules. The first module ME: Personal Space within Physical and Virtual, which emphasises the synergy between

conventional and digital approaches in textile and clothing design, was completed at the end of May 2023. The name "ME" sums up the core of this initiative and symbolises the empowerment of students in the context of complex digital transformation. This empowerment is inextricably linked to the values of inclusivity, diversity and sustainability, which serve as fundamental principles for the project. The first module promotes the digital transformation of the design process. In testing the module, four subjects (Fashion Design, Textile Design, Digital Design and Garment Pattern Development) were brought together and practised with first year textile and fashion design students. It was taught by five mentors and three technical assistants, each with specific expertise. The students learnt new skills in using digital tools to develop their creativity and create sustainable projects. Using CLO3D software, they learned about digital pattern creation, digital product development, 3D visualisation and exporting 2D patterns for physical garment production. The module took students through the process of developing a virtual garment inspired by an A-line dress.

They learnt four different techniques to add volume to a dress and were encouraged to be creative with their newly acquired skills. The students learnt how to create their own print and use its repeat in the virtual garment. The process began and ended manually to better understand the benefits of digital technology. The module demonstrated the sustainable side of digital garment development with less waste of time and materials and consists of six key milestones where manual and digital processes seamlessly merge. Starting with 'Manual Pattern Development', where students learnt the techniques of manual pattern making, they created five 1:4 scale models (Fig.1).

In the transition to the digital sphere, steps two to five focused on digital design principles. In Step 2 they worked on digitally prepared prints and embroidery (Fig.2) and in Step 3 they learnt about CLO3D. In Step 4 'Digital pattern cutting' the students learnt the same techniques they had created in Step 1 (manually). This time, however, in a virtual environment with CLO3D. In Step 5, the students were asked to work with different virtual materials and apply their



Fig.1 Adding volume on patterns in the scale 1:4 - teaching material. *Photo: Uroš Batič.*



Fig.2 Digitally added and deformed stripe patterns on garments created at 1:4 scale. *Author: Julija Potočnik*

embroidery and prints (Fig.3). Our associated partner TRONOG played an important role in this step by providing the professionally scanned textile materials. The final step is a combination of manual and digital work, where students learnt how to prepare

virtual garments that were then printed and produced in the physical world. The result was digital collections and physically produced garments that represent a close connection between the real and virtual worlds (Fig.4).



Fig.3 CLO3D visualisation of the garments, experimenting with prints. *Authors: Tara Urbanč, Eva Strnad, Zala Marolt and Taja Sejdić.*



Fig.4 Top row – CLO3D visualisation of the garment, bottom row – physical garment. *Photo: Marijo Županov. Model: Maja Gazvoda. Authors: Larisa Gregor, Urban Dereani, Ema Cestnik and Ida Križnič.*

The teaching method included: presentations ('Digital fashion industry', 'History of the A-line dress', 'The A-line dress in Slovenian textile and clothing heritage'), seminars ('Prints and stripes as an artistic element'), tutoring (refreshing manual pattern cutting techniques), teaching (step-by-step digital pattern cutting and virtual sampling), self-study (creative exploration of digital tools, teamwork and discussion among peers), analysis (final virtual and physical garment). Students worked in groups of two and four, which led to a significant learning effect as they supported each other in discussions. The entire module is presented through teaching materials: screen recordings, videos, PDFs, tutorials, manuals, etc. on the website: me-you-us.education.

3. Conclusion

Students used CLO3D to learn different ways of digitally manipulating patterns, virtual sampling, 3D design, digital product development and exporting digital patterns for physical garment assembly. Sustainability was a recurring theme, sensitising students to its relevance and showing them how digital tools contribute to greener design. The aim of the module was to explore the synergy between manual and digital and to understand the process of product development. By giving students the opportunity to design virtual clothing using digital technologies, the goal was to promote innovation and sustainability in the fashion industry. The focus was on bridging the gap between virtual and physical garment production. The module effectively integrated theory and practise by combining theoretical discussions with practical activities such as virtual prototyping, pattern making and sewing. This integration deepened students' understanding, enabled them to apply their knowledge in practise, empowered them to critically analyse the fashion industry and promote innovation, democratic design and new business models. The module fostered students' critical thinking by encouraging them to question digitalisation, sustainability and inclusivity in the fashion industry. This critical perspective leads to the development of analytical skills and a deeper understanding of the subject matter.

In summary, the module and outcomes represent a significant step forward in fashion education as they address the needs of the industry and prepare students for the digital future of the industry. The success of the module is reflected in the performance of students achieving their learning objectives and increasing their creativity through virtual prototyping.

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