Digital technologies in the creative sector - design and development of clothing for the gaming industry

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Professional paper**

The paper presents the creative development process of designing and shaping a 3D digital original character, based on a previously developed video game concept. It focuses on the possibilities of digital sculpting and modeling, with the 3D model created using a parametric body model from a CAD system for clothing design. The study explores the compatibility and integration potential of various CAD programs in the design and digital development of costumes for the selected character. Accessories were also modeled in 3D using digital sculpting software. All development steps were carried out in a digital environment, where patterns were analyzed and refined in CAD tools until the desired outcome was achieved. This approach represents a significant advancement compared to traditional clothing modeling for game characters and opens new possibilities for integrating clothing engineering with this rapidly growing and innovative industry.

Keywords: *CAD systems; digital design; virtual clothing; gaming industry; sustainable design*

Stručni rad**

Rad prikazuje kreativni razvojni proces dizajna i oblikovanja 3D digitalnog autorskog lika, temeljenog na prethodno razvijenom konceptu računalne igre. U fokusu su mogućnosti digitalnog kiparenja i modeliranja, pri čemu je za izradu 3D modela korišten parametarski model tijela iz CAD sustava za projektiranje odjeće. Istražena je kompatibilnost i mogućnost integracije različitih CAD programa u svrhu dizajna i računalnog projektiranja kostima za odabrani lik. Također je izrađeno 3D modeliranje dodataka pomoću softvera za digitalno kiparenje. Svi razvojni koraci odvijali su se unutar digitalnog okruženja, gdje su krojevi analizirani i usavršavani u CAD alatima do postizanja optimalnog rezultata. Ovakav pristup predstavlja značajan iskorak u odnosu na tradicionalno modeliranje odjeće za likove u industriji video igara te otvara nove mogućnosti povezivanja odjevnog inženjerstva s ovom brzo rastućom i inovativnom industrijom.

Ključne riječi: *CAD sustavi; digitalni dizajn; virtualna odjeća; industrija video igara; održivi dizajn*

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1. Introduction

The intensive and constant development of digital technologies in the last decade has gradually led to changes in all areas of human work, significantly improving or completely replacing numerous processes and traditional work methods with automated, digitally driven systems [1,2]. The development segment of many industries has undergone a major transformation, as traditional techniques and methods of designing, projecting, and developing products have been replaced by specialized CAD systems and programs, becoming entirely digitalized [3,4]. Within the creative industries sector, the video game industry stands out, being entirely based on digital technologies and having grown into a leading industry within the media sector as a whole [5]. In 2020, the industry generated $159.3 billion in revenue, with the number of video game users reaching 2.69 billion players [6]. Additionally, mobile gaming serves as a driving force in the video game industry and is expected to further accelerate market growth [7]. Recent preliminary data show that the Croatian video game industry generates an annual income of more than EUR 66.66 million, with further growth anticipated due to continuous development and an increasing number of users [8]. The development and application of various input and output devices as enhancements to game consoles and computers enable users to experience greater realism of characters and virtual worlds or environments in video games. The use of head-mounted display (HMD) devices is becoming increasingly common [9]. These devices are part of a complete VR (virtual reality) set, which includes additional components that provide users with a comprehensive experience of the virtual world where the game action takes place. These devices often have built-in motion sensors to detect direction and movement, as well as speakers [10]. This intensive technological development places additional expectations on video game development teams, as users demand that characters in virtual environments be as realistic as possible and that their clothing corresponds to the physical properties of the real world [11]. The current level of development does not meet these expectations, as clothing on virtual characters is still created using principles of computer 3D modeling [12]. This clothing does not properly adapt to the character's body and is not yet connected to the accurate development of simulated clothing cuts and textile materials. This area presents opportunities for intensified interdisciplinary research, enabling the connection of clothing engineering and computer-aided clothing development with video game development teams. The goal of the research presented in this paper is to explore the possibilities of character development for a computer game based on the author's story [13] and the development of digital clothing and accessories for the character. The study investigates the possibilities and compatibility of several different computer 2D and 3D programs, as well as a specialized CAD system for clothing design [14], in the context of the complete development process.

2. Digital tools for computer design, 3D modeling and clothing design

When discussing digital tools for computer design, it is essential to consider the various design segments through which we aim to develop the design, as well as the end result we want to achieve. CAD (Computer-Aided Design) programs can be used for graphic design of clothes. Examples include Adobe Illustrator, which is used for vector drawings, and Adobe Photoshop, which has evolved into a tool for digital photo editing and creating and finishing graphic illustrations. For the needs of 3D design and shaping of 3D objects or models, such as creating a 3D model of the human body, the ZBrush program can be used. This program enables the independent creation of realistic models from simple geometric shapes and detailed editing of models using various tools that faithfully simulate traditional three-dimensional design techniques from different materials and work with brushes. Specialized CAD systems are employed for the process of computer-aided pattern development and the complete design and simulation of 3D models of garments [15]. The entire development process is carried out through a series of interconnected compatible programs. Most computer-aided design programs allow compatibility with other programs due to the various document formats that can be read or stored in those programs. However, specialized CAD systems intended for clothing design are not always fully open to connection and data exchange with other programs or CAD systems from different manufacturers. In some cases, data can be exchanged using additional programs for converting data from one format to another, while in other cases, it is not possible to use data generated in one program on other systems or programs. In the experimental part of this work, CAD programs such as Adobe Photoshop were used for the graphic design of the author's character and clothes, ZBrush for designing the character for the computer game and modeling accessories, and Optitex for designing clothes.

For the successful installation and stable operation of the mentioned computer programs, a powerful computer configuration is necessary, particularly

regarding the processor, working memory, graphics card, and computer peripherals. Expanding the standard configuration of a personal computer with a graphic tablet can significantly facilitate work within design program interfaces, simulating the traditional way of drawing on paper while providing much greater freedom of creative expression when creating the desired design.

3. Experimental part

To carry out the experimental part of the work, a computer with the following configuration was used: Intel Core i7 13700KF, 3.4 GHz / 5.4 GHz, 16-core processor; GIGABYTE GeForce RTX 3060 Eagle 2.0 graphics card, 12GB GDDR6; 32GB KINGSTON Fury Beast DDR4 3200MHz working memory. The MOUNTAIN Everest Core TKL mechanical keyboard was used as a computer peripheral, along with the WHITE SHARK Azarah GM-5003 computer mouse (6400 dpi, optical, wired), Wacom Intuos tablet, and 27" SAMSUNG LF27T350FHRXEN monitor (IPS, 5 ms, 250 cd/m^2, 1,000:1).

In the following sections of the paper, the segments of the conducted research on the development of the author's character as an avatar for a video game, along with digital clothing and accessories created using the aforementioned computer equipment and programs, are described and presented.

3.1. Digital creation of avatars and clothing for a video game in a graphic design program

The inspiration for designing and digitally developing the avatar for the video game came from the author's story, which served as the basis for the game's concept [13]. The story was influenced by the study of myths about elves, which have appeared in various forms throughout the history of video games and in mythological lore [16]. Fig.1 illustrates the creative process of character and clothing design for an individual avatar in video games.

The concept drawing of the character was created using Photoshop, starting with initial research of body movements and modeling the character in various dynamic positions (Fig.1a). This was followed by selecting a model and exploring different possibilities for skin coloring and shading (Fig.1b and 1c). The digital drawing of the character served as the foundation for designing clothes that would further define the character. The initial step in creating the clothes involved designing the cut model on the body model, followed by presenting different color combinations (Fig.1d).

The basic colors of the garment and the additional texture of the material were then determined (Fig.1e). To complete the graphic design of the character with the created clothes, partial reshaping of the character's head and the creation of head accessories were performed.

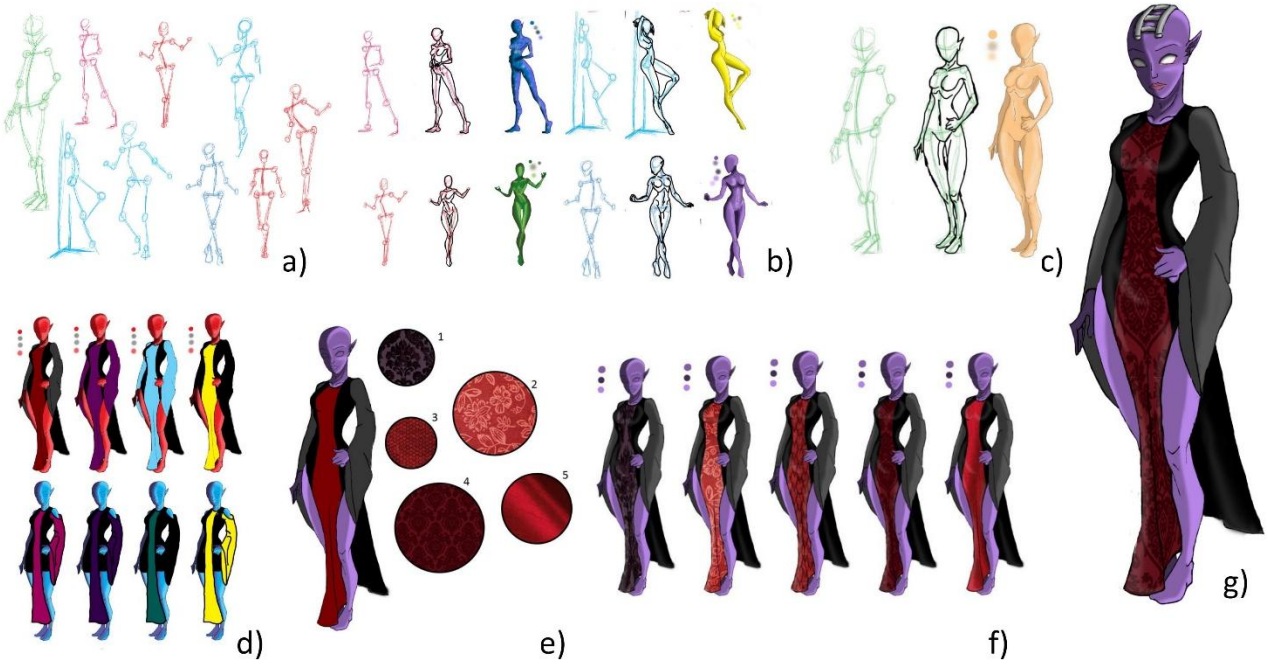

Fig.1. Concept development for character and clothing design for the needs of an individual avatar in video games

Additional realism and three-dimensionality were achieved using tools for working with lights and shadows (Fig.1f). The finished character in the graphic program (Fig.1g) serves as the basis for further development into a virtual three-dimensional avatar and the design of clothes and accessories, as described in the following sections.

3.2. Development of a computer 3D model of a garment

The development of the clothing model for the created character involves a complete computer design process using a specialized 2D/3D CAD system. This system includes programs for constructing and developing patterns and 3D simulations of clothing items, enabling better integration between design, garment construction, textile material selection, and, to some extent, the technical preparation for garment production when applied in industrial settings. This methodology allows for the simultaneous development of a 3D model of a garment for a video game character and the potential real-world production of the garment in full size. In this way, a video game can serve as a medium for promoting digital clothing before its actual production, tailored to the preferences of potential customers. This approach ensures that real production occurs only for garments with confirmed buyers, significantly reducing unnecessary clothing production and positively impacting environmental pollution.

Computer-aided clothing design enables the simulation of joining two-dimensional tailoring parts and realistically displays virtual clothing on a three-dimensional computer model of the body with specific anthropometric characteristics.

This approach allows for:

– Realistic visualization and analysis of the garment model design before creating an actual sample.
– Analysis of the accuracy and precision of the construction and modeling of the garment pattern.
– Assessment of the fit of the garment pattern on a 3D computer model of the body, adjusted to the selected clothing size (Fig.2a).
– Evaluation of the desired 3D form of the garment model considering the selection of textile materials with varying physical and mechanical characteristics.
– Analysis of the movement, stress, and stretching of the simulated 3D garment model on the 3D body model.
– Functional assessment of the model.
– Fit and appropriateness analysis of a specific model design on different body types and sizes.
– Examination of the garment model in terms of color, texture, decorative seams, details, etc. (Fig.2b).
– Complexity analysis of the garment model, serving as a starting point for creating a technological operations plan for garment sewing.

A computer model of clothing for a video game character is developed and analyzed following these steps and is stored in a standard record format for 3D objects in CAD programs. This allows the model to be implemented in a 3D sculpting and modeling program for further refinement to meet the needs of the video game character (Fig.2c).

3.3. Shaping body models and accessories in a digital sculpting program

Next, the possibility of digital modeling and additional shaping of parts of the parametric body model, typically used in a specialized CAD system for clothing design, was investigated. Considering the design of a character created for an individual avatar in video games (Fig.1), a parametric body model was loaded into a digital sculpting program to explore

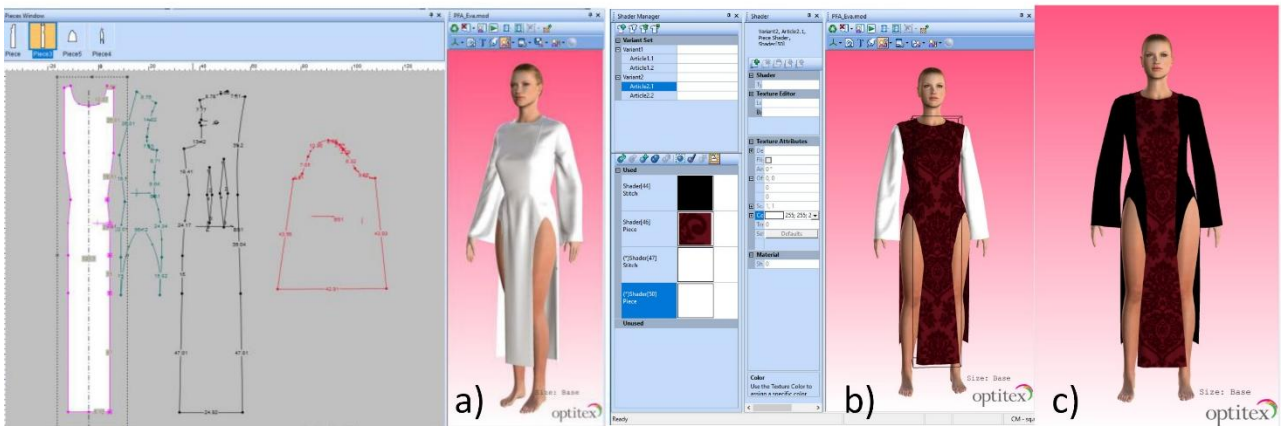

Fig.2. Computer 2D/3D design of garment models

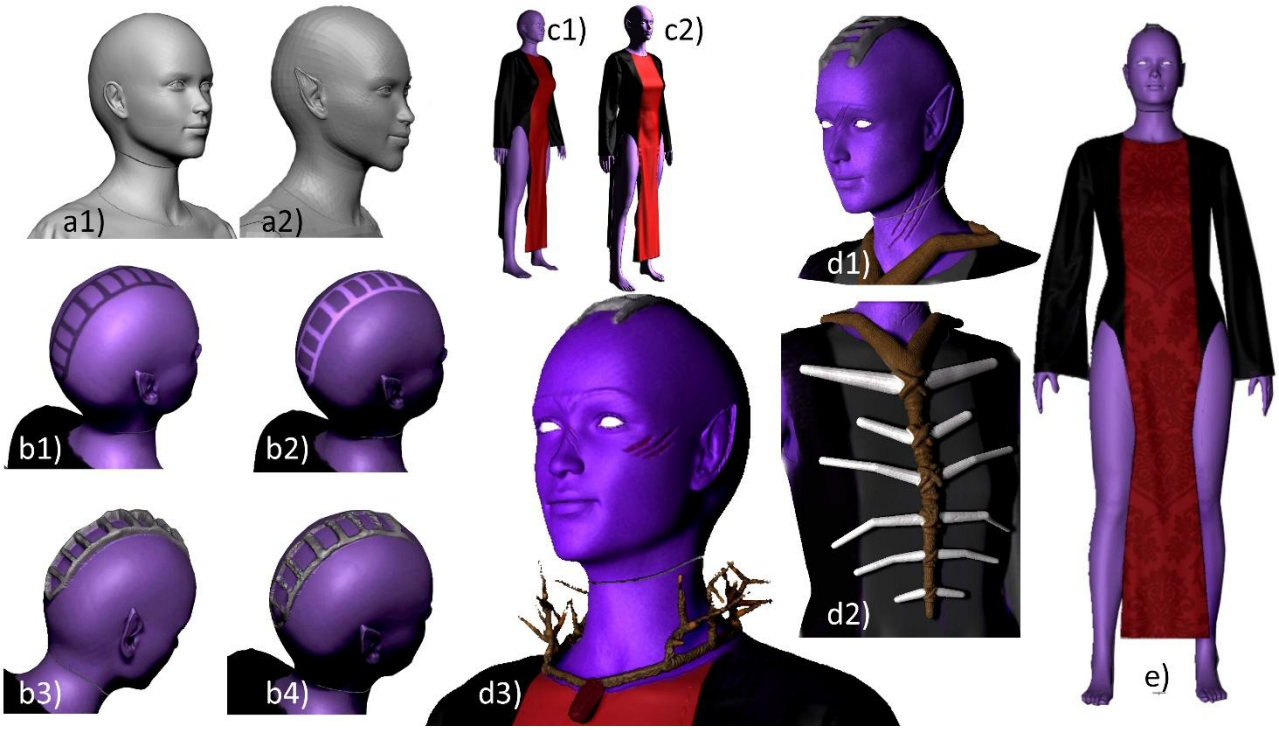

Fig.3. Shaping of body models and 3D modeling of accessories in the Zbrush program

targeted reshaping of the head using 3D object shaping tools. The goal was to transform the human body model into an elf body model, following the story concept . The reshaping of the surface mesh in the ear area was performed using a tool for extracting parts of the surface to achieve a pointed shape, characteristic of the designed figure (Fig.3a1 and a2). According to the story concept, one feature of the elf character is a metal crown on the model's head, symbolizing a certain social status. Using the marking tool, a part of the head was selected, and 3D modeling of the crown was performed in further steps using program tools (Fig. 3b1-b4). The crown detail was modeled directly on the model, forming a unique unit with the body model (Fig. 3d1). In contrast, the necklace and corset details (Fig. 3d2 and d3) were modeled and shaped as separate objects and then added to the model. Separate details can be stored as individual 3D objects and added to other models as needed. However, while the parametric body model was successfully loaded from the Optitex CAD system into ZBrush, and body segment modeling was successful, there was a need for additional processing of textures on the model, indicating that the programs are not fully compatible in this aspect (Fig.3e).

4. Results

Based on the research conducted on the possibility of integrating different CAD programs and a specialized CAD system for clothing design in developing a digital avatar, clothing, and accessories for a video game, results were achieved across all research segments. Using the Optitex CAD system, a 3D model of the garment was designed for the character model in the video game. Simultaneously, the garment was digitally developed and prepared for the real manufacturing process. Utilizing a digital sculpting and shaping program, the body model segments and accessories that complete the character were successfully reshaped. Through digital processing, all elements were integrated into a cohesive whole, connecting the avatar's body with the designed garment and modeled accessories. This integrated model can be implemented in the video game concept and, if necessary, on a platform for digital clothing promotion. Fig. 4 illustrates a 3D avatar with applied clothes and accessories, developed for implementation in a video game.

5. Conclusion

Exploring the possibilities of digital technologies in the design and development of clothing for creative industries, such as film and video games, allows designers to harness and develop their creative potential using digital tools while applying professional knowledge and skills. The intensive and continuous advancements in computer technologies, computer graphics, application development, and

Fig.4. An avatar developed for a video game with applied digital clothing in a virtual environment

video games place increasing demands on users for education. Simultaneously, these advancements enhance user experiences at various service levels and offer new technology applications, with augmented and virtual reality representing future development trends in different areas. In this context, the video game industry stands out as particularly dynamic, with further growth expected in this economically significant sector. The trend of virtualizing clothing for the video game industry provides an opportunity to link clothing engineering with the development teams of video game companies.

Traditionally, character development in video games and 3D films has been based on a concept where clothing was an integral part of the character but lacked realism. New development trends in this area necessitate complementing character development with separate digital clothing development, where CAD systems for clothing design, typically used in real clothing production, can be applied. In the future, digital platforms and video games could become mediums for promoting and selling clothing collections, replacing traditional methods of clothing promotion and sales. Given that the presented clothing development concept relies on digital resources, it can be considered highly positive from a sustainability and environmental impact perspective. It eliminates the consumption of energy and materials and the waste generated by producing excessive amounts of clothing on a global scale, promoting production based on customer requirements.

R e f e r e n c e s :

[1] Pal, R.; Jayarathne, A. Digitalization in the textiles and clothing sector. In The Digital Supply Chain; L. MacCarthy, B., Ivanov, D., Eds.; Elsevier, 2022; pp. 255-271, ISBN 978-032-391-614-1. https://doi.org/10.1016/B978-0-323-91614-1.00015-0

[2] Banerjee, T.; Kumar, S. Transformation in Textile & Apparel: Leveraging Martech Strategies within Industry 4.0. J Inform Educ Res 2024, 4, 2057–2068, https://doi.org/10.52783/jier.v4i3.1552.

[3] Akhtar, W.H.; Watanabe, C.; Tou, Y.; Neittaanmäki, P. A New Perspective on the Textile and Apparel Industry in the Digital Transformation Era. Textiles 2022, 2, 633–656. https://doi.org/10.3390/textiles2040037.

[4] Ready to Transform Textile ETP 2022 Startegic Research and Inovation Agenda. Available online: https://textile-platform.eu/news/the-public-version-of-our-2022-strategic-research-and-innovation-agenda-is-now-online (accessed on 27/07/2022).

[5] Baltezarević, R.; Baltezarević, B.; Baltezarević, V. The video gaming industry: From play to revenue. Int Rev 2018, 7, 71–76, https://doi.org/10.5937/IntRev1804071B.

[6] Lozić, J. Globalna industrija video igara: pregled stanja. Politehnika i dizajn 2021, 9, 208-214, https://doi.org/10.19279/TVZ.PD.2021-9-3-07.

[7] Video Games in the 21st Century: The 2020 Economic Impact Report. Available online: https://www.theesa.com/wp-content/uploads/2024/02/Video-Games-in-the-21st-Century-2020-Economic-Impact-Report-Final.pdf (accessed on 20/11/2022).

[8] Gaming industry annual revenue in Croatia exceeds €66 million. Available online: https://www.croatiaweek.com/gaming-industry-annual-revenue-in-croatia-exceeds-e66-million/ (accessed on 9 12 2022).

[9] The Future of Gaming (HMD & Cloud Gaming). Available online: https://steemit.com/technology/@stylo/the-future-of-gaming-hmd-and-cloud-gaming (accessed on 27/11/2022).

[10] Stein, C.: Virtual Reality Design: How Upcoming Head-Mounted Displays Change Design Paradigms of Virtual Reality Worlds, MediaTropes 2016, 6, 52–85.

[11] Donatiello, L.; Morotti, E.; Marfia, G. Exploiting Immersive Virtual Reality for Fashion Gamification. In IEEE 29th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), Bologna, Italy, 9-12 September 2018; IEEE: 2018 17-21, doi: 10.1109/PIMRC.2018.8581036.

[12] Giri, N.; Stolterman, E. Pixel Perfect: Fashion Styling in Virtual Character Design Process. In HCI in Games: Second International Conference, HCI-Games 2020, Copenhagen, Denmark, 19–24 July 2020, Springer-Verlag: Berlin, Heidelberg, 2020; 76–87, https://doi.org/10.1007/978-3-030-50164-8-5.

[13] Mesek, L. 3D modeliranje ljudskog tijela i odjeće za koncept video igre, diplomski rad, Sveučilište u Zagrebu Tekstilno-tehnološki fakultet: Zagreb, 2019. Available online: https://urn.nsk.hr/urn:nbn:hr:201:958929 (accessed on 27/11/2022)

[14] Petrak, S.; Mahnić, M. Implementacija suvremenih računalnih sustava u procesima industrijskog dizajna i konstrukcije odjeće, In Zbornik radova 5. međunarodnog znanstveno-stručnog savjetovanja Tekstilna znanost i gospodarstvo, Ujević, D.; Penava, Ž. Eds., Sveučilište u Zagrebu Tekstilno-tehnološki fakultet: Zagreb, Hrvatska, 2012; 25–36.

[15] Petrak, S.; Mahnić, M.; Rogale, D.; Ujević, D. Computer Design of Textile and Clothing Collection - Assumption of Contemporary Remote Busi;ess. In Proceedings of 11th World Textile Conference AUTEX 2011, Adolphe, C. D.; Schacher, L. Eds. Ecole Nationale Superieure d Ingenieurs Sud-Alace: Mulhouse, France, 2011; 1162–1168.

[16] Lindow, J. Norse Mythology: A Guide to Gods, Heroes, Rituals, and Beliefs, Oxford University Pres: New York, 2002; pp. 32–112, ISBN 019-515-382-0.