Virtual Prototype of Clothing in Academic Environment

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Abstract

Validation through prototypes is of fundamental importance in the new products development process. This procedure, common in industry, allows to speed processes, validating design, checking errors, identifying changes and observing new potential solutions. Also in academic environment, prototyping is used in activities related to the teaching of clothing pattern design. This procedure allows student to materialize ideas, providing tangible support for discussion, facilitating dialogue with teacher and visualizing the improvements throughout the process. The use of 3D CAD systems as prototyping tools is widely used in professional and academic environment. This promotes support for the development of engineering projects, namely mechanical engineering and in some segments in product design, such as furniture, electronics and others. The use of 3D CAD tools in apparel design has shown growth, but still resilient. Being the simulation of textile structures and virtual prototyping in 3D objects its main applications in this sector. However, 3D CAD systems present a high potential for the practice of design and fashion teaching. This paper documents the use of a virtual prototyping experience, in the development and evaluation, of the pattern design process of a functional garment, in an academic environment, referring the main benefits and disadvantages identified during the study, from the perspectives of student and teacher, relating them to the development and validation of traditional pattern-making methods.

Keywords: 3D CAD system; Virtual prototyping; Fashion product development; Pattern design teaching.

1. Introduction

Validation through prototypes is of fundamental importance in today's textile and apparel industry, particularly in those involved in processes of new products development. These processes allow the professionals in the area to accelerate processes, more easily identify errors, define changes, and enable the visualization of new potential solutions. According to Baxter [2], during the construction of the prototype product, the designer will be able to validate the proposed project ideas, and thus, follow up on its development. In the clothing universe, the prototype, apart from allowing to verify aesthetic aspects, has the function of verifying functional aspects, such as the garment assembly and flat pattern fit, observing tissue trim, clothing capacity to dress well and the various aspects of comfort related to use [3].

In a complementary way, we can consider that the physical prototype has the capacity to identify pattern design errors. In return, it requires updating of flat patterns and a new prototype construction, until the final approval of the clothes collection [9]. The short development times, motivated by a constant demand and short runs, requiring the continuous production of novelties to consumers, emphasizes that the traditional process of prototyping is considered time consuming and expensive for the companies.

The use of 3D CAD systems as a prototyping tool is widely used in different engineering projects, namely in mechanical engineering, and in some segments of product design development such as furniture, electronics and others [5]. On the other hand, textile simulation and virtual clothing, elaborated through the use of 3D CAD systems, can still be considered of reduced use in the context of the creativity project of textile products, and not as an artifice intrinsic to the process of clothing development, as it happens in other categories of products. Nevertheless, it has a high potential to contribute to the development of fashion products, due to its flexibility and quick results visualization, and consequent reduction of costs.

According to Sayem, Kennon and Clarke [8], there are currently a series of software programs that respond to the demand for virtual prototyping in the fashion segment, the main ones being: Vstitcher™ developed by Browzwear; 3D Runway developed by OptiTex International; Accumark 3D developed by Gerber; TUKA3D developed by Tukatech; Modaris 3D developed by Lectra; Vidya developed Assyst.

In an updated review, Pires [6] refers to other systems with similar proposal, adding: the systems Clo 3D and Marvelous Designer, developed by Clo Virtual Fashion**.**

In the context of academic environment, development of pattern design projects, aims to approach the student to the experience of the professional performance. For this, it is important to introduce concepts related to anthropometry and ergonomics, aspects related to the physical behaviour of the materials used to produce garments, among others. As well as the study of the interaction between the user and the elements that surround him, the context of his actions, improving his well-being and achieving a better performance of the product system [4], resulting in, products with better ergonomic performance. We can emphasize the pattern design process as the main responsible for materializing the ergonomic factors, allowing greater functionality and differentiation of clothing products [1]. Therefore, we believe that the search for innovative pedagogical processes, that can help in the objective perception of the garment project, justifies the implementation of 3D CAD software capabilities in an academic environment as a didactic design tool.

2. Methodology

The procedures used in this research were organized as a descriptive research. According to Sampieri, Collado and Lucio [7], this consists of measuring, evaluating or collecting data about the various aspects, dimensions or components of the phenomenon, i.e. the process of describing what is being researched. It was documented the experience of using virtual prototyping tools from the perspective of product development and evaluation of a pattern design project for functional clothing in academic environment. Considering the benefits and disadvantages, from student´s and teacher´s perspectives, comparing them to traditional product development and validation technics.

For the design proposal in academic environment it was selected workwear garments, used by the employees in de main departments at University of Minho. The project was included within the scope of the discipline Garments Design of the Design and Marketing of Textile Products, Clothing and Accessories Master course from University of Minho. The work procedure in the creation of the proposed collections for each department, including the phase of flat pattern design, was done in the traditional way, using 2D techniques in paper. After this phase, with the objective to evaluate the functionality of the proposed pattern design, virtual prototyping was developed as an alternative to the physical prototyping of each garment. The 3D CAD tool Marvellous design, developed by Clo Virtual Fashion company, was used as an analysis platform. The diagram of Figure 1 shows the work steps taken to develop the prototype in a virtual environment.

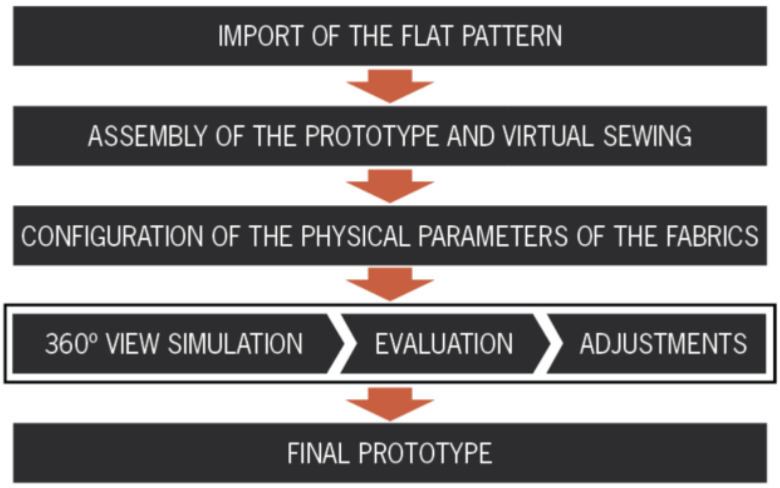

Fig. 1. Work steps used in prototype validation.

3. Results and discussion

The assembly and stitching stage of virtual prototyping, allowed a quick visualization of the three-dimensionalization of each proposed style. With the dynamic visualization between the 2D and 3D designs, made possible by the software interface, students with different experiences in flat pattern design of garments, were able to understand more quickly the impact of shape and the assembly process of the whole garment, better understanding the layout of the construction lines of each pattern to produce the projected garment.

Figure 2 represents an example of the assembly process of the prototype developed in this study.

Fig. 2. Assembly process of the prototype with virtual sewing.

The software provides a sample of different materials, with pre-programmed physical simulations, respecting the different volumes and resulting draping behaviour of each type of material, including samples of plain fabrics such as denim, satin and knitwear materials, like jerseys, interlocks, among others. These samples are easily simulated when the flat patterns are assembled and arranged in the virtual 3D mannequin. The visualization of physical simulation in virtual environment contributed to the students' perception of the impact of the materials selection, in relation to the intended fit design. For the same visualization, using the traditional method of prototyping, students would be required, besides the design of patterns, to do the preparation of fabrics, cutting each pattern and assembling the whole garment for each type of material meant to be evaluated. This would turn this task dynamics much more time consuming, tiresome and expensive. Due to the immediate response of the 3D simulation, it was possible to verify greater curiosity and interest in the activities proposed by the students.

In order to obtain even greater fidelity in the physical simulation of the materials, it is necessary to define, in a first phase, the real materials to be used, and from that, to fine-tune in the virtual parameters of the software. In this process, comparative tests between the virtual sample and the real sample are required, as well as the technical knowledge of a deeper level of the software operation, revealing a more complex and time-consuming procedure. Thus, in the stage corresponding to the physical parameters configuration of the materials, it was decided to use the pre-set denim parameters of the software. It was predicted that this type of raw material would be able to produce similar effects to the range of materials that could be used in the real project of this type of workwear, simplifying this task, as the access to other materials would not be easy for students.

For the simulations and usability analyses, the main observed aspects were:

[1] Reproduction of three-dimensionalization of the flat patterns;
[2] Aesthetical representation of volume and draping of the material;
[3] Assessment to the ergonomic behaviour of the garment, simulating the test garment in a static position and in a dynamic position, during a common work task;
[4] Identification of the limitations related to modifications of the flat patterns and expansion of the developed collection.

The evaluation procedure was carried out by analysing the images taken from the virtual environment of the software. Three different typologies were used:

[1] Simulation images with sketch effects;
[2] Realistic simulation;
[3] Simulation in a tension graph.

The typologies with sketch and realistic effects represent the aspects of aesthetic order, namely the tissues trimmings and volumes of the materials, constructive details of the cuts and aesthetical elements like colours, textures, etc.

Simulation with sketch effect allows to evidence the constructive lines, seams and folds, through its black highlight.

Simulation in a tension graph shows the ergonomic aspects of garments. It indicates, through a color diagram, the areas of greatest and least tension exerted on the surface of the simulated fabrics.

Figure 3 represents the three types of visualization options of the software used.

Fig. 3. Simulation typologies: Sketch, Realistic and on Tension graph.

Observing the simulation images with sketch effect, it was possible to verify design areas with potential to be improved:

- Small adjustments in the darts and heights;
- Positioning of aesthetic details, such as the logo in the front;
- Aesthetic-ergonomic attributes, such as:
  - Evaluation of the proposal for an innovative sleeve, overlapping two sheets, aiming to unite the aesthetical and the ergonomical components. These visualizations allowed to option for its rejection because it did not offer the desired aesthetical attributes;
  - Evaluation from the ergonomic perspective, based on the images resulting from the tension simulation. This feature of the 3D CAD systems allowed to compare parts with different ergonomic attributes, checking their compression behaviour on the test body. Figure 4 represents this comparison.

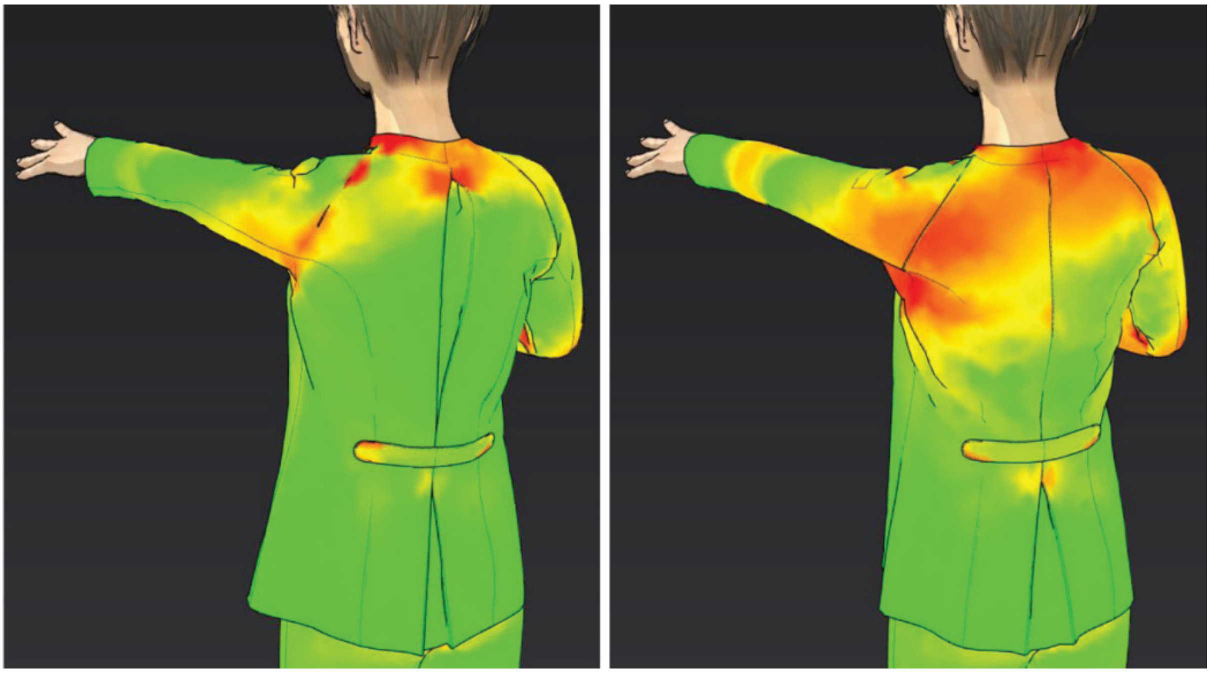

Fig. 4. Comparative evaluation of ergonomic attributes.

In Figure 4 it was also possible to observe the representation of the tension in the garment, with different design proposals, namely a proposal with an ergonomic fold in the middle of the back panel (left) and a proposal of the style without this type of fold (right).

With this simulation, it was possible to infer that different designs result in different performances. The style with the back fold had less tension of the material on the test body and consequently provided a greater range of movements.

Similarly, Figure 5 shows the resulting tension diagram when comparing the behaviour of the garment, simulating an active use situation, with the body assuming a dynamic posture.

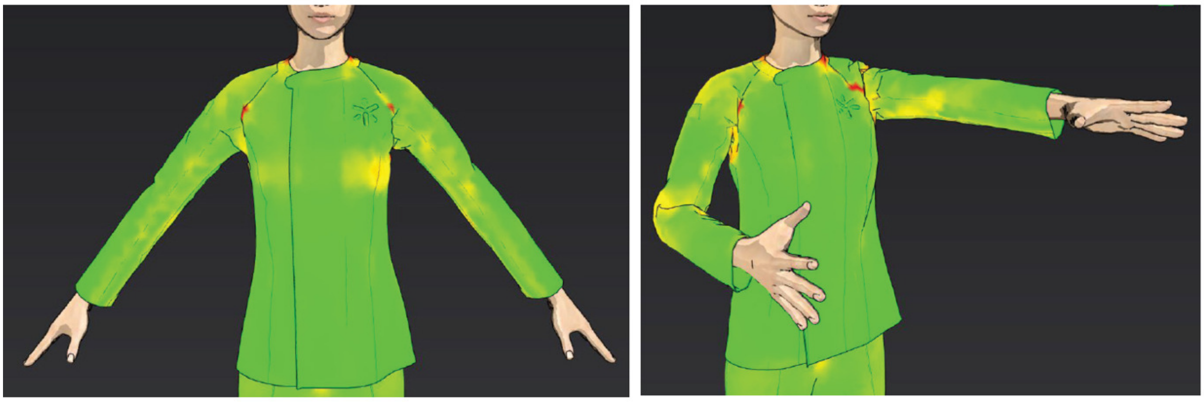

Fig. 5. Evaluation of a dynamic posture.

The process of simulation, evaluation and adjustment was repeated several times, until reaching the desired effect. The comparative simulations between the design proposals in different poses will favour the understanding of the behaviour of the pattern design of each garment, both in static and dynamic positions, simulating its daily use.

Figure 6 represents the enlargement of the collection in 3D CAD software, from the stylization of the base patterns blocks, through the application of ease values, cuts, pockets, recreation of dimensions and colours.

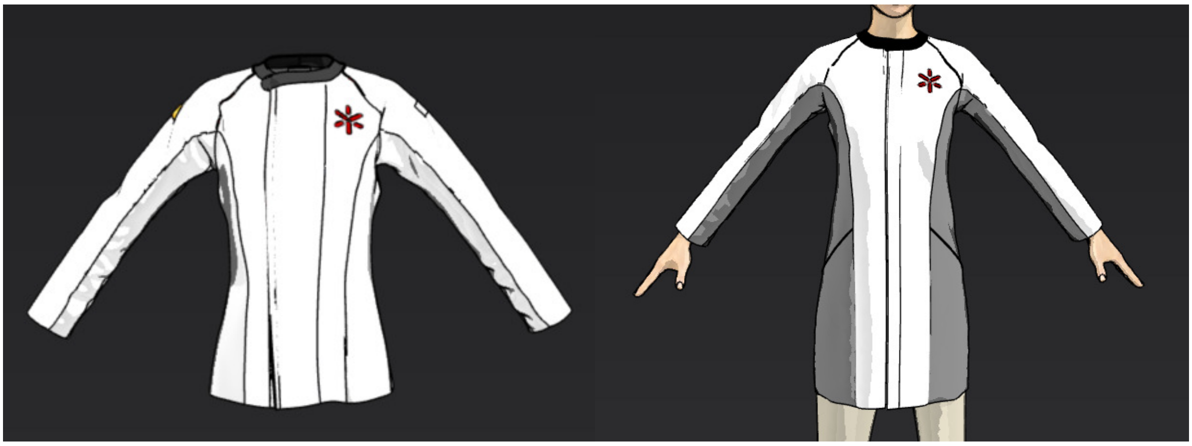

Fig. 6. Expansion of collection

However, the data obtained for analysis is still imprecise, not promoting the complete detailed understanding of the behaviour of the design in each real situation of use. This shows the need of continuing producing the physical prototype, for a more accurate validation. Nevertheless, the attempts to reach a better result can be mitigated with the use of 3D Cad systems, reducing costs and providing an alternative way for students to learn about the whole process of garment design.

4. Conclusion

The development of clothing projects in an academic environment aims to provide student's an approach to the experience of a professional performance. Design features aligned with innovation and creative thinking are facilitated by the exploration and experimentation of alternative and innovative work methods, even if not yet popular in the traditional context of industry.

The experimental use of 3D CAD tools during the design practice of functional clothing developed within the scope of this study has allowed a great dynamism in visualizing the desired aesthetics and ergonomic effects. It enabled students to produce fine adjustments and stylization of aesthetic and functional elements in a 3D environment, without the need to redesign in paper the pattern making or to produce several physical prototypes during the process. Another positive aspect identified of this procedure was favouring the dialogue among the students of each team, as well with the teacher. Through the use of this technology, the members with less pattern design experience were able to visualize and understand with greater dynamism the impact of the changes of the flat patterns in the three-dimensional garment. Immediate visualization of the changes brought fluidity to the development and design of new potential solutions.
In the teacher's perspective, the experience was very positive, since communication with the working group was also facilitated. According to the professor, the creative potential of each student was amplified, as they were able to visualize different ideas and evaluate the final result due to a fast simulation, without having to physically perform them. The teacher also believes that 3D CAD tools used in pattern design teaching will be an asset for schools that have this possibility, integrating them with traditional teaching, because in the end, the physical realization of the approved prototypes will always have to be done.

However, in addition to the difficulties in handling the software, the main obstacle was the access to this technology, due to the high cost and/or distribution policies. In addition, to achieve a good tool use it needs a preliminary knowledge of the pattern design process, as well as to have enough training in the use of the software. We believe that for a greater simulation fidelity, it is necessary to have knowledge of the physical characteristics of the materials to be used in the real garments. For this, it is necessary to have real tissue samples so that the parametrizations of the virtual elements reach the desired similarity. In the case of this study, the pre-programmed properties of the denim raw material, provided by the software data base, were used in order to streamline the process. Nevertheless, it was sufficiently illustrative, as an academic exercise.

We believe that the use of 3D CAD simulation systems in garment projects provides significant gains in the development process and product´s validation in an academic environment. The visualization of ideas were accelerated, turning them tangible. This process allowed developing an objective way of discussion between teacher and students, facilitating the understanding of the pattern design process, even for the students with less technical knowledge of the process. However, due to the absence of reference data to support the comparison of the virtual and real universes, the analysis of the projects only in the virtual environment did not allow a complete understanding of the technical aspects of the project. For this reason, the physical production of the prototype is still essential as a parameter of comparison and final validation.

Acknowledgement

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