# Digital Product: a Textile use case

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***Abstract*— TexP@ct Project aims to support the digitization of textile industry. The main goal of this subproject Digital Product (WP06) is to develop solutions to support the creation and validation of Digital Products for Textile industry.**

**Textile industry is just starting to integrate ICT technologies to support its processes, and one of the biggest challenges is how to create a digital representation of a textile product. Currently textile industry is one of the industries less digitized, due to the complexity of the processes and specifications of different materials. Some efforts are being performed but there are still lot of limitations and ambiguous procedures.**

**TexP@ct – Digital Product (WP06) aims to contribute to improve the efficiency of digital representation of textile products, namely through the development of a solution that allows to validate if a digital representation of a product has the same characteristics as the product it represents. On the other hand, it aims to develop a solution that allows users to have an immersive experience before buying their products. Using AR technology, it is possible to visualize and feel, using a physical standard sample, how a product will be after being produced. This will contribute to reduce the amount of samples produced and to reduce the time and cost associated with that.**

***Keywords—Digital product, digitization, AR, 3D, Computer Vision***

## I. Introduction

Textiles for the automotive industry represent significantly both the textile industry and the automotive industry in Portugal. Portugal has a long tradition in the textile industry, the specialization of companies in the production of automotive textile products results from this experience, in particular in the know-how acquired in the development of differentiating and high-quality technical products.

The investment made over the last few decades in the development of innovative solutions and the implementation of advanced technologies to develop new materials and production processes allowed to combine the great quality that already highlighted the sector with a highly competitive capacity. Among the innovative solutions available, technical textiles and high-quality textile materials for car interiors stand out, allowing to meet the high quality and safety standards imposed by the automotive industry and allowing national companies to supply the best automotive brands at a global scale, producing products such as fabrics for car seats, headliners, carpets, door panels, and curtains, among others.

In recent years, the automotive industry has been one of the most active in adopting very strict policies that guide sustainability in its products. Some standards were developed to guide and certify the compliance of the products with the standards defined in terms of sustainability, safety, quality, durability, and efficiency. [1][2][3] In this sense, textile production processes were adapted to become more efficient, and materials were replaced with more sustainable ones.

The textile industry plays a significant role in Portuguese society, but it also faces considerable challenges in terms of sustainability and resource consumption. The textile industry, including the automotive sector, has a significant impact on the environment, generating between 8 and 10% of the global carbon dioxide emissions. In the EU in 2020, 121 million tons of carbon dioxide equivalent (CO2e) greenhouse gas emissions were emitted. [4] The continuous search for sustainable solutions is essential to mitigate this environmental impact.

Every year, the textile industry consumes around 93 trillion liters of water, which represents around 20% of wastewater. [5].The production of raw materials for the Textile Industry also consumes a lot of water resources, considering the example of cotton, the production of 1 kg of cotton fiber requires between 7,000 and 29,000 liters of water.[6].

Unlike the clothing and fashion industries, where consumerism leads to excessive consumption, excessive production, and the consequent production of a lot of waste, which requires the imposition of laws that aim to rethink production strategies considering the production, but also its disassembling and upcycling. Automotive textiles always stood out for the quality and durability of its products since they are not supposed to be replaced throughout the useful life of the vehicle's lifetime.

Automotive textile samples are usually shared with OEMs who request them in physical form. All samples are designed as if they're a product. The current process is quite expensive and time-consuming, with a series of selection and validation processes involved. Initially, and following the specifications defined by the customer, a large number of products are designed. From these products, some are re-designed according to feedback from OEMs, a process that is repeated several times. In the end, after validating a smaller quantity of products, those that will move on to the next step, the validation of the physical product, it is selected, requiring the production of physical samples.

In total, less than 10% of the total designed samples are physically produced, as this is an expensive and time-consuming process. Thus, samples are produced and sent to brands to evaluate their quality, pattern, and color, among other attributes. This process, in addition to being time-consuming and expensive, is very unsustainable, due to the resources consumed, the waste generated, and the need to transport the samples. The production of samples is a complex process that impacts companies' productivity, besides the need to stop normal production to allow the production of those samples. After this process, the product might need to be updated, and led to the need to produce more samples.

When the properties of a product are finally validated, its design and production parameters are adjusted allowing the evaluation of its production costs, and the budget is presented to the customer. Only after this validation the contracting of the product's production can proceed.

This project will innovate in the development of a textile sample dematerialization system for automotive textiles sector, involving the application of emerging technologies with the adoption of creative approaches to improve efficiency, reduce costs, and minimize the environmental impact of the production and presentation of samples.

This project aims to develop a digital catalog through the digitization of physical samples and the production of digital samples presentation system and their implementation in a 3D/VR/AR environment, this solution will allow Borgstena to present its fabric samples to their customers, virtually and interactively, improving communication and collaboration and reducing the time-to-market for new products. This solution will allow the presentation of samples, as well as applying them to the products for which they are intended, such as the car seat, or the door panel, providing the customer with a realistic experience.

## II. State of The Art and Current Situation

Textile industry has a significant environmental impact on the consumption of Natural Resources, namely water, energy and raw materials. On the other hand, waste resulting from production processes is not always reused and is often discarded without any treatment which can lead to the pollution of soil and water resources.

The textile industry uses raw materials of natural origin such as cotton, wool, silk, linen, or hemp as well as raw materials of synthetic origin such as polyester or viscose. Both the production of natural and synthetic materials and production processes consume a large amount of resources, namely water and energy. Cotton is one of the most used natural materials in the textile industry due to its properties, such as water absorption capacity, softness, and durability, as well as its versatility. The production of raw materials for the textile industry plays a significant role in the agrarian industry, promoting job creation and stimulating the rural economy.

Sustainable manufacturing must be analyzed considering four aspects of sustainability: environmental, economic, social, and cultural as presented in Fig. 1.[7]Sustainable manufacturing aims to create products and processes that minimize the environmental impact, promote energy efficiency, reduce waste, and consider social well-being.

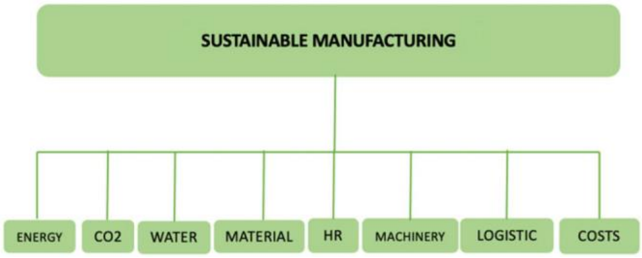


Fig. 1. Criteria for analyzing sustainability on Manufacturing Enterprises

Sustainability in the textile industry is a growing concern, driven by consumer awareness and the need to protect the environment. Thus, companies have been changing their paradigm by adopting more sustainable practices with a view to sustainable manufacturing, particularly in terms of product design and development considering the use of more sustainable materials and processes. Among the measures adopted, the use of recycled materials, efficient resource management, and digitalization stand out.[8] The circular economy is another essential concept for promoting sustainable manufacturing. The circular economy aims to minimize waste and maximize the reuse of resources, promoting recycling and upcycling after the end of products' useful life, giving it in a new life. The EU has been working to reduce textile waste, increase product life cycle, and promoting textile recycling.[9]

Thus, the current production paradigm focuses on energy efficiency, reducing consumption, reducing emissions of greenhouse gases and pollutants, efficient resource management, efficient waste management, minimizing production and promoting products reuse and recycling, as well as on Sustainable Product Design choosing sustainable raw materials with less environmental impact and planning the product with a view not only to its production, but also to its recycling after its useful life.

Textile products play a crucial role in vehicle manufacturing, being used in various parts of the car, from seats, door panels, headliners, seat belts, flooring, or carpets. Automotive textile items contribute to comfort, functionality, and aesthetics. These products stand out for their wear resistance, durability, and safety. Over time they have become more sustainable.

To become more sustainable, the textile industry has adopted more environmentally friendly strategies such as using more sustainable materials, such as recycled materials, or changing the paradigm in the design and innovation of products, which allows them to provide long-lasting, better quality, and easy to recycle products. [10]

Borgstena is a company with over 50 years of experience in automotive textiles. Borgstena offers a wide variety of textile solutions, including solutions that include sustainable materials. Currently, to produce a physical fabric or collection of fabrics Borgstena’s Product development follows several stages, namely:

- 1) Briefing. It starts with a briefing of the compilation of information regarding colors, shapes, raw materials, fulfilling aesthetics, technical requirements, price targets, and time plan.

- 2) Analyze trends and technologies used in the market, this research is made in websites, Trend books, and fairs.

- 3) Verify raw materials available in library stock, or order new ones if needed.

- 4) Consult physical sample library to identify similar materials to propose.

- 5) Development of patterns in CAD system based on Briefing, several patterns are created to be produced.

- 6) Fulfillment of the Technical information to produce the samples.

- 7) Planning of samples based on machine's availability and the lead times to fulfill the time plan.

- 8) Development of samples into Process /Extrusion/ Warping /Weaving /knitting/ Finishing/Inspection/Cutting of samples

- 9) Definition of Key tests to be elaborated

- 10) Analyze test results

- 11) Definition of final presentation with physical samples to the customer using Samples in A3 or A4 size mockups / Travel associated.

- 12) Report on selected samples from customers and communicate to the allocated team.

- 14) New development of samples in bigger batches of samples to define production specifications.

A digital textile sample is a virtual representation of a physical textile sample. Sometimes called digital twins, digital samples must reflect the visual and physical characteristics of their real counterparts - having the same drape, weight, and texture, and behaving in the same way when subject to movement and under different lightning conditions.

Digital textile samples have revolutionized the creation of samples in textile industry, as well as their presentation to the outside world. Online car configurators are examples of these solutions, allowing customers to apply different textures in car objects.

In a traditional process for obtaining digital textile samples, digitization allows the conversion of physical samples into digital samples through scanning. Eliminating the need for large-scale production of physical samples, as well as easing access to a much more intuitive library without the need to have a specialized infrastructure, also reducing waste and environmental footprint. Digitization can be effectively used, either: in customization, changing existing samples, and at a speed of response, without additional costs and traditional response times. Digitization as well as its multiple applicability, allows the use of rendering engines, with countless scenarios. Its only limitation is the creativity and needs of the end client.

In this work, a non-traditional process was used allowing to use of software already used in the production of textile materials, NedGraphics, to get relevant information about products, namely, mapping texture, colors, and brightness, among others. In other words, this process allows to get the same maps that digitization of an existing article would provide, but with the quality of information that would require additional inputs from the creator of the same raw material. [11]

Both processes, the digitization of a product from its scanning (traditional) and the digitization using the information included in the product creation process (Non-Traditional) will result in the compilation of information which is grouped in several maps, namely, Normal Map, Displacement Map, Roughness Map, Texture Map, Fiber Density Map, and Pattern Map. Normal Maps represent the direction of the fabric surfaces, each pixel indicates the orientation of the surface, created to obtain realistic reflections and shadows in rendering. Displacement Maps, present the geometry of the fabric, indicating reliefs and deformations. Roughness Maps indicate the variation in the surface of the fabric, rougher areas appear darker, while smoother areas are lighter; Texture Maps, represent the surface texture of the fabric, highlighting rough, smooth, patterned or relief areas; Fiber Density Maps, show the density of the fabric fibers, denser areas have more fibers; finally, Pattern Maps, which facilitates the perception of pattern repetition.

Regarding the automotive industry, there are unique potentials to the dynamics of both approaches, digital samples allow designers to quickly create and visualize different fabrics, colors, and patterns, this speeds up the design process and reduces the need to produce physical prototypes. whether they are just samples of the product or the final products. Environmentally digitalization avoids the need to produce physical samples in large quantities, reducing material waste and costs associated to the production of physical samples.

A digital representation of a product is a way of visually or functionally presenting the characteristics of a product using digital means, facilitating its evaluation. There are several types of digital products representation, from their graphic design, their technical drawing to their representation in a 3D environment. Digital Products stand out for their scalability, since they can be replicated and distributed on a large scale without a high cost, since the cost of implementing the solutions is high but is easily amortized, as well as for their agility and interactivity since the solution can quickly and simultaneously be used by people all over the world.

In the textile industry, digital representations of the product have been implemented for Design and Prototyping using 3D design software to create virtual models of products before its physical production, for e-Commerce platforms that allow the purchase and customization of products. Augmented Reality (AR) solutions have been used for personalization and visualization of products, as well as for Digital Marketing.

The adoption of digital representations of products has great potential for application in the textile industry, promoting the reduction of raw materials consumption and waste production. It also supports an easy solution for the customization of products and reduces lead time, but mostly it reduces companies' environmental footprint.

The solutions currently available have limitations on their use. Usually, they integrate a few parameters that can be customized and a limited number of options for it. Most of the time users feel it is not enough to support its decisions. Other existing solutions are not very intuitive, which makes them difficult to use. However, the major limitation to the adoption of these technologies is the high costs of developing these types of solutions.

Realistic digital representation is something that is increasingly required by industry. Representing a material, a scenario or a product in a realistic way makes the entire process much more practical, economical, and sustainable. Digital product presentation allows to take more targeted decisions without additional processes and costs.

There are several software programs capable of representing these samples and materials at the desired level, including Blender, Unreal Engine, VRED, Unity, etc. These pieces of software share very similar languages when it comes to manipulating and implementing scenery and textures, however, it is necessary to understand their full potential and direct them towards their area of implementation. Blender is free software that allows you to work on plugins with an average rendering time/quality rate.[12] Unreal Engine is free software up to a profit rate, providing very good rendering time/quality making a real-time setup fluid and realistic.[13] VRED provides a very strong communication cloud, allowing you to achieve good quality/time but greatly enhancing connectivity between several users, allowing you to change things in real-time.[14]

The difficulty in implementing this degree of reality is compatibility between all the files and software. The materials have to be scanned in great detail and as uniformly as possible so that we can show the textures as real as possible through their color, texture, and depth.

Currently, the adoption of digital representations of products still has some limitations, namely the lack of a sensory experience. The touch of the fabric is an extremely important parameter for the customer's decision, who with a purely digital representation cannot evaluate the texture and touch of the fabric, the visual experience of the solutions is often also limited.

## III. 3D/VR Design Studio Approach

This project proposes an innovative approach to a textile sample dematerialization system for automotive industry considering the design and scanning of samples, 3D Modeling, and the development of an interactive presentation system.

Currently, Borgstena designs its products, including samples using NedGraphics, a software used for the design and development of textile products. This is the software used by most Portuguese textile companies to develop their products, as it includes a wide range of development modules dedicated to the development of patterns, textile structures and other characteristics of a product such as the definition of the specifications of the production of that product in the production line. Using NedGraphics to all these processes allows to produce a product just after its approval, as all the information required for its production is already associated with it. Fig. 2 presents an example of a Pattern Map designed by Borgstena with NedGraphics.

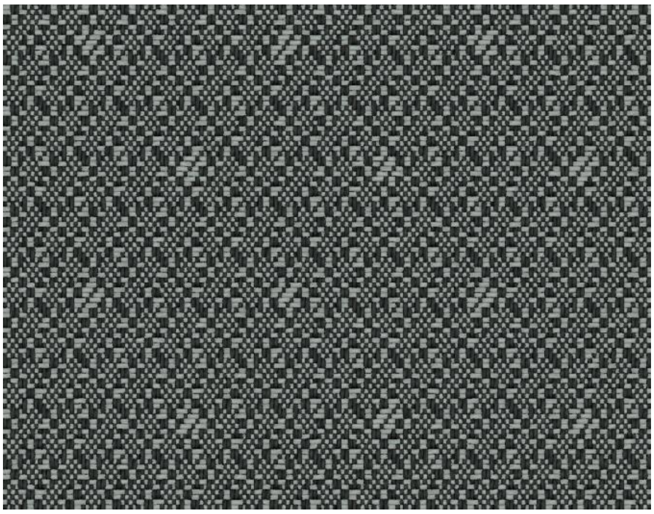

Fig. 2. Design of a Pattern map

Vizoo system allows to obtain better results in the process of digitizing textile materials. This offers digitalization and materials digitalization solutions for a variety of sectors, including automotive, footwear, home, and fashion.[15]

Vizoo's hardware is specifically used for accurately and efficiently scanning materials, comprising: a material scanner, equipped with controlled lighting, high-quality cameras and a precise positioning system to ensure consistent results; a scanning table, with a flat and uniform surface to ensure that the materials are well positioned; a control software, with an interface for viewing and predicting captured images; an automatic or assisted calibration system, ensuring precision in measurements, using reference targets and specific procedures to ensure that images are sized correctly; and finally, a computer with connection to the internet, the capacity for processing the images captured, easy to connect with other systems.

xTex is a software, essential for digitizing materials, allowing the creation of 3D images, has a built-in rendering feature and the creation of realistic image presentations. xTex is also very flexible, it provides a plugin interface with Adobe Photoshop and Blender, to support an even better visualization experience and manipulation of textile materials.[16] Fig. 3 represents the digitization of textile samples using xTex.

Fig. 3. Product digitization using xTex.

In this project the digitized samples will be used as the source of the textures to be applied in the digital samples or products. To apply the textures representing the materials to the samples or products it will be repeated infinitely, using artificial intelligence tools. On the other hand, if the "drawing" is too large for the system to recognize, there are solutions (Photoshop plugin) where the desired repeat image is constructed, without ever compromising the information contained in the maps provided by xTex.

Regarding this use case Vizoo system is integrated into a collection of information, in this case digital, of different types of textile materials for automotive sector. This allows the use of that information to support the creation of an augmented reality or virtual reality solution, highly realistic, and rich in characteristics of the materials. Fig. 4 presents the digitized version of the product.

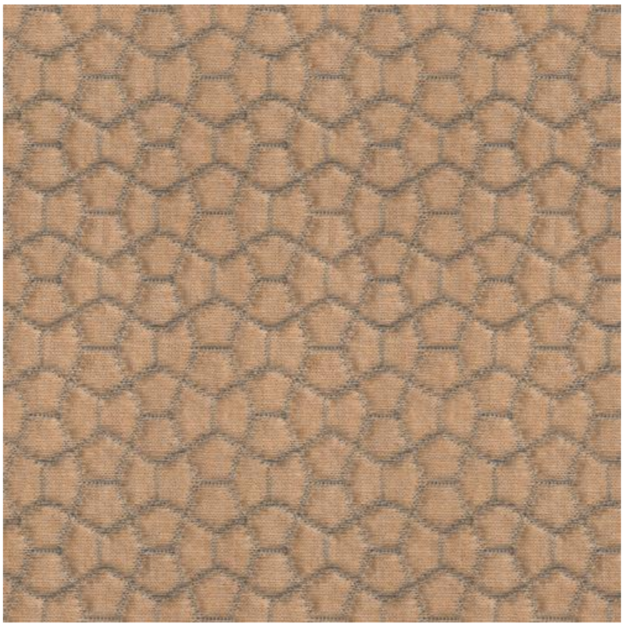

Fig. 4. Digitized fabric.

Using the channels obtained by digitizing the material and the U3M file acquired through Vizoo and NedGraphics, it is possible to create a realistic material. The difficulties and limitations are in the direct implementation (drag and drop) of the materials provided by this software in the rendering. To achieve the desired degree of realism, it is necessary to manipulate the channels manually, understanding their scales, reflections, and textures. Fig. 5 presents a digital workspace representing some applications of the textures obtained in the interior of a car using bases such as Vizoo and NedGraphics. Fig. 6 represents the properties of a texture that will allow to realistically apply it to an object.

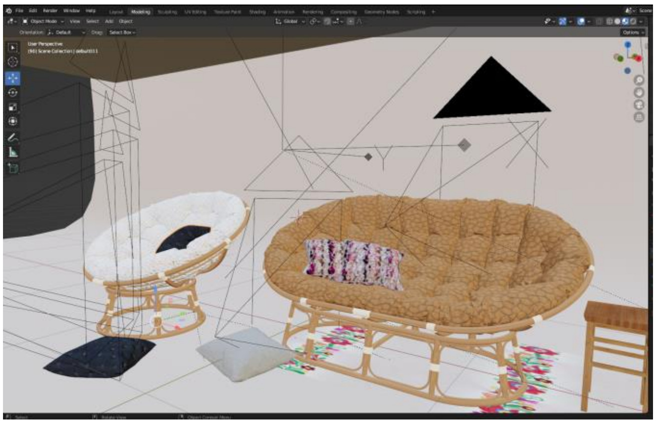

Fig. 5. Texture application

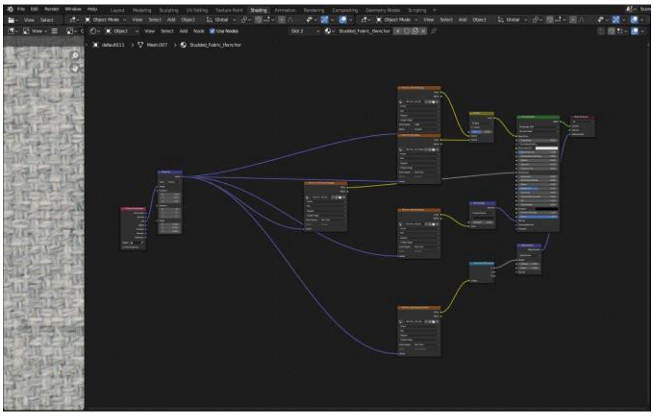

Fig. 6. Digital Workspace

This project aims to ease and standardize the transition process between material creation. using NedGraphics and its realistic representation in a rendering software, making it more practical, intuitive, and automated, getting as close as possible to the final product/sample produced and sent to OEMs.
Its solution will allow Borgstena to share its products with its customers in a customized environment allowing the customer to visualize how the product will be when applied to the final product. Fig. 7 presents an example of the application of a sample digitized using Vizzo and xTex an applied to a car interior, namely in car seats.

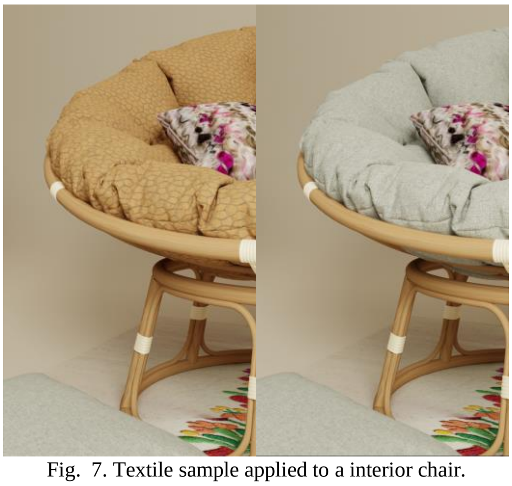

Fig. 7. Textile sample applied to a interior chair.

To complement this solution a mini catalogue of materials is being developed. This catalogue contains small samples of Borgstena's fabrics which will allow customers to feel the touch of its fabrics and to see the touch of its fabric. IT will also allow users to see how the solution will look like using AR over it.

## IV. Conclusions

This solution proposes a digitalization method which allows to easily obtain detailed information regarding each product allowing to present a detailed and realistic image to its customers in the presentation of the samples. It will support the share of digital samples easily between designers, manufacturers and suppliers, improving communication and collaboration throughout the value chain.

This sample dematerialization system will simplify the sample selection process, but also promote sustainability, efficiency, and customer experience. The dematerialization allows to increased productivity since the production of physical samples, in addition to being a time-consuming and expensive process, requires the usual production to be stopped to produce small samples. This process also reduces the environmental impact, resource consumption, and waste production. All these factors will increase Borgstena's competitiveness.

This system allows to considerably reduce the production of physical samples with an immediate impact at a business level, immediately reducing the number of resources used in production, namely, raw materials, materials, energy, and water. Reducing the need for production, it is possible, in the one hand, to optimize the management of the production process, increasing the production capacity of the equipment while reducing the associated environmental impact. The solution will also allow to reduce the storage space required, which currently has a significant impact on Borgstena's storage unit. These measures have a direct impact on corporate sustainability, reducing costs and increasing competitiveness, while also having a direct impact on the company's environmental footprint.

This solution combines the know-how, tools, and materials available at Borgstena with the technical knowledge of CeNTI and CITEVE to develop a hybrid dematerialization system to dynamically and sustainability present its products to its customers.

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