

Innovation in CAD: 3D simulation and virtual prototyping at ITMA 2023

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Introduction

At ITMA 2023, there were continuous efforts from companies to push boundaries with Industry 4.0-certified technologies for creating more realistic virtual sampling and integrating it into the product life cycle. This digital transformation is imperative to accelerating every aspect of the product life cycle, including planning, design, the facilitation of sustainable manufacturing, and sales promotion. At the exhibition, companies presented different levels of three-dimensional (3D) simulation and virtual prototyping software and system platforms.

The concept of 3D simulation in computer-aided design (CAD) includes developing 3D virtual samples out of 2D digital patterns and allows users to customize and develop 3D virtual fitting models, present 360-degree views, and expand reality on the computer (Hudson & Hwang, 2022). Some advantages of virtual prototyping include minimized time and cost spent on actual sample making, reduced lead time for product planning, the ability to use realistic virtual samples in presale events, and the ability to determine market potential for optimizing inventory (Shima Seiki, 2023).

Virtual prototypes provide different levels of visualization depending on their immersion. For instance, some companies use 2.5D visualization for rapid virtual sampling, such as texture mapping over a static view where the base image does not

change, producing image-type output in formats such as jpeg, png, and tiff. On the other hand, some companies use 3D visualization, such as rendering 3D effects of garments and virtual models in a 2D environment, producing various output types, including STL, OBJ, fbx, and avi along with other 2D outputs such as dxf, AAMA, and jpeg that can be seamlessly imported for other virtual environments. In addition, creative support tools have emerged that adopt artificial intelligence (AI) that leverages big data and computational capabilities to advance the CAD process of developing effective virtual sampling to facilitate the product development process.

This paper deals with innovation in 3D simulation and virtual prototyping with regard to the CAD process. The paper presents a range of virtual sampling systems and software, including cloud-based 3D suite systems and stand-alone software for garments and textile development, with different levels of immersion. It also discusses software and tools that would facilitate the visualization process, including the contributions of two start-up companies that use AI-based tools such as fit validation and print development for virtual sampling. This paper addresses the opportunities in virtual sampling for the apparel product development process and contributes to new innovative technologies and sustainable manufacturing.

3D Apparel Design System

Audaces is an Italian-Brazilian company that provides software that is “easy to learn, use, and maintain” with the goal of accelerating apparel creation, development, and production. The software can also be used in the upholstery, footwear, furniture, and other flexible material sectors (Audaces, 2023). The company produces *AUDACES360*, a complete system that develops software and plug-in options and provides a platform for CAD processes such as PLM (*Isa*), spec sheets and automated preliminary costing (*Idea*), virtual designs (*Fashion Studio*), 2D garment pattern making (*Pattern*), pattern digitizing (*Digiflash*), pattern markers (*Marker*), and 3D simulation (*3D*). In particular, *Fashion Studio* software provides a unique function compared to other 3D simulation and pattern-making tools. It promotes the creation of “pre-patterns” and designs directly in a three-dimensional avatar without the need for 2D patterns, which facilitates a faster product development process (Audaces, 2023). This is particularly important for the CAD process. The user can visualize his or her visions by clicking and drawing 3D outfits directly on a 3D mannequin, and the system will automatically generate 2D garment “pre-

patterns.” The software also generates a quick 3D virtual sample without needing high-quality renders or assembling. As shown in Figure 1, the avatar wears a pre-set garment of white tights, and the designer can use the embedded tools to edit and create new patterns by manipulating the garment in 3D (e.g., shortening, lengthening, tapering). In addition, the model pre-cost is created automatically, which allows designers to test and define the variants of designs quickly and to improve their accuracy before needing a higher resolution and data processing. Thus, one can easily attach images to the tech pack, reduce cutting costs, and enhance sustainability with digital approval from the initial stage of design without making a pattern. The software also allows novice pattern-makers, such as merchandisers or those involved in the product lifecycle management (PLM) stages, to use the tool to communicate since it is user-friendly in creating design variations. Compared to *Fashion Studio*, *Audaces 3D* provides higher rendered 3D simulation with test measurement and fitting. This allows one to digitally approve the first prototype, render images for marketing and sales, and further enable an online fitting room with compatible output generated using the software.

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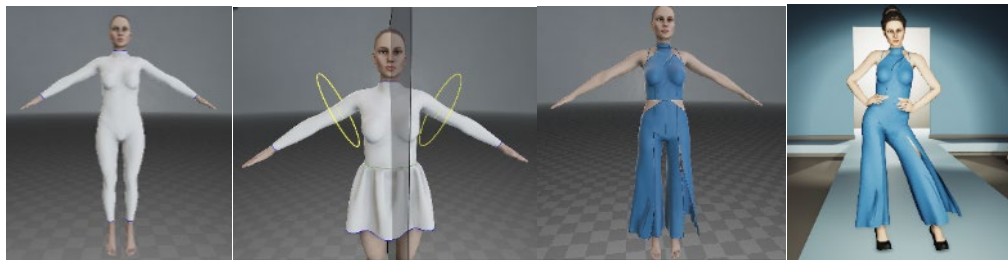


Figure 1. Creating pre-patterns and rapid visualization using *Fashion Studio*, AUDACES360

Linctex is a company located in China that offers software and service platforms for apparel design and product development specializing in 3D visualization. As shown in Figure 2, it offers

a variety of 3D functions, including 3D modeling, 3D rendering, 3D animation, fabric simulation, and virtual sampling in a VR showroom.

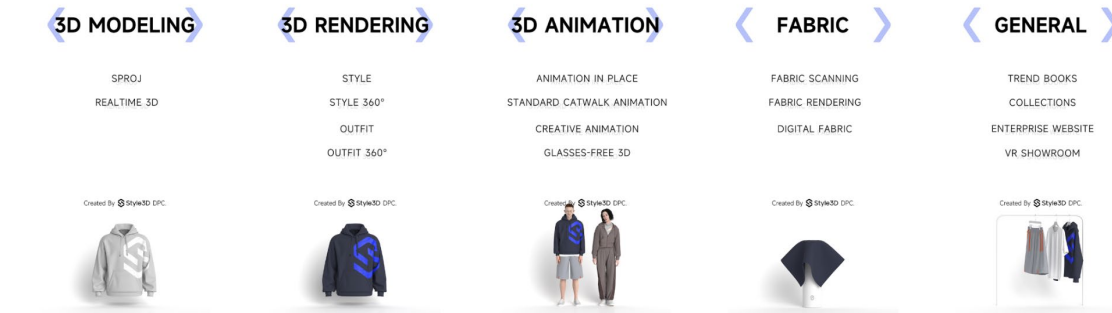


Figure 2. An overview of Style 3D software using 3D virtual sampling (Style 3D, 2023)

Style 3D Fabric, especially, captures and processes textiles into highly rendered, digital twin assets that can be further edited with various textile attributes. The hardware comes with 1 scanning device, 2 stretch-testing devices, and 3 bending-strength-testing auto-devices, as shown in Figure 3. The system measures the physical parameters of the fabric, including weight, thickness, tensile strength, and bending strength. With the 3D fabric test, those parameters can be transferred as digital fabrics. The scanning device can obtain more realistic colors than other methods, since its high light sensitivity captures up to 45.7 million pixels of a sample. It automatically generates 6 PBR maps that virtualize fabric, and many fabric properties, such as existing transparency, metallicity, and roughness, can be transferred to digital format as well (Style 3D, 2023).



Figure 3. Style 3D fabric-digitizing devices (Style 3D, 2023)

Another software entry from Lintex is *Style Studio*, a patternmaking and virtual fitting workplace that includes 2D and 3D pattern making, virtual avatars, CPU and GPU rendering, and output presents, producing hyper-realistic 3D data as a result. The function offers the visualization of 2D progress in 3D simulation, and one can

directly draw on the 3D avatar and generate 2D garment patterns. The software offers a large number of preset poses, environments, props, light settings, and motion capture actions that can facilitate the visualization of virtual samples. Other tools contributing to virtual sampling include *Style Cloud*, an all-in-one platform for collaboration, 3D asset management, sourcing, and networking, offering online design and collaboration opportunities. For instance, one can create, edit, and visualize samples in a 3D environment on the platform and customize styles with modular components, which makes it easier to communicate design variations in real time throughout the product life cycle. This leads to the development of virtual show spaces where customers can explore and click on a hyperlink for details to visualize and interact with virtual samples.

SDS-ONE APEX 4 is a 3D apparel design system produced by a Japanese company, Shima Seiki, a notable manufacturer of computerized flat knitting machines and design systems (Shima Seiki, 2023). SDS-ONE APEX is a continuously evolving design system with integrated hardware and software, and it provides a lineup of an all-in-one design system with 3D virtual sampling, pattern CAD functions, and knitting machine programming, which are useful for planning and designing various products for prototype creation and sales promotion. Unlike general-purpose software, the specialized simulation CAD system for knit items is specially linked with machine production and produces virtual sampling in ultra-high resolution, which facilitates

improved accuracy and the product development process. The system offers software for yarn creation and loop simulation, patternmaking and grading, 3D simulated fitting, real-time 3D viewing, and 3D virtual sampling. As shown in Figure 4, *APEXFiz* is a subscription service specifically for design software, and data produced by *APEXFiz* can be converted to machine data by a qualified manufacturer to directly produce a physical sample. The system offers a wide range of CAD software, such as *Design Jr.* (for fabric simulation and the production of virtual fabrics), *Design-Standard* (for powerful imaging tools, including 3D), *Design-Knit* (for tools that aid flat knit or circular knit designers), and *Design-Weave* (for tools that aid weave and towel designers).



Figure 4. An example of proceeding from virtual sampling to production using *APEXFiz*

Another CAD tool offered by Shima Seiki is *Yarnbank*, a digital yarn-sourcing website for virtual sampling in the SDS-ONE APEX series (Windows 10 or later). One can review an extensive library from *Yarnbank*, with categories that include wool, cashmere, cotton, and other sustainable materials. These categories can be searched through subcategories that include season, yarn count, gauge, features, price range, and color. Designers can further contact yarn suppliers directly through the website after reviewing a variety of information attached to each yarn. The high-quality data from the website can be downloaded free of charge and used to produce high-quality rendered fabric and 3D

simulations, allowing efficient product planning and sustainable manufacturing.

A new addition contributing to virtual sampling is the *SHIMA Datamall*. This new web service offers digital data, such as original knit samples, jacquard patterns and knit designs, and 3D model patterns, comprising over 8,000 items. The site allows users to search, browse, and purchase a variety of useful data for the planning, production, and sale of apparel items. Further, as shown in Figure 5, the site is compatible with other SPEX series 3D design systems and *APEXFiz* software, so users can streamline their operations and download knitting, pattern, and 3D virtual sample data for product planning.

Finally, *VRknit.com* is Shima Seiki's virtual showroom. It features 3D virtual samples and suggests new ways of utilizing virtual samples for presentation and promotion. For instance, virtual sample data produced by the SDS-ONE-APEX series can be exported and imported into a virtual space and output in VR and AR modes, and there is an opportunity to showcase designs in various Metaverse platforms.

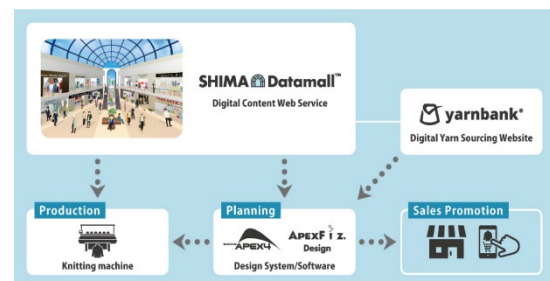


Figure 5. An overview of *SHIMA Datamall* and other services that promote digitalization and improve business efficiency

Logica 3D Suite with cloud technology is another specialized 3D virtual sampling CAD system for knitwear. Logica is an Italian company that develops software and hardware in the mechanical-textile sector. Using *3D Simulation* software, virtual sampling can be visualized with natural stretch effects, shadows, and the natural curves of the pattern. The simulation can be

generated from most compatible format files used in the industry (e.g., Dat, .000, .Sin-Jac-Setx, Lg). A newly launched software product is *New Shaping*, which offers an integral garment module for flattening machines and allows one to quickly create a pattern from preset shapes (e.g., raglan, set in, parachute) and apply graphic functions. It also allows modifying values and simultaneously viewing changes in shape as well as automatically generating various sizes. When simulating virtual sampling, potential errors can be visualized, which can be difficult for technicians to see in integral garment patterns from physical samples.

Logica also showcased the *Paintknit* system, which allows simulating a large variety of stitches. This allows the possibility of choosing the yarn type and varying combinations, such as single jersey, double jersey, jacquard, structure and cable, fully fashioned, and rib with tuck. Virtual sampling developed on *PaintKnit* can be streamlined through *PaintKnit Tryon*, which offers a 3D interactive visualization of textures on self-try-on totems (Logica, 2023). Animations can be applied to various types of models and scenes, and textures can be applied to enhance the colorway and photorealistic rendering characteristics. This virtual sampling can be used in virtual showrooms and allows one to create collections and knits directly in the *Metaverse* and *PaintKnit VR* platforms, which provide a highly immersive virtual reality environment using compatible VR headsets such as Oculus.

AraView 3D is a cloud-based platform that makes it easy to apply fabric texture and visualize 3D virtual sampling. The software was developed by Arahne, a software company located in Slovenia that specializes in developing CAD/CAM systems for dobby and jacquard weaving. The company offers a range of software, such as *ArahPaint* (for seamless patterns with fabric density), *ArahWeave* (for woven fabric design and simulation), *ArahDrape* (for creating simulations of final products), and *ArahView 3D* (for showing fabric on 3D models). *AraView 3D* offers a selection of

more than 40 different 3D models, including clothing, furniture, bags, and fabric samples to which one can apply the fabrics designed in *ArahWeave* CAD software for dobby and jacquard fabric design. This is done with a compatible image file format, shown in Figure 6, which allows designers to quickly render from the preset 3D models and visualize what their fabric design would look like on a final product in 360 degrees. Another software entry by Arahne is *ArrahDrape*, in which one uses a flat image of the model (e.g., sofa, apparel, bags, shoes, bed linen, curtain) and applies fabric textures to the fabric area.

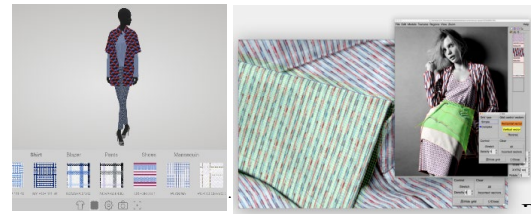


Figure 6. Virtual sampling through (a) AraView 3D and (b) ArahDrape (Arahne, 2023)

Textronics Design Systems, developed by India-based Textronics, provides a range of CAD and CAM textile design software aimed at a variety of textile mills and apparel and fabric designers. Textronics offers a range of virtual sampling platforms with different immersion levels. For rapid visualization, its *Design 3D* software offers 3D texture mapping in which surface depth dimensions are extracted from 2D scanned images. Rendering factors such as light source, viewing distance, and shading information are defined and stored in 3DP formats for accuracy. One can also drag and drop original designs on an image to create realistic 3D texture mapping, and ATLAS, an intelligent library management system, graphically maintains the 3DP images on designated objects. The 3D texture-mapped images can be exported and can be sent to customers or transferred to pre-press advertising companies. The company also offers *3D Images*, which functions on mobile

devices and empowers one to easily create, refer to, archive, and edit virtual samples and download them. Another software entry, *Tailor-I*, is an augmented reality-based interactive platform that can be used for visualizing and customizing clothing. The program has a simple user interface that helps one select different silhouettes and design details such as cuffs, collars, plackets, lapels, and fits. The configurator enables combining these elements into a garment and visualizes virtual sampling in a customized made-to-measure outfit. This promotes mass customization and interactions between designers and customers for a sustainable product development process. Finally, *TryOn* is an augmented reality-based virtual dressing room app that digitally manages product options. It allows customers to visualize their selected garments and try on clothes virtually by simple wave and swipe gestures.

3D Virtual Sampling Tools

Along with the 3D apparel design systems discussed above, there were other tools at ITMA 2023 that seem to be accelerating virtual sampling process. **MYTH** is a start-up company founded in Turkey that has developed an AI-based

pattern design tool that contributes to virtual sampling. AI-powered tools increase efficiency and productivity and offer accessibility to novice designers, as well as enhance the overall value of creative work (Myth, 2023). By employing AI algorithms and machine learning, designers can analyze extensive data, develop novel designs, and automatically generate customized patterns, which significantly reduces time and effort and streamlines the CAD process. As shown in Figure 7, one can input an image for inspiration, and the program will generate a final pattern design with unlimited variations. These pattern repeats can be exported and used for 3D visual models, facilitating the CAD process and taking inspiration from new design ideas that were automatically generated. **TAILR** is another start-up company that offers a cloud-based platform that simplifies a complicated production process and helps companies streamline production and ensures consistent sizing. In particular, size grading rules ensure garment sizing is consistent with brand guidelines across all styles and from season to season and its fit recommendation function can be used to facilitate the 3D simulated virtual sampling process (Tailr, 2023).

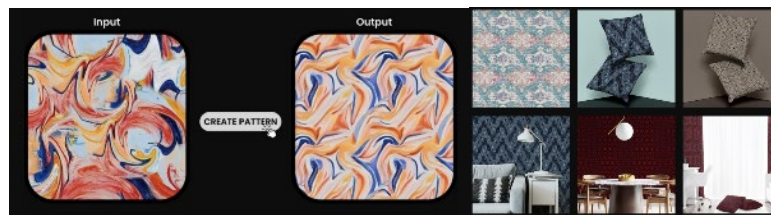


Figure 7. AI-generated pattern design from Myth (Myth, 2023)

Patterns Room is an Australian-based online pattern company that offers “commercially-ready, premium sized” clothing patterns, focusing on sportswear patterns (Patterns Room, 2023). It offers a library of more than 300,000 quality patterns that are consistent in fit from babies (size 00) to size 28 in women’s and 8XL in men’s sizing. According to the company, the patterns have been tried and tested over 13 years for better fit. The patterns can be

digitally downloaded in standard DXF and AI formats, along with graded sets of six and 12 sizes for an extra cost, and can be used for 3D virtual sampling. Other types of formats, such as cardstock, paper, or sketch, are available in addition to the digital formats. The CAD and virtual sampling processes can be enhanced by using better clothing patterns, so Patterns Room could contribute to a more sustainable manufacturing process.

PhotoSHAPE, an automatic

digitizer for patterns, was developed by Lakeview Technology, based in Switzerland. The system allows one to quickly vectorize perimeter, holes, and reference points of a garment with .3 mm precision and internal annotations (Lakeview Technology, 2023). After taking a picture directly from the software, it is ready to be edited within any CAD system. The company also offers *CAD4Fashion* where 2D garment patterns can be developed and edited and then exported as DXF (AAMA, ASTM, AUTOCAD), HPGL, and ISO formats to be used in 3D software for virtual sampling. Finally, **CadModeling** is an Italian company specializing in designing and customizing made-to-measure anthropometric fit mannequins. It offers 3D/AR models, and using the *Formax 3D Virtual model*, one can conduct regular simulations and fitting sessions as well as ergonomic simulations. The range of fit mannequins is based on realistic human anatomy called Theory of Body Shape, which was developed by the company's founder. It offers eight different mannequin types, including Formax Woman (12 body shapes), men, kids, and form heads with fifteen different head circumferences with facial features ranging from baby to adult. Figure 8 shows virtual and physical mannequins, which are fully customizable in size, shape, and volume. The virtual avatars can be imported and used in any CAD system for the virtual sampling process.

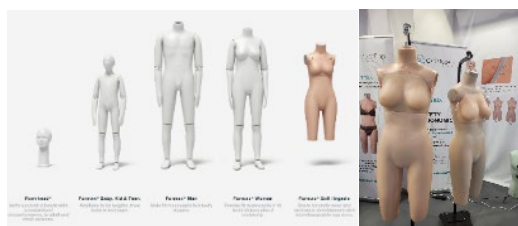


Figure 8. Virtual and physical forms from CadModeling (CadModeling, 2023)

Conclusion

This paper summarized the innovation in 3D simulation and virtual prototyping for the CAD process presented at ITMA 2023. A range of virtual sampling systems and software for garments and textile

development with different levels of immersion, along with other tools that facilitate virtual sampling, were presented. Rapid visualization, ease of digitalization, and seamless integration of 3D simulation were the main themes. It is essential for companies to create and integrate more realistic virtual sampling into their product life cycle process to accelerate their planning and designing and to facilitate sustainable manufacturing. The various CAD software products and platforms discussed here could be adopted to suit a company's need to initiate and advance virtual sampling to accelerate its planning and sustainable production process.

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