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ITMA 2023: Developments on Ergonomics in the Fashion and Apparel Industry

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Introduction

Ergonomic apparel seeks to optimize comfort, functionality, and efficiency for the wearer. Customers would be able to benefit from ergonomic garments, not just to provide more comfort, but also to prevent injuries. Safety is intertwined with physical ergonomics topics. Effective ergonomic design can optimize pressure distribution, and reduce impact force, and discomfort. Ergonomic garments provide users with advantages such as positive impacts on human performance and health, mental workload, decision-making, skilled performance, human reliability, and productivity (McCauley 2012).

There are many parameters such as proper fit, pressure and fabric tension on the skin, and friction between fabric surface and the skin that should be met in well-designed ergonomic, and comfortable apparel. Implementation and development of ergonomic parameters in textile products requires developments on the production lines. Many enterprises work on providing textile firms with equipment which can assist them to meet ergonomic garments requirements in their production. Nowadays, comfort and fit is one of the top priorities of individuals in selecting apparel (Parker et al, 2004; Chowdhury & Akter, 2018; Abdolmaleki et al 2018). Many parameters should be considered in designing ergonomic garments. Finding the proper fit plays an important role in this matter which designers deal with. At the ITMA 2023 in Milan, Italy, several companies presented their products to facilitate the production of well-fitting and ergonomic clothing. This paper will introduce some of them and their developments in facilitating the manufacturing of ergonomic apparel.

Customization with 3D body Scanning

During the last two decades, some studies have been accomplished regarding the utilization of the 3D body scanning technique to find the fit in apparel production (Istook & Hwang, 2001; West & Gabel, 2014; Irzmańska and Okrasa, 2018). This technology has aided the textile industry in various fields from the classification of body shapes to finding the alterations of body dimensions in different postures. (Devarajan & Istook, 2004; Lee & Wang, 2015; Zhang et al 2022)

Customized Avatars

Pattern-making is one of the earliest steps of apparel production. Nowadays many fashion designers are benefiting from Computer-aided design (CAD) software to design their desired clothes. To design fit garments, designers need a 3D avatar with a great similarity to real body shapes. AUDACES is an Italian-Brazilian company that has considered this issue in its developing program. This company has been active in different areas of the fashion industry for

over three decades including but not limited to the pattern plotter, fabric layers spreader, pattern conveyor cutter, and a wide range of software that are requirements of all garment, fashion, technical clothing and upholstery productions.

Figure 1. The booth of AUDACES company in ITMA 2023

Before garment production, 3D visualization software provides the ability to check garments on the 3D avatars. Besides the aesthetic aspect, comfort and fit parameters play an important role in pattern making. Realistic avatars provide a real perception of fit and comfort for designers in pre-production steps. AUDACES 3D is a three-dimensional visualization software presented by this multinational company. AUDACES has equipped its software with the ability to import the client's 3D body scanning photos as a customized avatar. So the designer would be able to understand how the garment will look on the body in reality. AUDACES has added the capability of importing customized avatars by using 3D body scanning techniques to their program. Customized avatars represent the client's body shapes and designers can adjust the patterns on the realistic body shape. To produce garments and gear for users with unique body types, including individuals with some diseases and disabilities, this technique becomes more considerable and helpful. This technique can provide disabled individuals with their desired fit and comfortable garments by aiming at measuring accurate and precise body sizes and simulating the morphological shape of clients with atypical skeletal structures and physical deformations such as scoliosis patients (Hong et al., 2017). As a result, the designer would be able to check the tension on the avatar and adjust or redesign the clothing patterns - if they are needed - to meet desired fit. Furthermore, designers can drape fabrics onto the mannequin to simulate the natural fall and behavior of the fabric on the human body. This enables them to visualize and adjust the pattern's shape, seams, and proportions for optimal fit and aesthetics. Companies can reduce their physical prototype, consequently, this technology helps in sustainably saving time and resources, and also it positively impacts customer satisfaction levels.

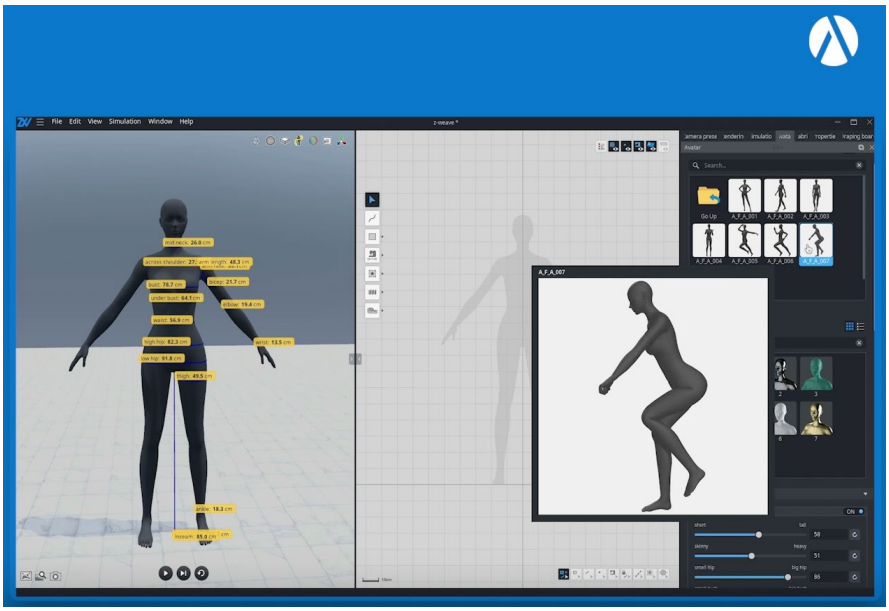

Figure 2. The Avatar in AUDACES 3D Software

Classified Clothing Patterns

An Australia-based company named *Pattern Room* presented a comprehensive clothing patterns database that is a game changer for designers and garments.

The main aim of this company is to provide a comfortable fit for clients. Experts in this company believe that fit is not size. Individuals, in addition to the right size, should consider the fit in garments to feel comfortable. They describe fit into 6 different categories including compression, tight, slim, regular, loose, and oversize. Designers should consider what the client is looking for to cover the blanks to fit. To benefit from the Pattern Room database, first of all, the type of garments should be selected. The customers easily find the desired styles in the next step. In the final step clients choose sizing and their patterns are quickly ready to purchase.

Figure 3. The Booth of Pattern Room Company in ITMA 2023

The *Pattern Room* company offers a comprehensive database aimed at resolving fit issues encountered by garment manufacturers and tailors. Designers can identify perfectly fitting garments for customers, which serve as representatives of the desired fit and size. The company utilizes a 3D body scanning technique to collect diverse body shapes, creating an optimized dimension database. Designers can then access clothing patterns which are classified by gender and body styles in this database for subsequent garments, ensuring consistent fit and customer satisfaction. This approach minimizes product returns and refund requests, leading to happier customers and potential positive reviews, ultimately contributing to increased profitability. Through the usage of this dataset, grading processes could become much easier and quicker for apparel designers and manufacturers. The *Pattern Room*'s garment patterns, developed through 3D visualization, are cost-effective, increase productivity, and reduce design process time, offering sustainable solutions for the fashion industry.

Customized Mannequins

An Italy-based company, *CadModelling*, targets providing fit, safe, and ergonomic apparel. They have worked on the tailor mannequin concept to evolve fit in the apparel industry and at the same time, Their developed technology in mannequin production saves time and resources in a sustainable way. They presented a technique to create customized mannequins. They are using the 3D body scanning technology to scan individuals' whole bodies or parts of their bodies. This process captures the shape and dimensions of the person's body and creates a digital 3D model. This photo capturing would be done by 3D scanned sensors and could be from the full body or only from the specific body part such as the hand, head, or foot to make mannequins for designing customized and well-fitting gloves, helmets, footwear, or other specific gear. The scanned photos should be exported in ".stl" or ".obj" files for further processes. Scanning has to be done in static status and the quality of sensors used in the body scanning directly impacts the quality of the results. It is clear to have better results, higher-quality scanner sensors should be used. The exported files obviously can be used as customized avatars for computer-aided design (CAD) purposes in 3D visualization software.

Figure 4. CadModelling Mannequins in ITMA 2023

For the further step of production, CadModelling utilizes the Computer Numerical Control (CNC) technology which is automated machinery controlled by computer programs to precisely cut, shape, and carve fiberglass. They selected fiberglass as a substance because it is strong and light enough to be a proper material to make durable and easy-to-use mannequins for seamsters. CadModelling exhibits how CNC can be valuable and efficient for the fashion industry. First of all, they import the 3D body scan files into 3D modeling software to refine and optimize the model. Through this step, they can make adjustments and clean up any imperfections, if it is needed, and then prepare digital models for CNC processing. They believe that CNC is the best option to make mannequins with the highest level of accuracy and similarity with the original models. Utilization of the CNC technique in the fashion industry is very rare and it is hard to find examples of usages of CNC in fashion

design and the textile industry. Seamsters and designers can visualize how the finished garment will look on their bodies by seeing it on a mannequin that closely represents their measurements and proportions. But *CalModelling* creatively not only provides comfortable, well-fitting, and well-designed garments but also helps the polluting fashion and textile industry to move toward sustainability.

Pressure Measuring Device:

As it is mentioned, fit is one of the most important parameters of ergonomics. Many companies such as those that have been mentioned earlier, tried to create clothing patterns, avatars, and mannequins which are precisely similar to real body shapes to provide designers with the tools to design beautifully fit garments for their clients.

But to test and find the fit issues, monitoring the pressure of garments, gear, or footwear on the skin is considerable. Manufacturers need equipment to measure the pressure to find the peak of pressure and evaluate the level of pressure which is safe and practical for users. To meet standard levels of pressure and reduce the risk of injuries to end users, clothing patterns may need to be modified or redesigned. There are many different types of pressure sensors, but they have to be feasible to be embedded and fixed in between the internal layer of the garment and the user's skin.

SWISSLASTIC is a company from Switzerland which presented an apparatus named Multi Pressure Tester. This device is a multipoint probe system which is offered in two models including MPT-4 and MPT-7 which are equipped with 4 and 7 sensors respectively. The sensors can be applied on most parts of the body including the foot, knee, elbow, abdomen, and lumber. It is functional for a wide range of garments such as socks, underwear, sportswear, sports bra, shapewear, etc.

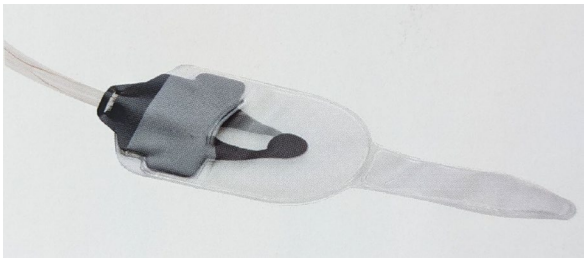

Figure 5. The pressure sensor used in the Multi Pressure Tester

The method of usage of this device has been easily demonstrated in the company's booth in ITMA 2023. At first, the operator applies the probes on the skin, then puts the garment on, and finally connects the probes to the multipoint hub to start measuring pressure. These sensors are also able to be installed on mannequins. They mentioned that portability and user-friendliness are the most noticeable and considerable advantages of this device. The range of pressure measurement by this equipment is 5-70 mmHg. The probs are designed with a 50 mm diameter and flat, therefore do not overstretch the garment and do not bother users during testing. At the end of the test, the results are shown on the screen of the device and can be transferred to the computer for further analysis. Multi Pressure Tester is a significant technology to find the right amount of pressure for designing ergonomic apparel and plays an important role in functional garments like sportswear, military clothing, firefighters' turnout suits, and protective hospital clothing.

Figure 6. The SWISSLASTIC Multi Pressure Testing in ITMA 2023

Utilization of pressure sensors in the textile industry to design ergonomic garments is a growing technique and the demands on it from the market are rising in comparison with the past. As a proof of concept, an Iran-based company named MR-KNIT Group which makes yarn tension meters, considering the increasing demand for the pressure meter of garments, has started to make this type of pressure sensor beyond their focused field on the yarn tension meters. It demonstrates how much demand is increasing for this technology. As mentioned, there have been other different pressure sensors which were not designed specifically to be used in the apparel and textile industry such as bladder pressure sensors and they have been applied for measuring the pressure of elastic garments on the skin. However, the SWISSLASTIC company believes their product is specifically designed for this purpose. Designers and garment manufacturers who care about ergonomics will find it useful, accurate, and easy-to-use equipment

Conclusion:

Since the demand for comfortable and well-fitting apparel is rising among consumers, designing and producing clothing that meets ergonomic parameters plays an important role in getting the market share. The tendency of individuals to wear comfortable garments is rising. It is the fashion and textile industries' responsibility to design and produce ergonomic clothing to meet this demand. Fit is one of the most significant parameters of ergonomics and should be considered by designers. The textile and fashion industry by manufacturing ergonomic garments is not only able to improve the level of client satisfaction but also moves towards sustainability by saving time and resources, increasing the lifetime of garments, and reduction in return rates. This enhances customer satisfaction, consequently, it could reduce the chances of returns and waste. The high return rate negatively impacts environmental sustainability and increases greenhouse gas emissions (Bozzi et al 2022).

In ITMA 2023, many companies in the textile and apparel industry presented their novel developments that are assisting the fashion industry in providing customers with ergonomic apparel. By benefiting from the 3D scanning technology, CadModelling creates customized mannequins, the Pattern Room company has prepared a wide range of well-fitting clothing patterns for various body shapes and AUDACES 3D can import customized avatars for each client. As the representative of the SWISSLASTIC company mentioned in their booth, the probes of their multi pressure device can be applied to the body and on mannequins. Combining this technology with customized

mannequins can have significant effects on easing the production of ergonomic apparel. All these products provide garment manufacturers with developed requirements to produce more comfortable and fit garments for customers. As a result of ergonomic garment production, the textile and fashion industry become more sustainable and environmentally friendly due to the reduction in resource consumption and waste, saving time, and increasing the level of consumer satisfaction.

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