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Application of ETcad Technology in Down Jacket Pattern Making: Innovative Practice and Advantages of CAD Technology

Song Yang[1], JingJin[2*]

[1] Clothing printmaker, Hangzhou Shanshang Clothing Co., Ltd., Hangzhou City, Zhejiang,310000, China

[2] Industrial Artist, Doctor of Philosophy (PhD). Candidate Guangzhou Industry & Trade Technician College, Guangzhou, 510425, China

Corresponding Author: JingJin

Industrial Artist, Doctor of Philosophy (PhD). Candidate Guangzhou Industry & Trade Technician College, Guangzhou, 510425, China

ABSTRACT

The present study delves into the application of ETcad technology in down jacket pattern making and conducts a comparative analysis with traditional manual pattern making. Through the analysis of practical cases, the study reveals the significant advantages of CAD technology in improving pattern making efficiency, reducing production costs, and enhancing product quality. The research findings indicate that ETcad technology, by means of accurately calculating down filling quantities, optimizing pattern design, and automating material layout, has dramatically shortened the pattern making time, reduced material waste, and increased fabric utilization. Moreover, it has demonstrated remarkable performance in handling complex designs and rapidly responding to market demands, thereby enhancing the market competitiveness of enterprises. This study also explores the impact of CAD technology on traditional pattern making processes and its future development directions, providing theoretical support and practical references for the digital transformation of the clothing industry.

KEY WORDS: CAD technology; Down jacket pattern making; Digital transformation; Comparison with manual pattern making

1. Introduction

The pattern-making system is one of the most critical components of a clothing CAD system. It digitizes the process of transforming designers' creative ideas into tangible garment patterns. Pattern makers can quickly draft basic patterns, modify and adjust patterns, and output the final patterns either as paper patterns or directly transmit them to production equipment through this system. Additionally, the pattern-making system has a powerful storage function that allows commonly used patterns to be saved in a database for easy retrieval and modification. This not only increases the efficiency of pattern making but also reduces repetitive work and the likelihood of errors.

With the rapid advancement of technology, digital technology is increasingly being applied across various industries. In the clothing industry, traditional manual pattern-making methods can no longer meet the modern requirements for efficiency, precision,

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and diversity in garment production. In recent years, computer-aided design (CAD) technology has gradually become an important tool for pattern making in the clothing industry, significantly changing the traditional modes of garment design and production. This is especially true in the pattern-making process of complex products such as down jackets, where the advantages of CAD technology are more pronounced. The pattern making of down jackets involves multiple patterns, meticulous craftsmanship requirements, and relatively high material costs. Traditional manual pattern-making methods are not only inefficient but also prone to errors. Therefore, it is of great practical significance to study the application of CAD technology in down jacket pattern making and compare it with manual pattern making.

2. Research Questions

(1) What are the specific applications of CAD technology in down jacket pattern making?

(2) What are the advantages of CAD technology compared to traditional manual pattern making?

(3) What significance does the application of CAD technology in down jacket pattern making hold for the development of the clothing industry?

3. Literature Review

In recent years, the application of computer-aided design (CAD) technology in the field of garment pattern making has attracted widespread attention. Lin and Hu (2010) pointed out in *Practical Garment Techniques* that CAD technology has significant advantages in garment design, effectively improving design efficiency and accuracy. Wang and Yin (2013) further compared the advantages and disadvantages of CAD technology and manual pattern making, emphasizing the outstanding performance of CAD technology in improving production efficiency and reducing costs. However, there is currently a relative lack of research on the specific application of CAD technology in down jacket pattern making and its comparison with manual pattern making.

In evaluating the long-term economic benefits of ETCAD technology in down jacket pattern making, relevant studies have provided a multidimensional perspective. As an advanced computer-aided design system, ETCAD technology has demonstrated significant technological advantages in down jacket pattern making. It can significantly reduce design time, improve design quality, and lower error rates (Zhettessova et al., 2021). In down jacket pattern making, ETCAD technology optimizes the filling of down in various parts by accurately calculating the amount of down, thereby improving the quality and comfort of the finished product (Tianjin GetonAgain Technology Co., Limited, 2024). In addition, ETCAD technology reduces the complexity and error rates of manual operations through automation and intelligent processes. For example, Bosideng Company has achieved large-scale grading and automatic assembly through an intelligent CAD system, significantly improving cutting speed and production efficiency (Chinese Academy of Engineering Consulting Research Project Team, 2018). This not only enhances production efficiency but also reduces material and energy consumption, further enhancing the economic benefits of the enterprise.

The application of ETCAD technology in down jacket pattern making can significantly reduce production costs. By accurately calculating the amount of down and optimizing design, ETCAD technology can reduce material waste and improve fabric utilization (Tianjin GetonAgain Technology Co., Limited, 2024). At the same time, the automated and intelligent production process reduces dependence on manual labor, lowering labor costs (Chinese Academy of Engineering Consulting Research Project Team, 2018). In addition, CAD technology can shorten the production cycle, reducing the time from order to delivery to 7 days, which not only improves production efficiency but also reduces inventory costs (Chinese Academy of Engineering Consulting Research Project Team, 2018).

The application of ETCAD technology can significantly improve the quality and design level of down jackets, thereby enhancing the market competitiveness of enterprises. Studies have shown that there is a positive correlation between CAD technology and the quality and innovative design of garment manufacturing companies, employee productivity, cost-effectiveness, customer responsiveness, production efficiency, shortened delivery times, and competitive ability (Chaudhary et al., 2020). This means that by adopting ETCAD technology, enterprises can launch higher quality and more innovative products to meet market demands and enhance brand value. In addition, ETCAD technology can help enterprises better cope with changes in market demand. The fashion industry requires rapid product adjustments and market responses, and ETCAD technology, through three-dimensional visualization and rapid prototyping, can help enterprises adjust design and production more quickly (Hu, 2011). This flexibility and rapid response capability is key for enterprises to maintain a competitive advantage in the fierce market competition.

From the perspective of social and economic benefits, the application of ETCAD technology not only improves the economic benefits of enterprises but also brings broader social benefits. CAD technology can reduce the dependence of design results on changes in the design team and improve the work efficiency and satisfaction of designers (Zhettessova et al., 2021). By improving production efficiency and reducing costs, enterprises can expand their market share, increase sales, and drive the development of the entire industrial chain (Zhettessova et al., 2021). Relevant studies have also pointed out that the cost of implementing a CAD technology system can be recovered in about 3 years (Zhettessova et al., 2021). This means that after the initial investment, enterprises can achieve a return on investment in a relatively short period of time. In addition, the service life of a CAD technology system is relatively long, and if enterprises can continue to use and optimize the system, its long-term economic benefits will be more significant.

In summary, the application of ETCAD technology in down jacket pattern making not only has significant technological advantages and cost-saving effects but also enhances the market competitiveness and brand value of enterprises, bringing broad social and economic benefits. Therefore, in-depth research on the application of ETCAD technology in down jacket pattern making and its comparison with manual pattern making is of great theoretical and practical significance for promoting the digital transformation of the garment industry.

4. Research Methods

This study employs case analysis, focusing on the application of ETcad in making quilted down jackets to provide a detailed examination of the use of CAD technology in down jacket pattern making. By comparing the specific operational steps, efficiency,

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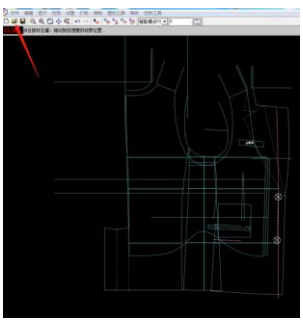
and costs of CAD pattern making and manual pattern making, the advantages of CAD technology are analyzed. In addition, interviews with industry experts and actual production data from factories are used to further verify the application effects of CAD technology in down jacket pattern making.

5. Case Study

5.1 Practical Analysis of Down Jacket CAD Pattern Making

5.1.1 Drawing the Basic Pattern

Open the CAD pattern-making interface, click on the folder in the upper left corner, and locate the basic mother pattern previously saved in the pattern file. This step saves the time required for drawing the basic pattern and ensures that the basic shape of the mother pattern is verified and error-free. Next, save the file under the desired style name and use the smart pen tool to create the pattern. According to the designer's requirements, draw the cutting lines, extract the pattern pieces, and refresh the seam allowances (see Figures 1 and 2). Through these basic operations, pattern-making efficiency can be increased several times over, while also reducing the workload of the pattern maker.



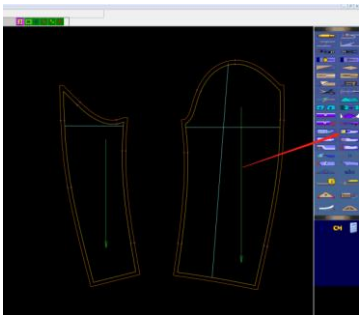


Figure 1. CAD Basic Mother Pattern Making Interface

Figure 2. CAD Sleeve Pattern Making Operation Interface

Source: Drawn by the researcher.

5.1.2 Quilting Line Drawing on Pattern

Typically, the pattern maker determines the size and proportion of the quilting lines according to the designer's requirements and then uses the cutting line function on the ETCAD pattern-making interface to automatically generate equidistant parallel lines (see Figure 3). With this function, when grading the pattern, these quilting lines will automatically extend along with the edges of the pattern. This advantage cannot be demonstrated at all in the traditional flat pattern grading process.

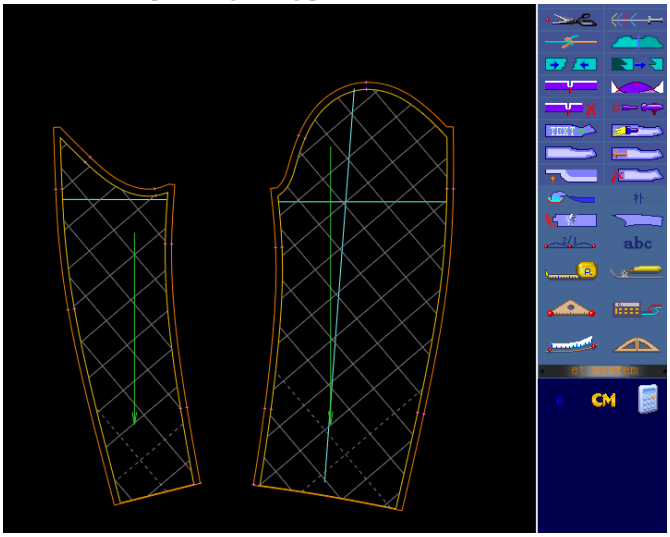


Figure 3. ETCAD Cutting Line Function Pattern-Making Interface

Source: Drawn by the researcher.

5.1.3 Sizing of Lining Pattern

The lining pattern is generated by copying the face fabric pattern. In traditional manual pattern making, some craftsmen would directly add a 1.5-2 cm seam allowance to the copied pattern as the lining pattern, but this method is not scientific. In the CAD interface, the scaling tool can be used for proportional sizing. There are usually two sizing standards for down jacket lining patterns: one is for face fabric quilting lines, in which case the scaling tool in the CAD interface is used (see Figure 4). This scaling requires enlarging the pattern by 1-2 cm, which ensures that the lining fits well during sample making and prevents the face fabric from puckering; the other is for lining quilting lines, in which case the lining pattern needs a larger scaling ratio, typically 3-4 cm larger than the face fabric pattern, so that the finished garment will be flat and not sagging. The advantage of this function is that the lining pattern is enlarged proportionally according to the needs, rather than simply adding seam allowances that would enlarge only locally.

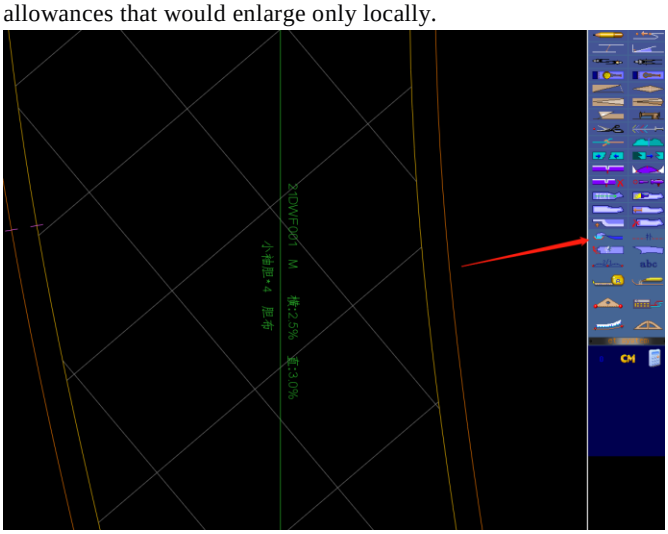


Figure 4. ETCAD Face Fabric Quilting Interface

Source: Drawn by the researcher.

5.1.4 Lining Pattern Making

The lining pattern is also generated by copying the face fabric pattern. During the process, the pattern should be simplified as much as possible, with sections that can be merged into a single piece being made whole to streamline the process and promote efficient mass production, thereby reducing costs. Additionally, a 0.8-1 cm ease allowance should be added to the armpit area of the sleeve to ensure that the lining is smooth under the armpit in the finished garment.

5.1.5 Down Filling Calculation

The method for calculating the amount of down filling involves multiplying the area of the pattern piece by the unit weight. Traditionally, in manual flat pattern making, craftsmen would use a sheet of paper with 1 cm² grid squares to estimate the area of the pattern piece. In contrast, the CAD pattern-making system can quickly and accurately calculate the area of the pattern piece using an area calculation tool (see Figure 5), which significantly reduces the time and increases the accuracy of area calculation. The advantage of this function is that the calculated area is more precise than that obtained through manual flat pattern making. In terms of down filling, it allows better control over the thickness

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of the filling pieces, ensuring uniform thickness of the garment and reducing unnecessary waste of down.

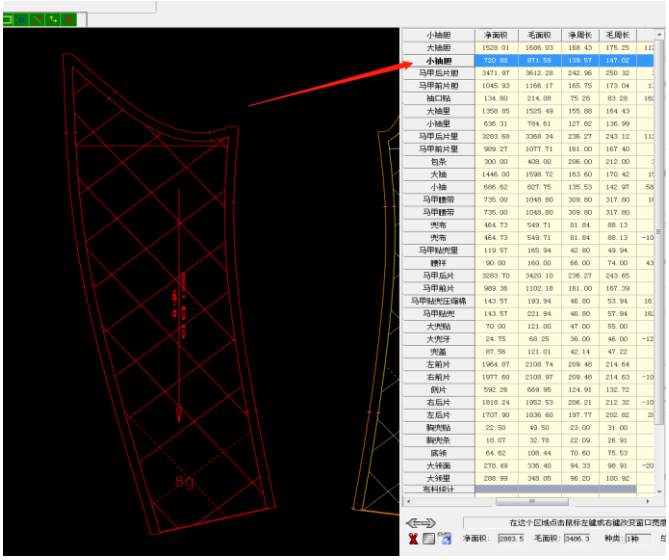

Figure 5. ETCAD Down Filling Calculation Interface

Source: Drawn by the researcher.

5.1.6 Application of the Nesting System

The nesting function of the CAD pattern-making system is highly convenient. It can accurately calculate the fabric consumption for a single garment and achieve high utilization rates in mass production nesting, with no deviation in grain direction and no issues such as missing or omitted pieces. The nesting data can be directly printed on marker paper and handed over to the cutting table, eliminating the technical requirements for manual nesting. Factories with the capability can even transmit the nested data to an automatic cutting machine for automated cutting, an advantage that manual nesting cannot achieve (see Figure 6).

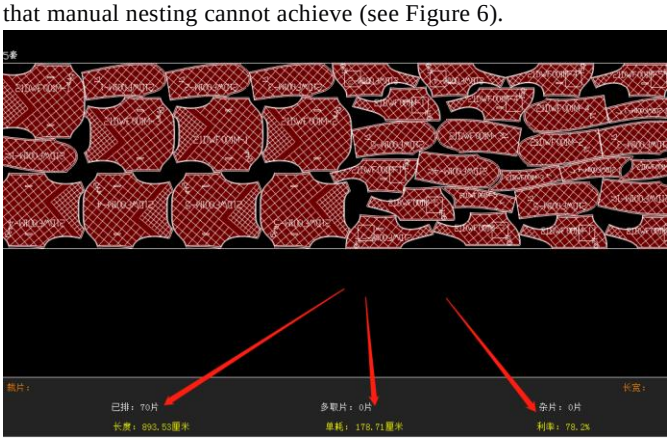

Figure 6. Nesting Function Interface of the CAD Pattern-Making System

Source: Drawn by the researcher.

5.1.7 Integration with Intelligent Production

Pattern data created using CAD for garment pattern making can be directly transmitted to the production system of intelligent equipment. This allows for the creation of quilting templates and editing of quilting files according to the style requirements, truly enabling the automation of equipment. The biggest advantage of automatic quilting is its ability to sew a variety of patterns with excellent results, ensuring smooth fabric pieces and even stitching without down leakage. Automatic quilting machines can handle stitch patterns that are impossible to achieve with manual quilting (see Figures 7 and 8).

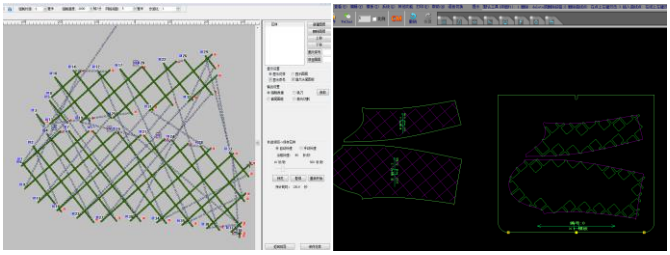

Figure 7 and 8. Intelligent Production Interface of CAD Pattern-Making System

Source: Drawn by the researcher.

5.2 Application Effects of ETCAD Technology in Men's and Women's Down Jacket Pattern Making

There are certain differences in the application effects of ETCAD technology in men's and women's down jacket pattern making, which are mainly reflected in the following aspects:

5.2.1 Applicability and Enterprise Needs

According to Qian and Chen (2023), ET clothing CAD technology is considered more suitable for enterprise use due to its comprehensive functions and convenient operation, which can meet the high-efficiency needs of enterprises for clothing pattern making. In contrast, although Fuyi clothing CAD has comprehensive functions, it is more suitable for beginners and educational purposes. This may imply that in actual production, ET clothing CAD is more widely and efficiently used in enterprises. Therefore, in the pattern making of men's and women's down jackets, ETCAD technology may be more inclined to serve enterprise-level production, while women's jackets may focus more on personalized design and educational uses.

5.2.2 Intelligence and Customization

As seen from the studies of Feng (2020) and Hu (2011), the application of digital and intelligent technologies (such as 3D fitting and assembly systems and CAD technology) in clothing design has made the design process more efficient and precise. In the pattern making of men's and women's down jackets, ETCAD technology may improve efficiency through these techniques, such as virtual fitting, body measurement, and 3D modeling to optimize design. However, women's down jackets may focus more on personalized design and customization needs, which may require more flexible software support. In this regard, ETCAD technology may need further optimization to meet the diverse needs of women's jackets.

5.2.3 Technical Complexity and Operational Convenience

According to Papahristou (2016), intelligent clothing design systems simplify operational steps compared with traditional CAD systems, reduce intermediate links, and improve efficiency. ETCAD technology may have the advantage of simplifying the operational process in the pattern making of both men's and women's down jackets. However, women's jackets may focus more on detail processing and personalized design, thus having higher requirements for operational convenience and flexibility. This means that in the pattern making of women's down jackets, ETCAD technology may need more powerful functions to support complex customization needs.

5.2.4 Cost and Benefit

Papahristou (2016) mentioned that the clothing industry needs to use advanced computer-aided design (CAD) technology to reduce costs and improve competitiveness. ETCAD technology may have

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the advantage of reducing costs in the pattern making of both men's and women's down jackets. However, women's down jackets may focus more on the needs of the high-end market, thus having higher requirements for the advancement of technology and cost control. This may lead enterprises to prefer using more advanced ETCAD technology in the pattern making of women's down jackets.

5.2.5 Technological Integration and Innovation

According to D and Wu (2024), ETCAD technology may achieve higher design precision and innovation through integration with other technologies (such as virtual simulation technology and intelligent tools) in the pattern making of men's and women's down jackets. However, women's down jackets may focus more on the combination of innovation and fashion elements. Therefore, more innovation and adjustment may be needed in terms of technological integration.

Although ETCAD technology has the effect of improving efficiency and reducing costs in the pattern making of both men's and women's down jackets, women's down jackets may focus more on personalized design, customization needs, and competitiveness in the high-end market. Therefore, higher requirements for the flexibility and innovation of technology are needed.

6. Research Results and Findings

6.1 Advantages of ETCAD Technology in Down Jacket Pattern Making Compared with Manual Pattern Making

Compared with manual pattern making, the application of ETCAD technology in down jacket pattern making has significant advantages in terms of efficiency improvement, precision optimization, and resource conservation. The following is a detailed analysis from multiple aspects:

6.1.1 Efficiency Improvement

Compared with traditional manual pattern making, ETCAD technology has realized a fast and efficient pattern-making process through the computer-aided design (CAD) system. The CAD system can automatically complete tasks such as pattern design, cutting, and fabric layout, thereby significantly reducing the time required. For example, in the production of short-sleeved men's T-shirts, the CAD system is more than 1.5 times faster than manual methods in fabric layout and cutting (Datta et al., 2022). Similarly, in down jacket sewing, fully automatic template sewing technology generates template design files through CAD software and completes sewing with the help of laser cutting machines and fully automatic template sewing machines, which significantly improves production efficiency (Zhu, 2018).

6.1.2 Precision Optimization

CAD technology can precisely control the size and shape of garments, reducing errors caused by manual operations. For example, the CAD system can accurately measure and adjust the size of garment components to ensure the matching degree between components (Suryani & Imayanti, 2018). In addition, CAD technology also supports the implementation of complex designs, such as the precise edging and multi-line design of parts like the placket and cuffs of down jackets (Zhu, 2018). In contrast, manual pattern making relies on the experience and skills of pattern makers, which can easily lead to deviations and inconsistencies.

6.1.3 Resource Conservation

CAD technology reduces fabric waste by optimizing the use of materials. For example, in down jacket production, the CAD system can accurately calculate the size and quantity of fabric needed according to actual requirements, avoiding excessive cutting (Zhang & Barbour, 2020). In addition, CAD technology also supports sustainable design by optimizing garment pattern marking and material utilization, reducing resource waste (Zhang & Barbour, 2020).

6.1.4 Flexibility and Diversity

CAD technology allows designers to easily modify designs and quickly generate new templates. For example, through software tools, designers can enlarge, rotate, and modify traditional embroidery patterns to meet different design needs (Sharma et al., 2020). This flexibility makes CAD technology particularly suitable for the down jacket production environment, which requires frequent design updates.

6.1.5 Cost-effectiveness

CAD technology not only improves production efficiency but also reduces labor costs. For example, using the CAD system can reduce the dependence on skilled pattern makers while increasing the flexibility of production scale (Pirone, 2010). In addition, the CAD system can also digitally store design models for easy modification and access in the future (Zhang & Barbour, 2020).

6.1.6 Applicability and Limitations

Despite the significant advantages of ETCAD technology in down jacket pattern making, its applicability is also subject to certain limitations. For example, some complex or non-standardized designs may require manual adjustments to achieve the best results (Qian & Chen, 2023). In addition, the operation of the CAD system requires a certain learning cost and technical support (Suryani & Imayanti, 2018).

6.2 Advantages of CAD Technology

From the above research, we can see that the application of CAD technology in down jacket pattern making has significant advantages. First, CAD technology can achieve precise pattern making. With digital tools, pattern makers can precisely control each size and shape, avoiding errors caused by human factors in manual pattern making. Second, CAD technology can quickly grade patterns. By setting the grading parameters on the x-axis and y-axis, it can quickly and accurately grade the patterns to the desired size. In addition, CAD technology can also quickly nest patterns, accurately calculate the consumption of garment fabric, improve the utilization rate of materials, and reduce waste. Compared with manual pattern making, the application of ETCAD technology in down jacket pattern making has significant advantages in terms of efficiency, precision, and resource utilization (Datta et al., 2022; Suryani & Imayanti, 2018; Zhang & Barbour, 2020).

6.3 Significance of CAD Technology for the Development of the Clothing Industry

The application of CAD technology in down jacket pattern making is of great significance for the development of the clothing industry. First, CAD technology improves the efficiency of pattern making, reduces repetitive work, and lowers production costs. Second, CAD technology improves the precision of pattern making and ensures the consistency of product quality. In addition, CAD technology also supports sustainable design. By optimizing the use of materials, it reduces fabric waste and meets environmental protection requirements (Sharma et al., 2020; Zhang & Barbour, 2020).

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6.4 Limitations of ETCAD Technology in Down Jacket Pattern Making

Despite the significant advantages of ETCAD technology in down jacket pattern making, there are still some limitations in practical application. It is necessary to combine manual adjustments to cope with complex design requirements and pay attention to technical training for operators to fully exploit the potential of the CAD system (Qian & Chen, 2023; Ugwu et al., 2023).

6.4.1 Technical Complexity and Operational Difficulty

Although ETCAD technology has certain advantages in garment pattern making, its complexity and operational difficulty are relatively high, especially for beginners and small enterprises, who may find it difficult to get started and become proficient in its use (Qian & Chen, 2023). In addition, teachers also face problems such as insufficient technical skills, lack of computers, and inadequate technical support when teaching garment pattern making. These issues may affect the popularity and effectiveness of ETCAD technology in practical application (Ugwu et al., 2023).

6.4.2 Cost and Resource Constraints

The use of ETCAD technology requires high hardware and software costs, which to some extent restricts its promotion in small and medium-sized enterprises. For example, the application of digital technology in swimwear pattern making shows that although digital methods can improve efficiency and accuracy, they require professional skills and high software and hardware costs. This is a considerable burden for many enterprises (Afifi et al., n.d.).

6.4.3 Functional Limitations

Despite the fact that ETCAD software can handle three-dimensional garment pattern design, its functions still have limitations. For example, some software may not be able to fully simulate the real wearing effect, which leads designers to return to traditional flat design for modification. This weakens the advantages of CAD technology (Zhang et al., 2008). In addition, the applicability of ETCAD software may not have been fully verified, which means that it may not be able to meet all needs in practical application (Qian & Chen, 2023).

6.4.4 Insufficient Education and Training

Problems such as teachers' insufficient skills, inadequate technical support, and students' low interest in courses in the process of teaching garment pattern making also reflect the limitations of ETCAD technology in education and training. These problems may lead to students' inability to effectively master ETCAD technology, thereby affecting its application effect in down jacket pattern making (Ugwu et al., 2023).

6.4.5 Challenges of Mass Production

Although ETCAD technology has certain advantages in personalized production, it still faces challenges in mass production. For example, research on electronic textiles (e-textiles) shows that mass production needs to overcome problems such as the lack of production standards and technical barriers from prototype to production. These challenges may also apply to the application of ETCAD technology in down jacket pattern making (Zhu & Kao, 2022).

7. Discussions

7.1 Impact of CAD Technology on Traditional Pattern-Making Techniques

The widespread application of CAD technology has had a profound impact on traditional manual pattern-making techniques. On one hand, traditional manual pattern making relies on the rich experience and manual skills of pattern makers, while CAD technology has achieved standardization and automation of pattern making through digital tools. This makes the pattern-making process more efficient and precise, reducing human errors. However, this may also lead to the gradual loss of some traditional manual pattern-making skills. For example, some complex three-dimensional cutting techniques and manual adjustment methods cannot be completely replaced by CAD systems. Therefore, how to retain and pass on the essence of traditional manual pattern making while promoting CAD technology is a question worthy of in-depth discussion.

7.2 Popularization of CAD Technology and Talent Cultivation

The widespread application of CAD technology has put forward new requirements for the talent structure of the clothing industry. Traditional pattern makers need to master the operation skills of CAD systems, and new talents need to have the ability of digital design and pattern making. At present, there is a relative shortage of CAD technology talents in the clothing industry, which to some extent restricts the popularization and application of CAD technology. Therefore, strengthening the education and training of CAD technology and cultivating compound talents who understand both traditional pattern making and CAD technology is the key to promoting the digital transformation of the clothing industry. At the same time, enterprises also need to increase investment in CAD technology and provide a good learning and practice environment to promote the widespread application of CAD technology in the clothing industry.

8. Conclusion

This study systematically investigated the application of ETcad technology in down jacket pattern making and comprehensively analyzed its comparative advantages over traditional manual pattern making. The research found that ETcad technology excels in improving pattern-making efficiency, reducing production costs, and enhancing product quality. Its precise size control, rapid grading and nesting functions, and flexible response to complex designs significantly enhance the overall efficiency of down jacket production. Moreover, ETcad technology supports sustainable design by reducing fabric waste and meeting environmental requirements. However, the application of ETcad technology also faces some challenges, such as technical complexity, operational difficulty, and cost constraints. Therefore, while promoting CAD technology, it is important to focus on the inheritance of traditional manual pattern-making skills and the cultivation of compound talents. In the future, with the continuous progress of technology, CAD technology will continue to improve and provide more possibilities for the intelligent production and sustainable development of the clothing industry. However, the irreplaceability of traditional manual pattern-making skills also reminds us to balance traditional and modern technologies in the digital transformation to achieve comprehensive industry development.

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