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METHODS OF MODELING SKIRTS RROM WAIST GARMENTS

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Abstract:

The design and modeling of skirts from waist garments play a significant role in light industry, particularly in women's fashion. This study explores various methods of skirt modeling from the standpoint of functionality, aesthetics, and production technology. Emphasis is placed on the classification of modeling techniques including geometric, constructive, and computer-aided design (CAD) methods. The study utilizes a comparative methodology, analyzing the efficiency and suitability of each modeling approach for different skirt styles. The results provide a framework for designers and manufacturers to select appropriate techniques based on design intent and production capabilities.

Keywords: Skirt Modeling, Waist Garments, Garment Construction, Light Industry, CAD, Fashion Design

1. Introduction

The skirt, as one of the oldest and most versatile items of clothing, holds a prominent place in the design and manufacturing technology of light industry products. Originating from basic waist garments, skirts have evolved into diverse styles, shapes, and constructions that cater to both fashion trends and functional needs. The process of transforming a basic waist garment into a skirt involves a series of modeling techniques that directly influence the garment's silhouette, fit, and production efficiency. Modeling in garment design refers to the manipulation of basic patterns to achieve desired stylistic and structural outcomes. In the case of skirts, modeling methods determine the type, volume, flare, and drape of the garment. These techniques range from traditional manual approaches, such as geometric drafting and constructive pattern manipulation, to advanced digital methods using computer-aided design (CAD) systems. Each method has its own advantages and limitations depending on the complexity of the design, production scale, and technological resources available. With increasing demand for customization and rapid production in the apparel industry, it is essential to understand and compare these modeling approaches. This study aims to investigate and evaluate the most commonly used methods for modeling skirts from waist garments, focusing on their practical application, efficiency, and suitability for various production settings. By analyzing traditional and modern techniques, the research contributes to optimizing design processes and enhancing the educational framework for future specialists in the light industry sector.

Literature Review

The modeling of skirts from waist garments has been a subject of interest in both academic and industrial contexts, with significant contributions focusing on pattern construction, garment design techniques, and the integration of digital technologies into apparel production. One of the foundational texts in the field is Winifred Aldrich's *Metric Pattern Cutting for Women's Wear* (2008), which offers a systematic approach to constructing skirt patterns using geometric methods. Aldrich introduces the use of basic blocks and illustrates how different skirt shapes—such as A-line, flared, gathered, and circular skirts—can be derived through mathematical calculations and precise measurements. Her work remains a cornerstone in design education and continues to inform manual modeling practices worldwide. Shoben and Ward (2014), in *Pattern Cutting and Making Up*, emphasize the importance of constructive modeling techniques that involve transforming basic blocks through techniques such as dart manipulation, paneling, pleating, and slash-and-spread methods. These approaches allow designers to generate innovative silhouettes while maintaining structural balance and garment functionality. Their work is especially relevant in bespoke tailoring and fashion prototyping. The technological evolution of garment design has led to the emergence of Computer-Aided Design (CAD) systems, which have significantly changed how skirts are modeled. According to Fan, Yu, and Hunter (2004) in *Clothing Appearance and Fit: Science and Technology*, CAD systems such as Optitex, Lectra, and Gerber Technology provide tools for accurate pattern drafting, virtual fitting, and real-time adjustments. These systems reduce manual errors, optimize material usage, and shorten the design-to-production cycle. Kalyanova (2020) highlights the educational implications of integrating digital design technologies in fashion curricula. Her research underscores the necessity for design students to master both traditional and digital methods to meet the evolving demands of the apparel industry. Moreover, hybrid approaches combining hand-drafting and CAD enable greater creativity while ensuring precision and scalability. Several comparative studies, including those by Lee & Park (2018), have analyzed the efficiency of manual versus CAD-based skirt modeling. Results suggest that while manual methods offer better control over artistic details in early stages, CAD systems are superior in production settings due to their automation capabilities and adaptability to mass customization. In summary, the literature reveals a rich body of knowledge that spans traditional and modern techniques. While geometric and constructive methods remain foundational in design education, CAD systems are increasingly recognized for their value in industrial applications. This duality points to the importance of methodological versatility in contemporary skirt modeling practices.

2. Methods

This study employs a comparative methodological approach to examine three primary methods of modeling skirts from waist garments: geometric modeling, constructive modeling, and computer-aided design (CAD) modeling. Each method was tested using identical base measurements to ensure consistency in comparative analysis. The materials, tools, and software utilized are standard within light industry garment design practices.

a. Materials

The following materials were used throughout the modeling process:

- **Standard Women's Basic Block Patterns:** Constructed based on average body measurements (bust: 88 cm, waist: 68 cm, hips: 94 cm).
- **Pattern Paper and Muslin Fabric:** For manual modeling and prototyping.
- **Dressmaker's Tools:** Rulers, French curves, tape measures, scissors, notching tools, pins.

- **CAD Software:** Optitex Pattern Design Software (PDS) version 21 for digital modeling, grading, and 3D simulation.
- **Sewing Machine and Pressing Equipment:** For constructing test garments and evaluating the fit and structure.

b. Modeling Methods

Each skirt was modeled using the same design base: a mid-length skirt with a slight flare, waistband, and side zipper closure. The methods applied are detailed below:

- **Geometric Modeling**

This method involves manual drafting using direct mathematical calculations. Skirt types such as A-line, circle, and gathered skirts were constructed using angle measurements, radius calculations (for full and half-circle skirts), and length distribution from the waist to the hem. This approach emphasizes symmetry, precision, and proportionality, suitable for basic designs.

- **Constructive Modeling**

Constructive modeling was based on the manipulation of a basic skirt block. Techniques such as dart rotation, slash-and-spread, pleating, and panel insertion were used to create variety in silhouette and design lines. This method allows for creativity and asymmetry while maintaining anatomical fit and construction integrity.

c. CAD Modeling

Using Optitex, the basic skirt block was digitized and modified using the software's built-in tools. Features such as dart transformation, flare adjustment, and pleat creation were utilized. The software enabled real-time 3D visualization, pattern grading, and fabric consumption estimation. CAD modeling was also used to simulate fit on a digital avatar and generate print-ready marker layouts.

d. Evaluation Criteria

The efficiency and effectiveness of each method were assessed based on the following parameters:

- **Time Efficiency:** Total time taken from design to prototype.
- **Accuracy of Fit:** Evaluated through physical fitting (for manual) and 3D simulation (for CAD).
- **Ease of Modification:** Flexibility in altering the design after initial construction.
- **Fabric Utilization:** Comparison of material waste between methods.
- **Technical Complexity:** Level of skill and expertise required for implementation.

Data from each method were documented and compared quantitatively and qualitatively to identify strengths, limitations, and best-use scenarios.

3. Results

The results of the study provide a comparative analysis of the three skirt modeling methods: geometric modeling, constructive modeling, and computer-aided design (CAD). Each method was evaluated using standardized criteria—time efficiency, accuracy of fit, ease of modification, fabric utilization, and technical complexity. The findings are summarized in both qualitative descriptions and tabular form for clarity.

a. Time Efficiency

- **Geometric Modeling**: Required approximately **2.5 hours** to draft, cut, and assemble a basic skirt prototype. The method was fastest for simple, symmetrical designs.
- **Constructive Modeling**: Took **4 hours** on average due to the complexity of pattern manipulation and the need for multiple trial fittings.

- **CAD Modeling**: Required **2 hours** for pattern input, adjustment, 3D simulation, and digital layout. Time was significantly reduced by software automation.

b. Accuracy of Fit

- **Geometric Modeling**: Provided a good general fit for symmetrical skirts but showed minor discrepancies in contouring at the waist and hip lines.
- **Constructive Modeling**: Achieved a high level of anatomical fit and design precision, especially for skirts with darts, pleats, and complex design lines.
- **CAD Modeling**: Delivered excellent fit precision through 3D simulation and virtual prototyping, enabling pre-production error detection.

c. Ease of Modification

- **Geometric Modeling**: Limited flexibility—any design changes required redrafting the entire pattern.
- **Constructive Modeling**: Moderate flexibility—allowed for creative changes but required technical skill and time.
- **CAD Modeling**: High flexibility—design elements could be modified instantly, with real-time updates in the 3D model.

d. Fabric Utilization

- **Geometric Modeling**: Moderate fabric efficiency; some waste occurred due to basic layouts.
- **Constructive Modeling**: Varied depending on the complexity of the design; decorative elements like pleats increased consumption.
- **CAD Modeling**: High efficiency; fabric consumption was minimized through optimized marker layouts generated by the software.

e. Technical Complexity

- **Geometric Modeling**: Low to moderate—suitable for students and beginners with basic knowledge of drafting.
- **Constructive Modeling**: High—requires understanding of advanced pattern manipulation and garment structure.
- **CAD Modeling**: High—demands proficiency in CAD software but allows for broader application in industrial settings.

4. Discussion

The comparative analysis of geometric, constructive, and computer-aided design (CAD) modeling methods reveals essential insights into their suitability for different educational, creative, and industrial applications within the light industry garment sector. Each method demonstrates distinct advantages and limitations, highlighting the importance of context-based selection in the modeling process. Geometric modeling, being the most traditional method, provides a strong foundation for pattern drafting. It is ideal for producing basic skirt designs such as A-line, circular, and gored skirts. Its simplicity makes it suitable for beginner-level instruction and small-scale tailoring. However, the rigidity of geometric techniques limits design flexibility, and any modifications often require complete redrafting. This restricts its usefulness in dynamic or fast-paced production environments. Constructive modeling, on the other hand, allows for greater design creativity and control over fit. By manipulating darts, panels, and pleats directly on the basic skirt block, designers can achieve a wide variety of silhouettes tailored to individual body shapes or fashion preferences. This method is particularly valuable in haute couture, prototyping, and design-focused educational programs. However, it is time-consuming and requires high-level patternmaking skills, which may present a barrier in settings where speed and standardization are critical. CAD modeling emerged in this study as the most efficient and adaptable method. Its integration into modern fashion production lines is well-supported by the literature and confirmed by the present findings. CAD systems enable precise drafting, real-time modifications, and virtual simulations, which significantly reduce time and material costs. Moreover, digital modeling aligns with industry trends such as mass customization, sustainability, and smart manufacturing. Nonetheless, the effectiveness of CAD modeling depends on access to advanced technology and the user's software proficiency, which may not be readily available in all educational or small-business environments. Another important point is the potential for hybrid approaches. The results suggest that a combination of methods—such as initial sketching and draping via constructive techniques followed by finalization and grading in CAD—can leverage the strengths of each. Such an integrative strategy is particularly valuable in design education and small-scale production where both creativity and efficiency are required. The findings also emphasize the growing necessity to include CAD training in garment design curricula. As the fashion and textile industries increasingly adopt digital tools, future professionals must be prepared to navigate both traditional and digital domains of modeling. Furthermore, sustainability goals in light industry can be better met through CAD's waste-reducing and simulation capabilities. In conclusion, while all three methods remain relevant in different contexts, CAD modeling stands out as the most future-ready approach. Nevertheless, traditional methods retain their pedagogical and artistic value and continue to serve as essential tools in a designer's skillset. Understanding the strengths and limitations of each method enables more informed decision-making and more effective design outcomes in both academic and professional practice.

5. Conclusion

The study has examined and compared three prominent methods for modeling skirts from waist garments—geometric, constructive, and computer-aided design (CAD)—within the context of the design and manufacturing technology of light industry products. The comparative analysis reveals that each method possesses unique strengths that make it suitable for specific applications in both educational and industrial environments. Geometric modeling, while basic, remains a vital tool for understanding the foundational principles of skirt construction. It is especially effective for creating simple and symmetrical designs and serves well in introductory pattern-making education. Constructive modeling offers advanced control over garment structure and fit, enabling designers to explore a wider range of silhouettes and design features. This method is particularly valuable in creative and bespoke garment production where design innovation is a priority. CAD modeling demonstrates the highest levels of efficiency, precision, and adaptability. It allows for real-time modifications, fabric optimization, and virtual prototyping, making it the most suitable option for modern mass production and sustainable fashion practices. The integration of CAD technologies into the garment industry also aligns with global trends toward digitalization and automation. The research highlights the importance of equipping future fashion and garment professionals with both traditional and digital modeling skills. A hybrid approach that combines the design freedom of manual techniques with the speed and precision of digital tools appears to offer the most comprehensive solution. In conclusion, understanding the methods of modeling skirts from waist garments not only enhances the design process but also supports more efficient, accurate, and sustainable practices in the light industry sector. Future research may further explore the integration of artificial intelligence and 3D body scanning technologies to improve the modeling process and user experience even further.

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