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Technological Advances in Embroidery: Driving the Textile and RMG Industry's Growth



K M Ahsan Zaman Anik¹, Rodela
Tabassum²

Department of Textile Engineering – Wet Processing
Engineering, National Institute of Textile Engineering &
Research, Faculty of Engineering & Technology, University of
Dhaka, Bangladesh

References: Masco Printing & Embroidery Ltd, MASCO Group, Bangladesh
Location: 318/A Khapara Road, Shataish, Gazipura, Tongi, Gazipur.

*Corresponding author's e-mail: ahsanzamananik@gmail.com

Abstract Embroidery, an ancient art, involves stitching colorful threads onto textiles to decorate them. Technology, like computerized machines and advanced software, has revolutionized embroidery, making designs more precise and production faster. Innovations like laser cutting, Heat Pressing, the new technology in machines and 3D printing have expanded creative possibilities, enhancing efficiency and quality. These advancements have driven significant growth in the embroidery sector, offering designers new techniques and materials to create unique and appealing textiles, ultimately benefiting marketability and consumer demand. As a result, the embroidery sector of the textile industry has experienced significant growth, fueled by ongoing developments in embroidery techniques and materials. These innovations not only enhance the aesthetic appeal of embroidered textiles but also improve their marketability and consumer desirability. From traditional hand embroidery to contemporary computerized processes, each advancement in stitching techniques has elevated the industry's capabilities, promoting creativity, efficiency, and customization. In conclusion, the symbiotic relationship between technological innovation and traditional craftsmanship has propelled the embroidery sector into a new era of creativity and effectiveness within the textile industry.

Keywords: *Embroidery, Traditional craftsmanship, Consumer desirability, Creative techniques, Textile industry, Technological innovation.*

Introduction Embroidery, a centuries-old trade, has long been a key component of the textile industry, adding elaborate designs, textures, and embellishments to textiles and garments. Embroidery, which has its roots in cultural traditions and skill, has grown over time, embracing modern technologies and inventive techniques to become a dynamic and thriving sector of the textile landscape. Embroidery, a type of decorative stitching, not only improves the aesthetic appeal of fabrics but also functions as a form of expression, narrative, and cultural identification. As early as 4000 years ago, there was a saying about clothing painting and clothing embroidery in China. Many people used embroidery to redesign clothing. After the emergence of modern fashion design, most people realize the close relationship between embroidery and clothing, and adopt embroidery to decorate clothing one after another. Embroidery has brought tremendous wealth to fashion design. Its importance extends across multiple industries, from fashion and interior design to art and crafts, contributing to the visual richness and diversity of our material environment. The embroidery industry has developed and transformed at an unprecedented rate in recent years, owing to technological improvements, changing consumer demands, and evolving market dynamics. From traditional hand embroidery techniques used by trained artisans to computerized embroidery machines capable of exquisite digital stitching, the industry has evolved dramatically, providing new opportunities

for creativity, customization, and efficiency. Furthermore, the growing awareness of sustainability and demand for ethically made textiles has fueled innovation in eco-friendly stitching materials and techniques, further changing the sector's trajectory. The embroidery sector's growth has been accelerated by rising demand for personalized and customized products. As consumers desire unique and personalized things, embroidery provides a versatile and customizable answer. Whether it's monogrammed linens, personalized garments, or bespoke accessories, embroidery allows customers to express their own style and character in ways that mass-produced, off-the-shelf products cannot. This increased desire for customization has opened up new avenues for growth and innovation in the embroidery industry, encouraging the development of new techniques and services to fulfil the needs of a discerning and increasingly diversified client base. The purpose of this thesis is to investigate the wide landscape of the embroidery sector within the textile industry, including its historical roots, technological breakthroughs, contemporary practices, and possible developments in the future. By digging into the complexity and nuances of embroidery as both a craft and an industry, this study hopes to shed light on the forces driving its rise, the challenges it faces, and the potential it provides for innovation, sustainability, and cultural preservation. One of the most significant contributions of innovation to the expansion of the

embroidery sector has been the introduction of computerized embroidery machines. These technologies have transformed the manufacturing process, providing greater precision and speed than traditional hand embroidery. Computerized embroidery machines have enhanced productivity by automating stitching patterns based on digital drawings, allowing for detailed and complicated designs that were previously difficult to accomplish manually. This thesis analyses case studies, industry trends, and academic research to explore how tradition and modernity, craftsmanship and technology, commerce and culture shape the embroidery sector in today's textile industry. The invention of new embroidery techniques has been vital to the growth of the embroidered business in the textile industry.

Aim of the Study

The aim of this research paper is to investigate the innovation of embroidery techniques within the textile industry. Specifically, the study seeks to:

1. Examine the historical evolution of embroidery techniques, from traditional hand embroidery to modern digital and automated methods, to understand the factors driving innovation in the sector.
2. Identify and analyze the various technological advancements that have revolutionized embroidery practices, including computerized embroidery machines, digital design software, laser cutting, and 3D embroidery techniques.
3. Explore the impact of innovation on the efficiency, quality, and creativity of

embroidered textiles, as well as its implications for market competitiveness and consumer preferences.

4. Analyze the role of innovation in increasing the range of materials, textures, and trimmings available to designers, as well as its contribution to the development of new embroidery techniques and aesthetics.

5. Assess the challenges and opportunities associated with adopting innovative embroidery techniques, including technological barriers, skill acquisition, cost considerations, and sustainability concerns.

6. Examine case studies and industry best practices to highlight successful examples of innovation in embroidery techniques, and identify key lessons and insights for practitioners, researchers, and stakeholders in the textile industry.

By addressing these objectives, this research paper aims to contribute to a deeper understanding of the innovation dynamics within the embroidery sector, and to provide valuable insights and recommendations for advancing the field in the context of an evolving global textile industry.

Exploring the Evolution of Embroidery Techniques:

Some of the earliest embroidery techniques or stitches include chain stitch, buttonhole or blanket stitch, Bar tacking, running stitch, satin stitch, and cross stitch. These stitches are still the

foundational techniques of hand embroidery today. Various types of accessories utilized in embroidery include EVA (Ethylene Vinyl Acetate), Lining materials, Sequins, Tapping, Chain beads, Dotted lining, Draw cords, Water-soluble Felt fabrics, Seed beads, and Satin fabric, among others. The machinery used in embroidery are numerous, ranging from old single-needle and multi-needle machines to advanced computerized embroidery machines. These machines improve the productivity and quality of embroidery work in industries such as fashion, textiles, and crafts by allowing for elaborate designs and accurate stitching. Here are some details about the types of machines commonly used in embroidery:

1. Single-needle machines: These are traditional embroidery machines that utilize a single needle to create designs. They are suitable for smaller projects and intricate details.

2. Multi-needle machines: Unlike single-needle machines, multi-needle machines have multiple needles, typically ranging from 2 to 15 needles or more. This allows for faster production and the ability to use multiple colors simultaneously, making them ideal for larger and more complex designs.

3. Computerized embroidery machines: These machines are equipped with computer technology that allows for precise control over the embroidery process. They can read digital embroidery files and automatically embroider designs with high accuracy and consistency. Computerized

machines are widely used in industrial settings for mass production.

4. Combination machines: These machines combine embroidery capabilities with other sewing functions, such as sewing, quilting, and surging. They offer versatility for users who require multiple functionalities in a single machine.

5. Embroidery digitizing machines: These specialized machines are used to convert digital designs into embroidery files that can be read by computerized embroidery machines. They play a crucial role in the design process by translating artwork or images into stitch patterns.

6. Industrial embroidery machines: Industrial-grade machines are designed for heavy-duty use and high-volume production. They are equipped with features such as faster stitching speeds, larger embroidery areas, and robust construction to meet the demands of commercial embroidery businesses. These machines vary in size, complexity, and capabilities, catering to the diverse needs of embroiderers across different industries and skill levels.

The growth of this industry uses a variety of embroidery machines, such as Tajima, Maya, Sun Star, Rich-Peace and many others.

Types of Embroidery

- Regular Stitch / Normal Embroidery
- Sequin Embroidery
- Beads Embroidery
- Tufting Embroidery
- Terry Embroidery

- Tapping Technique Embroidery
- Spangle Embroidery

The running stitch, backstitch, split stitch, stem stitch, satin stitch, and French knots are the six fundamental embroidery stitches. Embroidery machines are pushing industries to new heights. The



technology saves time while simultaneously providing exact stitches,



ensuring that the design is accurate.

Fig: Some hand stitches of Embroidery style.

Fig: Automatic Embroidery M/C

Production and Equipment:

The diversity in embroidery is vast, with embroidery machines capable of producing various designs, earning it the title of the ancient art of stitching. Embroidery machines can execute regular or normal stitch embroidery methods universally. However, specialized techniques such as Tufting,

Terry, Sequins, Chain Beads, and Drawcord embroidery require specific types of embroidery machines tailored to their unique designs. These diverse machines cater to the intricate demands of each method, ensuring precision and quality in the final embroidered products.

Raw Materials used in Embroidery

Yarn or thread is the primary raw material used in embroidery. While a variety of sewing threads can be used to create embroidered designs, filament thread is more commonly utilised in bobbin needles. Sewing thread made entirely of spun polyester from ECO threads is beneficial for embroidery because of its strength, dyeing quality, and lustre.

Regular Stitch / Normal Embroidery

This kind of needlework doesn't always fit into a certain category or technique. Simply put, it's surface embroidery. Its "free" or "free style" embroidery refers to the fact that it is done without using a fabric grid.

In summary, there are three common meanings associated with the word "surface embroidery":

1. "Free style" or "free" needlework that isn't tallied, or
2. ornamental needlework that defies categorization by method, or
3. A general phrase used by some to refer to all forms of embroidery.



Sequin Embroidery

Thanks to the use of the modern embroidery machines, we are able to create patterns consisting of even several types of sequins - so-called quadruple sequin. This is a unique embroidery technique on the market which allows us to create patterns made of sequins in four different sizes, colors or types at the same time. You can only find this technique with us!

We believe that sequins look even better when they are combined with other clothing decoration techniques. We can combine them with classic embroidery, as well as with pearls, glitters or rhinestones - all these different techniques of decoration give us opportunity to make a very interesting and unconventional designs.

For those who like interesting solutions, we also suggest to use in design sequins



on string. Such a combination gives a surprising effect, but it is just as beautiful as compositions composed of traditional sequins themselves.

A sequin is a tiny, glossy disc made of plastic or metal that is sewed onto clothing as an ornament. Sequins are

used in this decorating technique to produce eye-catching logo designs. A layout is digitally converted to a sequin dot format once it is finished. Sequins are then embroidered directly onto the garment to create the design. Although plastic is now widely used, even though it may be coated in metallic paper or a present, this embroidery was originally done with metallic disc-shaped beads. To add extra sparkle and gleam to the cloth, some sequin work uses discs with more reflective surfaces. Sequins with a diameter of 2 to 22 mm can be used. Depending on your intended use, a broad variety of sequins in sizes ranging from tiny to large or in shapes such as noncircular or eccentric type can be used to create your patterns as desired.



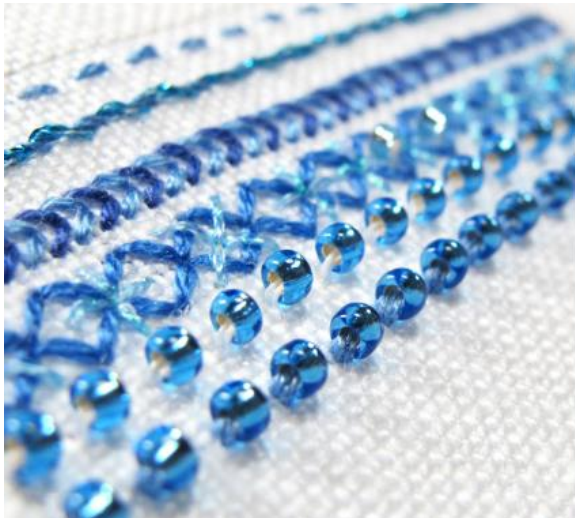
Fig: Sequins Embroidery



Fig : Sequins Embroidery

Beads Embroidery

The beading on the tombs of Ur in Iraq dates back to 2500 BC and is fashioned of lapis lazuli beads. The base was sewed together with the beads. During the excavation of Neolithic burial mounds in Europe, archaeologists discovered illustrations depicting simple bone



needles. Egyptian art and drawings also feature elaborately embroidered clothing.

The technique of bead embroidery involves sewing beads onto a surface

made of cloth, suede, leather, or any foundation material that is utilised to adorn the surface. Bead embroidery is a common technique used on apparel, jewellery, and accessories.

Metal and gemstones are the most commonly used materials for beads. A variety of various materials, such as glass, ceramic, porcelain, crystal, enamel, and more, are also available for selection. Our primary focus at Kernowcraft is on metal and gemstone beads.



Fig : Beads Embroidery

Tufting Embroidery

Tufting embroidery, also known as tufting or punch needle embroidery, is a technique that involves creating textured designs on fabric using a special needle or tool. This type of surface stitching creates elevated heaps or tufts by punching loops of yarn or thread into the fabric. Using a combination of machine embroidery and hand-made trimming, the tufting stitch embroidery technique produces a velvet-like texture that is as

soft and full as possible. This technique demands an exceptionally high level of precision. At Studio Designer, we apply this approach.



Fig: Tufting Embroidery

Terry Embroidery

Terry's loops are lengthy on either side. It might have equal loop lengths on both sides, or it can have greater loops on only one. The longer side will be softer and act as an absorbent to assist you rapidly remove moisture from your skin. This fabric is perfect for making bath mats, towels, and robes. Acrylic yarns or thread is widely used in Terry Embroidery techniques. Mainly fancy and aesthetic designs are suitable for terry embroidery. Terry embroidery is a specialized technique that involves embroidering designs onto terry cloth, a fabric

characterized by its looped pile on one or both sides. Terry cloth's unique texture, with its absorbent loops, makes it an ideal material for items like towels, bathrobes, and bath mats, where moisture absorption is key. However, this texture also presents distinct challenges and opportunities for embroidery, requiring careful consideration of the materials and techniques used.



Characteristics of Terry Embroidery

1. Thread Selection:

- Terry embroidery typically employs acrylic yarns or threads, known for their durability, colorfastness, and ability to create vibrant designs. Acrylic threads are also resistant to shrinkage and mildew, making them suitable for items that will be frequently washed and exposed to moisture.

- Polyester threads are also popular in terry embroidery due to their strength and resistance to fading, while cotton threads can be used for a softer, more natural look, though they may not be as durable as synthetic alternatives.

2. Design Considerations:

- ***Fancy and Aesthetic Designs*:** Due to the texture of terry cloth, simple and bold designs often work best. Designs with large, filled areas or thicker lines are more likely to stand out against the textured background, while intricate or delicate patterns may get lost in the loops of the fabric.
- **3D Effects:** The loops in terry cloth can add a dimensional aspect to embroidered designs, enhancing the visual appeal. Techniques like satin stitching or using thicker threads can create raised designs that pop off the surface.



3. Stabilization Techniques:

- Stabilizers are essential in terry embroidery to prevent the fabric from shifting and to ensure that the design remains crisp and aligned. A water-soluble topper is often used on top of the terry cloth to hold down the loops, preventing them from interfering with the embroidery stitches. A tear-away or cut-away stabilizer is typically used on the

back of the fabric to provide support during the embroidery process.

4. Loop Management:

- The length of the loops on terry cloth can vary, with some fabrics having equal loop lengths on both sides, while others have longer loops on one side for added softness and absorbency. Managing these loops is crucial in terry embroidery, as they can obscure fine details in the design. A topping material, such as a water-soluble film, is often used to flatten the loops temporarily, allowing the embroidery to sit neatly on the fabric's surface.

5. *Applications*:

- Terry embroidery is widely used in the production of bath-related items, such as towels, bathrobes, and washcloths, where the embroidered designs add a touch of luxury and personalization. Embroidered bath mats are also popular, combining functionality with decorative appeal. Additionally, terry embroidery is used in the creation of baby products, such as hooded towels and bibs, where the softness and absorbency of the fabric are essential.

6. *Durability and Care*:

- Embroidered terry products are designed to withstand frequent washing and heavy use. The choice of high-quality threads and proper stabilization ensures that the embroidery remains intact and vibrant even after multiple

washes. It's important to follow care instructions, such as using mild detergents and avoiding harsh bleaching agents, to maintain the longevity of both the fabric and the embroidery.

Challenges and Techniques in Terry Embroidery:

Terry embroidery can be challenging due to the fabric's thickness and looped surface. The key to successful terry embroidery lies in managing the loops and ensuring that the design is visible and well-defined. Techniques such as using a topping stabilizer, choosing appropriate designs, and using the right threads are essential. Additionally, adjustments to machine settings, such as increasing stitch density and length, can help achieve better results.

In summary, terry embroidery is a specialized technique that adds aesthetic and functional value to terry cloth products. By carefully selecting threads, managing loops, and using appropriate stabilizers, embroiderers can create beautiful, durable designs that enhance the appeal of items like towels, robes, and bath mats. The combination of functionality and visual appeal makes terry embroidery a popular choice in both personal and commercial textile products.



Fig : Terry Embroidery

Tapping Technique Embroidery

Tapping is an attractive technique in embroidery. Basically, cords and fabric created by laser cutting are employed in the tapping process. Cording embroidery is a specialised embroidery method that allows us to sew on materials such as ribbons, pearls, cords, or ornate chains. This type of embroidery is commonly referred to as "bead embroidery" because it allows us to sew on beads quickly - the embroidery machine does everything for us and we do not have to do it by hand. Cording embroidery is a specialist embroidery technique, which let us to sew on materials, patterns made of ribbons, beads, cords or decorative chains (e.g. metal or plastic chains). Very often this kind of embroidery is called "bead embroidery", because it allows us to sew on beads really fast – the embroidery machine does everything for us and we don't have to do it manually.

Types of Tapping & Cording :

Decorating materials has never been

easier or faster thanks to current embroidery machines. We can provide our clients with cording embroidery, which allows us to sew beautiful features like:

Cassettes, beads, decorative chains, and cables. Furthermore, we can offer you two alternative sewing processes for patterns created using cording embroidery. These are: Tape or zigzag.

Both methods described above enable us to create two entirely different versions of the same pattern/design. The tape variant involves sewing the cord along its middle, causing the cord to become flatter and wider. In the zigzag stitching variant, as the name says, the string is sewed once from the left side and once from the right.



Fig: Tapping & Cording Embroidery.

Laser techniques in Embroidery:

Our comprehensive variety of decorations includes laser techniques for cutting and engraving materials. We can cut both larger and extremely small elements with high precision utilising the most contemporary laser plotters with various domains of work. We provide laser decorating services, allowing you to create really unique decorations in a short period of time.

Furthermore, the use of a laser allows us to cut embroidered elements (embroidery with the application) and other elements, which may then be joined to produce ready-made ornamental pieces, such as flowers or brooches.

Types of Laser Decoration

- Laser cutting - entails cutting the elements of the chosen material through so that the cut out elements fall out, resulting in a decorative openwork impression. This technique allows you to create decorative patterns, such as ornaments or tassels, or simply cut the material so that the ends do not split out, because the laser beam melts the material while cutting, allowing it to finish smoothly.

- Laser engraving consists in burning the specified material so that its surface is rubbed rather than sliced through, allowing for concave ornamentation and

a three-dimensional look. Laser cutting and engraving work best on synthetic materials that burn easily during processing. We provide laser decorating services for a variety of materials, including textiles, knitted fabrics, leather, denim, felt, fleece, and polyester materials. Laser decorations work best on colourful fabrics with no obvious burns from the laser. For white materials, various experiments must be performed to identify the ideal burning time and laser intensity in order to reduce the appearance of light dirt on the material's edges caused by laser operation and material specifications.



Fig: Appliques from laser cutting.

Conclusion :

In conclusion, technological advances in embroidery have significantly contributed to the growth of the textile and ready-made garment (RMG) industries. The integration of modern embroidery techniques, such as computer-aided design (CAD), automated embroidery machines, and digital printing, has not only enhanced the efficiency and precision of production but also opened up new avenues for creativity and customization. These innovations have allowed manufacturers to meet the ever-evolving demands of global markets, offering high-quality, intricate designs at competitive prices.

Furthermore, the adoption of sustainable and eco-friendly technologies in embroidery has aligned the industry with global trends toward sustainability, making it more resilient and adaptable to future challenges. As the textile and RMG industries continue to evolve, embracing and investing in these technological advancements will be crucial for maintaining competitive advantage and driving continued growth.

Ultimately, the synergy between technology and traditional craftsmanship in embroidery has transformed the landscape of the textile industry, positioning it as a key driver of economic growth and innovation. Future research and development in this area will likely yield even more advanced techniques, further cementing the role of embroidery

in the success of the global textile and RMG sectors.

Moreover, these technological innovations have opened new opportunities for customization and creativity, allowing businesses to cater to the diverse preferences of consumers while maintaining consistent quality. The ability to produce complex and detailed embroidery at scale has not only elevated the aesthetic appeal of textile products but also positioned embroidery as a key differentiator in a highly competitive market.

Sustainability has also emerged as a crucial factor in the evolution of embroidery technology. The adoption of eco-friendly practices and materials, along with energy-efficient machinery, reflects the industry's commitment to reducing its environmental footprint. This alignment with global sustainability trends enhances the industry's reputation and ensures its long-term viability in an increasingly environmentally conscious world.

The convergence of technology and traditional craftsmanship in embroidery has created a dynamic and innovative landscape within the textile and RMG sectors. As these industries continue to evolve, the ongoing development and adoption of advanced embroidery technologies will be essential for sustaining growth, improving competitiveness, and driving further innovation. Future research and investment in this area will likely yield

even more sophisticated techniques, solidifying the role of embroidery as a pivotal force in the global textile and RMG industries.

In summary, the technological advancements in embroidery not only drive the growth of the textile and RMG industries but also pave the way for a future where innovation, sustainability, and creativity intersect to create a thriving and resilient industry.

The ability to integrate intricate and customizable designs into textile products has become a key competitive advantage, allowing brands to differentiate themselves in a crowded global market. This has been particularly important in an era where consumer preferences are increasingly shifting toward personalized and unique products. The flexibility offered by modern embroidery technology means that businesses can respond rapidly to market trends and consumer demands, thus enhancing their market responsiveness and agility.

Sustainability has also become a critical consideration in the development and adoption of new embroidery technologies. The industry's shift towards eco-friendly materials, energy-efficient machinery, and waste-reducing practices is in line with broader global movements towards sustainability and corporate social responsibility. These sustainable practices not only reduce the environmental impact of the textile and RMG industries but also improve the

industry's reputation and appeal to environmentally conscious consumers and stakeholders. As sustainability becomes a non-negotiable aspect of modern business, the adoption of green technologies in embroidery will likely continue to grow, further driving the industry's evolution.

Moreover, the fusion of technology with traditional embroidery craftsmanship has created a unique space where heritage and innovation coexist. This synergy has not only preserved the cultural significance of embroidery but also pushed the boundaries of what can be achieved through modern techniques. The result is a dynamic and innovative industry that continuously reinvents itself while staying true to its roots.

Looking ahead, the continued research and development of new technologies in embroidery will be essential for sustaining the momentum of growth within the textile and RMG sectors. Emerging trends such as the use of artificial intelligence (AI), machine learning, and advanced robotics in embroidery are poised to take the industry to new heights, offering even greater possibilities for customization, efficiency, and sustainability. These innovations will likely lead to the creation of entirely new products and markets, further cementing the role of embroidery as a vital and dynamic force in the global textile and RMG industries.

In sum, the technological advances in embroidery are not just driving the growth

of the textile and RMG industries—they are redefining the very nature of these industries, paving the way for a future where innovation, creativity, and sustainability are at the forefront. As these advancements continue to unfold, they will undoubtedly shape the future of the industry, ensuring its relevance, competitiveness, and contribution to the global economy for years to come.

