ACT/EMP
The Bureau for Employers' Activities

International Labour Organization

HOW TECHNOLOGY IS CHANGING JOBS AND ENTERPRISES

Sector brief: An analysis of how automation will impact the apparel sector value chain | April 2017

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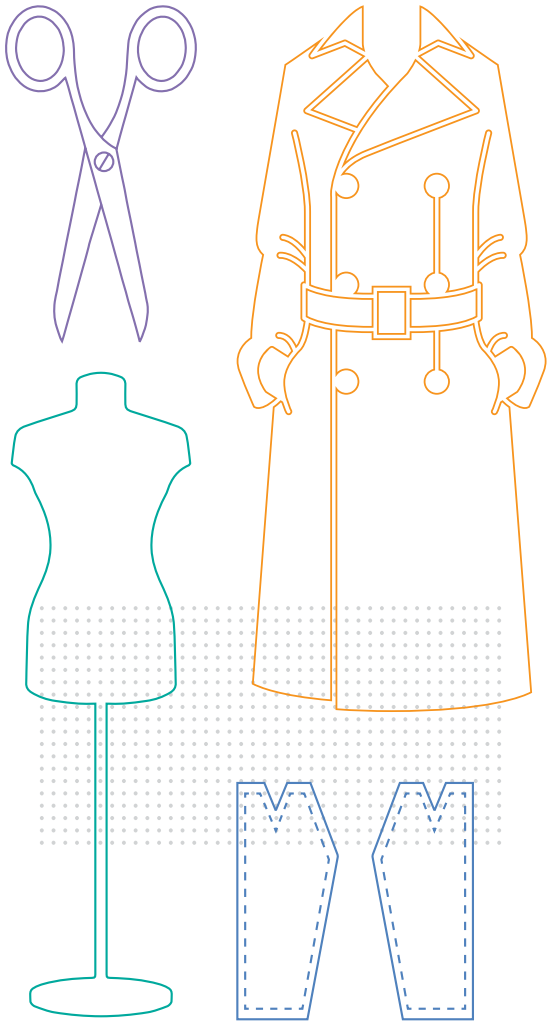


INTRODUCTION

The landscape of the apparel industry is rapidly changing with technological innovation. The ILO's report on *ASEAN in transformation- Textiles, clothing and footwear: Refashioning the future* disclosed this significant transformation, highlighting aggressive innovation and adoption of technologies by apparel brands, retailers and manufacturers and the fundamental and dramatic change brought to production and the workplace as a result[1].

Challenging the current production model, the report warns that the economics of offshoring to low cost countries in Asia will be less attractive as leading apparel brands and retailers look into using advanced technology to bring production closer to markets. When the off-shored model was adopted by apparel players to take advantage of global labour arbitrage, technological progress for the sector experienced a slow down due to the significant comparative and competitive advantage found in low cost labour in developing Asia. However, with continuous increases in wages and other costs of doing business across the region, investment in technology is making a comeback in great speed.

1 ILO. 2016. *ASEAN in transformation- Textiles, clothing and footwear: Refashioning the future, http://www.ilo.org/public/english/dialogue/actemp/downloads/publications/2016/asean_in_transf_2016_r6_textil.pdf.* Accessed 29 March 2017.

For example, major apparel brands such as Nike and Adidas that have a broad sourcing base in Asia were found to be investing heavily in knit technology, robotic technology and 3D printing with the determination to transfer production capacities closer to their primary customers in developed countries. An attraction of automation, for apparel brands critically includes reduced reputational and fiduciary risks at a time when the industry is frequently associated with poor working conditions in the factory floors. Automation has therefore become a top priority for the apparel sector to ensure cost competitiveness and improve production and workplace practices.

The most notable technology that emerged in 2015-16 as a game changer for the industry was the automated sewing machine which makes the most labour-intensive task of apparel-making automatable. Of concern is the impact of such technology on the millions of jobs in apparel-dependent economies like Bangladesh, Cambodia and Viet Nam. The displacement of low skilled jobs, in particular sewing machine operators, in these countries was examined in the aforementioned report which highlights that significant shares of workers in the apparel sector face high risk of automation, from 86 per cent in Viet Nam and 88 per cent in Cambodia.

This brief further explores the different types of apparel manufacturers, profit margins for industry players, and how technology like automated sewing machines will come into the scene for the sector. In addition, an in-depth case study that examines the automation decision of a US-based apparel manufacturer is presented to supplement the findings of *ASEAN in transformation*.

APPAREL MANUFACTURERS: TYPES AND PROCESSES

Depending on the capability and services provided, apparel manufacturers can be categorized into four major stages.[2]

Stage 1: Assembly/cut, make, and trim (CMT). Apparel manufacturers cut and sew woven or knitted fabric or knit fabrics directly from yarn.

Stage 2: Original equipment manufacturing (OEM)/ Full package/Free on board (FOB). The apparel manufacturers are responsible for all production activities, including the CMT activities, as well as finishing. These manufacturers must have upstream logistics capabilities, including procuring (sourcing and financing) the necessary raw materials, piece goods, and size trimming needed for apparel production. OEM is usually adopted by major brands.

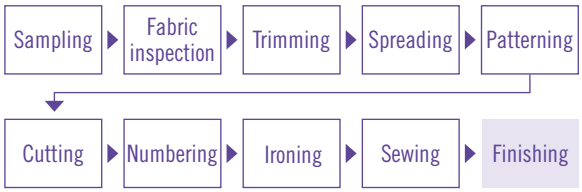
Stage 3: Original design manufacturing (ODM)/Full package with design. Manufacturers focus on adding design capabilities in addition to apparel production. ODM is common in private-label retail brands.

Stage 4: Original brand manufacturing (OBM). Manufacturers focus on branding and the sales of own-brand products, in addition to apparel design and production.

Apparel manufacturers in Asia are mostly limited to Stage 1 and few are in Stage 2. Additionally, since different machinery is needed for knit or woven fabrics, most factories only focus on one type of fabric.

Based on interviews with industry professionals and academic experts, the conventional manufacturing process for CMT apparel factories consists of various stages from sampling and fabric inspection, to cutting and sewing and finally to finishing (see figure 1).

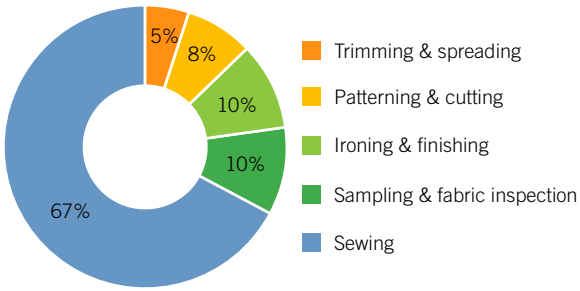
Figure 1: Apparel manufacturing process



It is important to note that the typical distribution of labour throughout the manufacturing process is not equal (see figure 2). Generally, trimming and spreading represents around 5 per cent while sewing can consist of over 65 per cent of a factory's workforce.

[2] "Skills for Upgrading: Workforce Development and Global Value Chains in Developing Countries" 17 Nov. 2011, http://www.cggc.duke.edu/pdfs/Skills-for-Upgrading-Workforce-Development-and-GVC-in-Developing-Countries_FullBook.pdf. Accessed 18 Jan. 2017.

Figure 2: Distribution of labour in apparel manufacturing process[3]



The skill level required for manual sewing is low compared to other steps in the manufacturing process. For example, sewing machine operators require no formal education whereas cutting machine operators need technical education[4]. The prevalent availability of low skilled and low cost labour in Asia provided two strong incentives for global apparel brands and retailers to build and source from factories far away from their major markets. However, this calculus is changing as apparel technology developers test and perfect robotic technology that automates the most labour intensive step of the apparel manufacturing process: sewing.

Profit margins for apparel players

The cost structure for an apparel manufacturer varies from factory to factory and from country to country. Industry professionals confirmed that a typical cost structure of manufacturer in Asia consists of[5]:

- Direct material (cloth, lining, fusible, zips pads, tapes, labels, tickets, hangers and packaging materials): 40 per cent
- Direct labour (cutting, sewing, machine operations, pressing, finishing, inspection and packing): 20 per cent
- Factory overhead: 30 per cent
- Sales commission: 5 per cent
- Profit: 5 per cent

A separate survey of US-based apparel manufacturers conducted for this brief showed similar but higher results for costs associated with labour reflecting the higher wage structure in the United States. 60 per cent of the respondents confirmed that labour costs is 30 per cent or above of their total cost[6].

Interviews with US-based manufacturers showed that their profit margin ranges from 15 to 20 per cent. On the other hand, manufacturers in Bangladesh, China and Pakistan confirmed a lower range between 5 to 15 per cent. This difference can be attributed to multiple factors, including the scale of orders, positioning of products, quality control, and logistics. Moreover, compared to manufacturers in Asia, US-based manufacturers tend to be smaller in scale and produce medium to high-end products, which generally have higher profit margins.

Furthermore, higher margins for US-based manufacturers are also byproducts of quality control and response time. US apparel manufacturers have faster lead time and response time to clients' requests since they are onshore. They can rectify errors in the production relatively quickly while manufacturers in Asia face challenges due to geographic distance. Inevitably, production error takes a longer time to correct, leading to increased cost for Asia-based factories.

The profit margins for brands and retailers are much higher than apparel manufacturers. In traditional retail, a designer shirt is marked up eight times when it reaches the consumer. Additionally, material costs and margins of manufacturers generally account for only 1/8 or 13 per cent of the retail price[7].

The visible profit gap between major brands and manufacturers provides brand marketers with the flexibility to explore and invest in new production technologies. Additionally, US-based manufacturers also have greater opportunities to make such investment than manufacturers in Asia as their higher profit margins provide them with a buffer.

3 ILO-UCLA interview with an apparel manufacturer in Bangladesh, 2017

4 The apparel global value chain: Economic upgrading and workforce development, Duke University, 2011.

5 Anshu Singh Choudhary, Cost Analysis in Garment Industry, International Journal of Recent Advances in Multidisciplinary Research. September, 2015.

6 UCLA AMR team executed a short survey with 30 retailers, brands and manufacturers in the apparel industry in February 2017.

7 Business and code of conduct implementation: How firms use management systems for social performance, ILO, 2003.

TECHNOLOGY TRANSFORMING THE APPAREL VALUE CHAIN

Automated technologies exist in all four stages of apparel production. Some examples are provided below[8].

- Product development: Digital printing and body scanning technology
- Apparel design: 3D body scanning, computer aided design (CAD) pattern tools
- Production: Fabric spreader truck, automated cutting machines, and sewing robotics
- Apparel finishing: Pressing automation

The focus of apparel technology developers are scattered through all four stages in an attempt to improve productivity, equipment capability, product quality and supply chain efficiency. While the finishing stage has ample space to be automated, manufacturers have indicated their preference to have manual labour to ensure quality control.

But the technology that has the potential to drastically reduce labour, lead time and associated costs is in the production stage where sewing exists as the most labour intensive part of the manufacturing process. Depending on how quickly automated sewing machines overtake factory floors, especially those in developed economies, substantial alterations will surface in the apparel value chain.

The penetration rate of automated sewing machines or sewing robots will depend on a number of factors which is analyzed using a framework that governs the rate of innovation diffusion: capability, compatibility, and complexity[9].

Capability. The key advantages of adopting sewing robots include labour cost savings, increased productivity and product quality, and reduced lead time and production waste. Interviews with various technology developers confirmed that the capability of automated sewing technology is somewhat limited today. For instance, one sewing robot developer suggested that the technology is at its early stage. The company's intellectual property lies in a chemical agent used to stiffen fabrics that the robot can then assemble, without creating wrinkles, and feed into sewing machine. At the moment, the stiffening chemical agent is not yet applicable to all types of fabrics. The sewing robot is capable of manufacturing products with basic design elements, such as T-shirts and underwear, and further innovation is required for these machines to seamlessly produce higher value apparel.

Yet advancement in technology is a matter of time. Another technology developer confirmed that they are lowering the cost of its system and robots, and testing the machine's capability with various types of fabric. From a labour input perspective, sewing robots require only 1 to 2 operators to control the production system. While the robots capability today is restricted to producing 2D products like as towels, automotive mats, and floor mats, the developer intends to release a fully functional 3D making sewing robot in 2019.

Compatibility. The sewing robot is comparable to operating existing apparel machines and does not require the manufacturers to create extra factory floor space. As the current apparel manufacturing process already involves many types of machines, the introduction of sewing robots is likely to be consistent with past experiences of using other technology.

Complexity. The operations of sewing robots require understanding of both equipment and software. When manufacturers adopt automated production technology, the labour skill requirements change from performing repetitive tasks such as manually sewing to operating machines. The operators of the machine, therefore, need to be educated in software application and mechanics in order to perform their tasks. Since the adoption of sewing robots will initially take place in the United States, Europe and to some extent China where a critical consumer market exists and major retailers and brands are headquartered, finding machine operators to manage sewing robots is not considered a barrier as these economies have a sufficient pool of skilled workers.

8 Garment manufacturing technology, Nayak and Padhye, Amsterdam: Woodhouse publishing. 2015.

9 Selection made based on Rogers' five factors on diffusion of innovation models.

CASE STUDY: APPAREL MANUFACTURER IN THE UNITED STATES[10]

Summary of findings

- Automatic cutting table saves 75 per cent of labour input in the cutting process for the company.
- Automatic cutting table saves 4 per cent on fabrics and 60 per cent of labour cost in the cutting process.
- The company is investing in the development of sewing automation technology for products with basic design element.

An in-dept interview and field visit was conducted with one of the largest full-service apparel manufacturers in Southern California in the United States to understand how automation decisions are made. About 85 per cent of the products manufactured are knit wears and 15 per cent are woven. The company's operation consists of:

- Modern 55,000 sq. ft. production facility with cutting, sewing and fulfillment capability.
- In-house garment dyeing and finishing for the latest wash techniques and looks.
- Large assortment of cotton and cotton blends in-stock fabrics for at-once orders.
- Pattern and sample room with exclusive 3D scanner for fitting.
- Graphic arts department for sublimation, silk screen designs and production

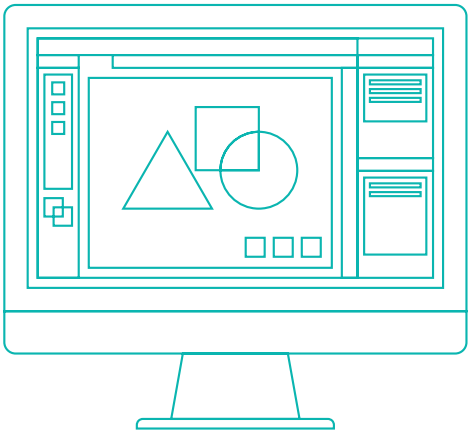
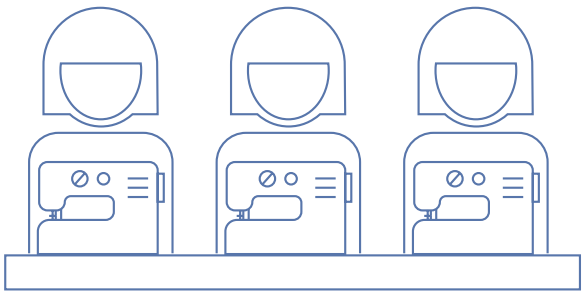


Table 1. Company information

Location	Los Angeles, United States
Employees	150 - 200
Capabilities	Sourcing and manufacturing fabrics, cutting and sewing, dyeing
Major products	• Knits: T-shirts, leggings, polos, tanks, fleece wear. • Woven: Dress shirts, blouses, jackets, pants
Major clients	Aqua by Bloomingdales, Nordstrom, Fred Segal, Alexander Wang, American Apparel, etc.
Major automation initiatives	3D body scanner, automatic cutting table, automatic sewing machine (under-going research)

Automation: Why now

Like most manufacturers in Los Angeles, the company has been using manual labour for the cutting, spreading, sewing and finishing process for the past 20 years. In 2016, the company decided to automate its manufacturing process to have better control over its cost structure and improve productivity. The company evaluated the cost and benefit of investing in technology, and decided to upgrade its cutting process first by purchasing an automatic cutting table and spreader to replace 1/3 of its existing manual cutting workers. At the same time, the company invested over US$ 3 million to develop a fully robotic sewing line for leggings and t-shirts. This automatic sewing machine is expected to replace 80 per cent of the current seamstress and to start production by January 2019.



[10] Findings are based on an in-depth interview and factory visit conducted by UCLA AMR team in 2017.

> "Technology in the apparel sector is now coming back. The 80s brought a near stop to garment research and development because the sector had no reason to depend on better technology to control cost. Rather, an abundant and low cost labour pool was available in Asia. The picture looks different today, and technological innovation is becoming the solution for overall cost effectiveness in the United States." - *Owner of company, Los Angeles, United States. ILO-UCLA interview, 2017.*

Responding to high labour cost and lack of labour through technology. The average wage for an apparel manufacturing worker in the Los Angeles area is close to US$ 15 per hour. Assuming the average work hours are 40 hours per week with 50 weeks per year, the annual salary of a typical worker is US$ 30,000. In comparison, the average annual earnings of ten apparel producing countries in Asia is less than US$ 2,400.[11] In addition to the high labour cost, manufacturers in the United States encounter significant labour shortages since work preferences of younger generations have changed drastically over the years.

Leading industry development. The company has a strong research and development team in developing cutting edge technologies in the apparel manufacturing process. The team's pioneering products include a waterless dyeing technology that the team partnered with a major sports brand to promote in the market. Critically, the company is currently developing a fully automatic sewing machine that will revolutionize their production. They have already developed a prototype of the automatic sewing machine, and expects the machine to be available in the market in 2019.

Cost-benefit analysis

Conducting a cost-benefit analysis of automation is a key decision-making step for the company. The cost-benefit calculations to invest in an automatic cutting table is shown in table 2.

Table 2. Cost-benefit of an automatic cutting table

Benefits		**Costs**[12]	
Annual fabric savings	Number of yards required per year = 4,680,000 yds. Price per yard = US$ 2.50. Total annual fabric cost = US$ 2.50 x 4,680,000 = US$ 11,700,000 4 per cent savings on fabric per year = **US$ 468,000**	**Automatic cutting table**	**US$500,000**
Annual labour savings	8 cutters x 15/hour x 40 hours/ week x 50 weeks/year = **US$ 240,000**	**Annual operator cost**	2 operators x 25/hour x 40 hours/ week x 50 weeks/year = **US$ 100,000**[13]
		Annual maintenance of automatic cutting table	**US$ 50,000**
Annual total savings	**US$708,000**	**Annual total costs**[14]	**US$ 200,000**

11 The ten countries are Bangladesh, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Pakistan, the Philippines, Thailand and Viet Nam. Wages and productivity in the garment sector in Asia and the pacific and the Arab States, ILO, 2017. http://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/publication/wcms_534289.pdf

12 The total cost of acquiring and maintaining automatic cutting table is based on secondary research.

13 The salary of an operator compared to a cutter is higher due to different skills requirement.

14 Assume the life span of the cutting table is 10 years.

The analysis shows that the company replaced eight cutters with two skilled operators, achieving a labour reduction of 75 per cent. The total cost savings from introducing an automatic cutting table is approximately US$ 508,000 per year. The substantial financial benefit is a strong motivating force for introducing further automation capabilities[15].

Achievement

Increased efficiency and cost optimization. With two well-trained operators, an automatic cutting table and spreader with computer programming cuts over 40,000 t-shirts per day, improving fabric yield by 4 per cent and reducing labour cost up to 60 per cent.

The company anticipates that the required number of workers in the factory will be significantly downscaled once automation is applied at wider-scale. The automatic cutting table replaced eight workers, and the automatic sewing machine is expected to further replace eight workers. The application of these technologies improves the company's human resource management and fills in the labour force gap for low skilled jobs while increasing their overall efficiency at reduced cost.

SUMMARY

The extent of technology being applied in the apparel sector differs across the value chain, and the attitudes and strategies toward automation varies across different geographic locations and market segments. Apparel technology developers, major brands and leading apparel manufacturers display an optimistic and confident view on the adoption and commercialization of advanced technology.

On the other hand, apparel manufacturers in Asia are more conservative as they perceive that the region's abundant and low cost labour remain competitive reasons for maintaining the status quo of the off-shored apparel manufacturing model. Of particular concern for these local manufacturers is their high dependence on brands and retailers for exports as well as their low awareness on cutting-edge technology that will bring sharp declines to orders, jeopardizing their eventual survival.

It's clear that major apparel brands, retailers and manufacturers in developed countries will be the first movers to explore and automate factories. As robotic sewing technology is currently limited to basic products such as T-shirts, the adoption is likely to commence in high price point products with basic design elements.

Brands and manufacturers in developed countries are more incentivized to adopt technology because of their higher profit margins coupled with an operating environment which is depicted with scarce and expensive labour while the complexity in operating the machine is less severe as there are more skilled workers in these countries.

Overtime the cost of technology will continue to decline considerably while their capabilities increase. This will inevitably bring upheaval to labour-intensive sectors like apparel and the impact will be felt in more severe and painful ways for countries that are highly reliant on the sector for development and growth. This points to the responsibility of policy makers in apparel-dependent economies who urgently need to reposition themselves to create a more conducive environment that leads to greater investment in human capital, skills-intensive sectors, research and development and high-value products. The price advantage is no longer enough.

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15 Since the automatic sewing machine is still in the prototype stage, the cost-benefit analysis of the automatic sewing machine has not been performed.

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