Knitted Footwear Technology – An approach towards Sustainability

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Abstract

Manufacturing footwear is a multi-process task where a variety of operations are conducted sequentially to manufacture full footwear. At the time, shoes were made of bits of leather and other synthetic materials that were cut and sewn together, known as "upper," and then applied to a hard sole. Much is still done by hand, given the use of machinery, with skilled workers required to bring the shoes together. The demand for leather shoes is also declining considerably due to environmental consciousness, resulting in a corresponding rise in demand for textile- shoes. Especially in the case of athletic footwear, the use of knit technology in upper making could transform the entire traditional shoemaking process. Athletic Footwear (Sport Shoes) accounts for about 36 per cent of all sales of footwear worldwide. A one-piece 3D upper is created by a CNC knitting machine, and then assembled with tongue, lining materials and reinforcements. The woven upper made from mainly recycled PET, creating a lightweight athletic shoe with a snug fit. It also uses an automated production process that reduces waste by weaving only what is required, rather than the conventional cutting and stitching system. The machines "knead" fibreglass fibres which could then be combined with a solvent to harden into a mould designed to match the foot of an person. The upper portion can be designed to interact with the foot anatomy; the fibres behave like tendons and enhance foot movement. Shoe uppers can be made in a single knitted layer with all the functionalities needed and appropriate. A tighter weave can be built to provide more arch support to the foot by changing the knit density in different areas and a thinner, breathable weave to provide more air flow. The possibilities are endless, since everything that can be made into a yarn: oil, wool, kevlar, even gold and stainless steel. The goods can be finished in one place from start to finish. Shoe knitting is an independent process, like 3D printing, which saves time, money and energy. This commonly used 3D knitting technique will improve the productivity of the industry by reducing material costs, reducing labour-intensive costs and keeping time running quickly. With the implementation of this technology, 80% less waste can be generated. Resulted factors such as global warming potential, edification, eco-toxicity and non-carcinogenic effects on human health indicate that development of knitted uppers have a lower environmental impact than conventional running shoes.

Keywords: Footwear, Knitting, Sustainability, Environment, Fast-Fashion.

Introduction

4D knitting changes the way shoes are produced with the ability to automate production, reduce work and reduce inventory costs. The future of shoe making has been launched by Nike and Adidas, Fly knit by Nike and Prime knit by Adidas. The uppers of these are made of a single piece of melting film — a model of sustainable and effective manufacturing, not made out of leather or nylon like conventional running shoes.

Excess products can’t be redeveloped or reused via the old shoe making cycle — producing massive quantities of waste. However, the sustainably made shoes result in 80 percent less waste, according to Nike's sustainability

report. Since only an exact quantity is used while dealing with yarn. Then, cut the thread and use the remainder of the yarn to create a new pair.The technique is also not confined to one fibre form. Anything made of a Fibre – oil, wool, Kevlar, gold and stainless steel-is ideal for making these shoes.

The only profit of these shoes is not one of sustainability as the simplicity of the project also rationalizes the industry. Knitted shoes reflect a reduction of resources, work, transport and time. The shoes will now be manufactured in one location so that they can be used by small businesses as independent processes. This ensures that demand can be produced locally – to the advantage of industry and customers alike. And that doesn't mean they aren't trendy just because the shoes are sturdy. While companies concentrate on sport footwear (Nikes with their running, football, soccer and basketball shoes), they are now trying to develop more casual shoes that people can use in their lives.

At the market stage, the knitted footwear provides a comfortable, lightweight fit, which is a long-standing unmet desire for its sportsmen and sportswomen. This may fix a customer pain point in which a lighter weight and athletic shoe is required. At the company level, products represent 60% of the environmental effects of the Nike shoes' lifecycle (e.g. water, soil, electricity, chemicals, and emission of greenhouse gases, contaminants, solid waste and waste). Nike reports the Fly knit 80 percent reduction in footwear waste compared with other "traditional" shoes. This allowed further study of the waste reduction potential of knitted footwear, as well as additional possible implications of the shoe, for example in relation to product distribution.

Design & Construction

In 2012, knitted footwear technology changed how athletic shoes are made. A CNC-knitting machine creates a one-piece upper design and is then fitted with the script, filling materials and armor systems. When used only on costly shoes, this knitting technology easily expands to lower-priced shoes. You will find Nike TM running shoes, Tubular X Knob Football shoes, Adidas TM's Hyper Boost TM or even Chinese local casual market shoes now with 4D knitting. The CNC kitting machine is becoming a popular sight in the big shoe making areas in China. The knitting machine has polyester, nylon or spandex fibres lined for the one-piece upper portion. A fibre mix and up to 10 colours are treated at once by the new knitting machines. It's possible to program the machine to cut one top at a time or three tops with a maximum width of 90 cm. The top may be thin, stretchable or thick and resistant to stretch, depending on the programming and fibres selected. With fibre variations, colour choices, knit density and opening configurations, the design possibilities are nearly limitless. Although these shoes look like they are completely knitted, the internal linings, reinforcement and padding are what you would find on a conventionally cut and picked shoe.

It's like a product rising instead of being broken together. The model may design the upper part of the foot anatomy, where the fibres act like tendons and enhance foot movement. It is all made at once instead of cutting the shoe out of a flat material and creating the shapes by inserting curves, so it is already in the form. And there is a variety of choices, not least because of the opportunity to combine multiple types of thread into one shoe and varying levels of knitted thickness. For areas with lower yarn, you can measure the knit, so that they are respired or knitted more extensively in an area.

Automated Production

While the seamless knitting process has removed post production cutting, it reduces work considerably, but is not fully automated yet. Each top of the shoes needs to be individually heat-set after a smooth shoe is knitted, and then sewn into the insole. This lab-intensive post-production process is a major hindrance to the further creation of seamless high-end shoes.

The industry can be precisely what the 4D seamless knitting technology requires to resolve this issue. This new technology makes it possible for flat knitting machines to create a full shoe upper that can be connected to the single machine directly. This leap in knitting technology offers an exciting chance to remove the work-dependent cutting, stitching and heat-setting from the manufacturing cycle – and to completely automate high-end manufacture of shoes.

Faster to Market Time

Current marketing and delivery programs can't be adapted to the needs of modern consumers. When all goes well, the average idea to market time is around eighteen months. In addition, the mode cycles are compressing. When the life cycle of new trends has been reduced to between three to five years, the method of concept-to-market must be changed. Adidas has been able to accelerate up to 3 times on the market. 4D knitting opens the way for a concept to market time streamlining through the implementation of a practical local development solution. Inventory prices, on average, account for 20 to 30 percent of the overall inventory value. Only the most effective inventory managers can't cut inventory cost to zero because the exact way in which a specific item will be priced is so difficult to predict ... Unpopular products are a significant cause of loss for many retailers, and many customers try to fix their problems.

4D knitting is an inventory dilemma solution. 4D knitting opens up the possibility of manufacturing local goods according to the real time demand rather than forecasting sales demand months in advance – and risk loss due to inventories that are unsold. This is one of the main advantages of 4D knitting. As a local manufacturing option, 4D knitting solution enables consumers to order and have shipped their personalized shoes within a couple of days by reducing their production and delivery time from several months to just a few days .. The Adidas Speed factory starts to understand the principle to a lesser degree. It hopes in future to equip every retail shop with a 4D knitter so that customers can measure their foot and store custom shoes.

Knitting Cost

The costs differ according to the number of colours and fibre types. A one-tone fibre polyester design will cost $2.50, while a multi-tone spandex polyester combination may cost $7.50 per oversize. MOQ is about 1000 pairs, with an installation charge of 300 $per module. Production of the sample is rapid – only 7-10 days will take more if individual colour fibres are needed. The automated manufactures can be run around the clock once the design is verified.

Drawbacks

Yet in the outdoor environment there are elements of the knitted shoe which do not fit well. Footballers get a closer look at the ball, with a smaller upside down, and thus improved ball control. Nevertheless, this knobbed envelope provides little protection of the knee when moving unevenly with walking, as well as other gyms with substantial lateral foot tension. And in sports such as rock climbing, which can be a blessing for lightweight purposes, the knitted material can protect against abrasion. Nylon definitely wouldn't, and it would have to produce other products.

The Future

While the entire shoe industry is moving into 4D knitting technologies, they still have a long way to go before they create a solution. In order to make a 4D knitting solution practical, a dual-sided upper must be knitted while preserving the durability and functionality of the uppers.

The seamless shoe tops which exist today were created by a slightly improved socking machine, created an end product which is too small, 'language free' and is very limited in terms of design options. Therefore, emerging technologies also require a certain amount of post-production processing.

Sustainability

Environmental Impact: The companies of Clothing are now working in a more sustainable manner, based upon sustainable product design and supply chain activities such as manufacturer selection and compliance monitoring. Environmental impacts: Corporate principles, top management engagement and business conditions are the key factors for sustainability.

The LCA analysis carried out in 2013 on Running Shoes found that, in line with previous studies on Puma and Puma and Timberland Shoes, a standard pair had a carbon footprint of 14 ± 2. 7 kg CO2-equivalent. This involved the creation and delivery of the whole shoe, the excess scraping content, packaging and differences between these studies.

An experiment is carried out with the environmental implications of the top shoe as it is the key point to differentiate between the knitted shoe and conventional shoe. Both shoes are expected to be a 9-size guy. Only the top of a single knitted shoe is 34 grams weighted and contains the recycled PET (95%), the synthetic shoes (5%) and the spandex shoes (5%); the typical shoe is 97.8 grams and mostly consists of polyurethane, polyester, synthetic and olefin copolymers.

The study shows that knitted footwear is waste reduction. But a separate running shoe LCA showed that material scrap loss for overall polyurethane output of conventional shoes amounted to approximately 50%. This indicates that the loss of the material scrap is not negligible in conventional shoes; knitted shoes are thought to be much lower because of their knitted pattern and have minimized environmental impact in different TRACI categories.

The global warming potential (GWP): mining, purification and distribution of raw materials have a major environmental effect in the manufacture of shoes. Reducing GWP in any one of these categories could bring major benefits in its global implementation. It is especially noteworthy that over the lifetime of the shoe the knitted upper has 1,29 kg of CO2 eq of GWP, which is less than half the typical shoe. Maintaining existing rates of consumption could lead to a reduction of the GWP of over 67,525,000 kilograms of CO2 eq year by year in knitted boots in an industrial sector which sold 46.25 million pairs of shoes to US consumers in 2013.

Energy use: The creative method of weaving for knitted top is more similar to the manufacturing of socks. Energy savings of 0.48 kWh are provided per pair of shoes using power figures for sock production and savings are achieved of 79,920 GJ, where all shoes sold to the U.S. industry is made by this technology. Minimal Waste: Raw materials are also a significant cost in the cycle of shoe making, which is only compounded by excessive material wastes. For example, warp knitting equipment wastes around 20-25% of the fabric during production (around 132,6 tons per millions pair). Every upper is completed with 4D knitting solutions individually and does not require the post-production cutting or stitching to create a fully seamless shoe upper — which reduces waste by as much as 60%.

Leather replacement: leather replacement with textile has a positive environmental impact. Leather shoes account for just one-quarter of total production of footwear, while the overall effect on all metrics including climate change, resource use and freshwater depletion is projected to be 30 to 80%. It compares strongly with textile shoes, which make up just 6-21 percent of the overall effect in the same categories.

Knitted footwear thus tends to have less adverse environmental and human health effects than conventional shoes. A smaller weight is sent for waste disposal, less energy is used and less GWP is produced over the shoe's lifetime.

Conclusion

The use of knitted material in the shoes transforms the shoe making process completely. Through the use of knitting technique will not only increase productivity but also decreases the need for supplies, shipping and time, through the flexibility of production from start to finish in one place only. Knit technology could only change the conventional method of shoemaking. Sporty sneakers represent 30 percent of sales, while Nike and Adidas lead, with a turnover of $14.5 billion and a turnover of $9.5 billion, respectively in 2013. Huge use of knitting techniques will improve the productivity of the industry — cutting materials, labour, transport, and time, as the goods can be manufactured in one place from start to finish. In the most recent Sustainability Report, Nike says that 80% less waste is made of a Fly knit running shoe than the conventional Nike style. So when we go out during our busy days, it is time to take a path towards a longer, more sustainable and productive future — leading by our knitted feet.

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