Far from the plastic baubles that fused filament desktop 3D printers fabricate layer after layer, new technology is inspiring innovation in traditional textile manufacturing.

Experimentation in 3D printing and textiles

The excitement surrounding 3D printing is turning the tables on traditional textile making, and particularly these machines' ability to produce objects of any shape, on the spot and as needed. Fabric and garment manufacturing rarely have the flexibility and customisation possibilities of 3D printing, and stand to gain by drawing on the abilities of these new devices. There is however one category of textiles that already functions on a basis similar to that of 3D printing: fully-fashioned knitwear is a process that knits in one go, a made-to-shape item of clothing requiring minimal finishing.

A technology talk at the trade show Performance Days in Munich last November discussed the possible links between 3D knitting and 3D printing. Joerg Hartmann, head of fashion & technology at Stoll, a company that manufactures flat-bed knitting machines, pointed out some of the similarities between the two techniques. Flat-bed knitting, he says, is "a highly versatile manufacturing method that produces fully shaped 3D panels". He went on to explain that flat-bed knitting is a form of "additive manufacturing" in that it "creates a product from the bottom up, as in 3D printing". In a way, he says, "we trick the machine to create a 3D shape out of a 2D panel".

In sports and medical uses, Stoll machines already knit to shape highly customised products. "We make high-compression braces that are based on body scans to fit each individual user perfectly. Like 3D printing, these products can be reproduced as needed," he explains.

Knitting is driving innovation in sports shoe uppers, as seen in Nike's Flyknit sneakers introduced in 2012. These are made of a single panel, knitted to shape, with no waste, and they can be engineered to offer varying degrees of support or

Hard Copy, the graduate collection of young designer Noa Raviv, is a subtle and intricate blend of pleated fabric and 3D-printed elements. "The tension between the real and the virtual, between 2D and 3D, inspired me to create this collection," she says.

Ron Kedmi

A 3-D printer developed by Carnegie Mellon University and Disney Research Pittsburgh feeds yarn into desired shapes and uses a needle to turn the yarn into a loose felt fabric object.

Carnegie Mellon / Disney Research

ventilation. A knitted shoe upper is said to take approximately 30 minutes to make. This is not a new technology, Japanese knitting machine maker Shima Seiki points out. "Almost any conventional knitting machine can knit shoe uppers. They are usually produced on 'shaping' machines that can knit products to shape rather than lengths of fabric from which product shapes are cut out and sewn together." Furthermore, it says that these uppers still require some sewing. "Shima Seiki goes one step further and offers a technology that knits an entire shoe upper in one piece without requiring any post-process sewing," says company spokesperson Masaki Karasuno. The machine produces a slipper-like shoe incorporating variations in knitting to form the upper and sole.

For sportswear, the Japanese company is introducing new developments in seam-free knitwear, a process it calls Whole Garment knitting. Thanks to progress made in material research, Shima Seiki says it can fine-tune the types of yarns and their placement to offer customised function and fit. Among the new options available, the company offers "pin-point pressure variations throughout the garment". Padding can also be knitted-in using spacer fabric knitting techniques, it says.

3D textile printers

While fully-fashioned knitting may be the textile industry's closest cousin to 3D printing, non-weaving may be the area where the new manufacturing paradigm could have the most impact. A number of research projects, in various stages of experimentation and scalability, are looking to produce non-woven textiles to specific shapes, like a 3D printer does. UK company Tamicare has invented a non-woven "textile printer" that makes disposable panties (see *WSA* January-February 2014, Fabrics: the next step in 3D printing?). CosyFlex, the name of the process, uses a patented combination of cellulose fibres and natural rubber latex that is sprayed onto a mould and produces a panty in just three seconds as it speeds along a conveyor belt. Different polymers can be combined and assorted ingredients or elements added during the process (cosmetic, medical or even electronic). "The options are virtually unlimited," says Tamar Giloh, founder of the Manchester-based company. Different surface effects are also possible, including mesh-like fabrics. In addition to the many customisation options, the company has focused on creating a machine capable of mass-production. Again, like 3D printing, CosyFlex produces no waste. "We reclaim the material that is over-sprayed during manufacturing," says Ms Giloh.

CosyFlex is one of the most advanced new machines in the pipeline, but has yet to come to market. Other non-weaving "printing" machines are in earlier stages of development. Californian start-up Electroloom is working on what it calls a "personal 3D printer for clothing". The process seems similar to electrospinning, as the three-person team's first experiments involved metallic chopsticks spewing out a web-like fabric. In June 2014, the first machine was up and producing seamless sheets, towels and pillowcases. The process starts "as a solution (in other words a liquid) of mostly synthetic polymers," says Joseph White, the company's computer engineer. He says that