New Textile Technologies Stand to Transform Modern Manufacturing

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Textile manufacturing—from spinning to fabric formation to dyeing and finishing—has changed little since the industrial revolution. While computers and robotics have made the process faster and less labor-intensive, 21st-century raw materials still undergo a complex series of processes, using vast amounts of resources like water, energy and chemicals, as they are turned into fabrics for apparel or other end uses.

But things are about to change. Paul Brody, global business services vice-president and global electronics industry leader at IBM, believes we should prepare for “the disruptive transformation of design and manufacturing” across the board, led by technologies like 3D printing, intelligent robotics, and open source design.

“Where these new technologies do have a role to play, the disruption they are likely to cause is substantial. They suggest that the era of offshoring and outsourcing is coming to an end, as is the global search for low-cost assembly,” Brody wrote in an executive report for the IBM Institute for Business Value.

Industries requiring large amounts of labor for low-cost assembly are ripe for such transformation, said Brody, speaking at the Smart Fabrics and Wearable Technology Conference in April, 2014. The textile and apparel industry is no exception, with a number of recently-introduced technologies poised to turn our current system of sourcing and manufacturing on its head.

Additive Manufacturing

Additive manufacturing, the process of joining materials together to create an object with little waste, is the hot topic in manufacturing today. Using technology that is similar to laser or ink-jet printing, desktop-sized 3D printers create objects by printing layers of material, usually polymer-based plastics. Creating a product from a software design at the touch of a button cuts the time and costs involved in traditional prototyping, and radically alters traditional economies of scale.

The leap from 3D-printed hard goods to textiles is already under way. A new, highly flexible and durable printing material, TPU 92A-1, has been used to create stunning apparel and accessories by designers like Iris van Herpen, Julia Koerner, and Anouk Wipprecht.

An innovative 3D printing process using yarn to create fabric objects in felt has been developed by Disney Research in collaboration with Carnegie Mellon University. Instead of extruding plastic filament, the “felting printer” lays down layers of yarn which are attached via entanglement.
While the designs in felt are less accurate than those rendered in plastic, the next step is to incorporate printed plastic elements within the soft felt designs to make them more durable.

The ability to offer customized, demand-driven manufacturing is another way 3D printing is changing the game. Active wear start-up Three Over Seven is using the technology to solve the problem of ill-fitting shoes by creating bespoke footwear. Custom-fit soles are printed based on a mobile app supplying precise sizing data. The company is hoping to open a digital shoe factory in London this year.

Belgian firm Materialise, inventors of TPU 92A-1, have also created a software platform for the 3D printing industry. Its online i.materialise site enables designers to upload and order 3D printed designs.

**Robotics**

A new generation of robotics is the second key emerging technology in the IBM Institute for Business Value report. According to Brody, “Where past robotic systems required massively complex installations—typically starting at $250,000 per assembly station—this new generation costs around $25,000 per robot and can be installed in less than a day. Suddenly, efficient, effective manufacturing automation is within the reach of even small companies.”

For example, highly-automated spinner Parkdale Mills processes 8,000 tons of yarn per week, some 60 percent of the cotton consumed in the U.S. The use of robots has enabled Parkdale to manufacture yarns at globally-competitive prices. In fact, 75 percent of the company’s business is exported.

At the National Spinning Company plant in Burlington, N.C., robots do most of the work. The dye machines, producing over 250,000 lbs of dyed yarn every week, are serviced by only two technicians.

The use of robotics has revitalized the spinning industry, both here and abroad, reducing labor costs and improving quality standards. While low-skilled, low-wage jobs have been eliminated, the remaining employees are better-trained and better-paid. Technology enables companies such as Parkdale and National Spinning to compete with labor-intensive overseas factories that pay their workers very little.

While textile manufacturing is becoming increasingly automated, the process of garment manufacturing—suffering from a shortage of labor in the U.S. and increasing worker demands in the rest of the world—faces the greater challenge.

**Knitting Revolution**

Knitting is perhaps the oldest type of additive manufacturing, but a new generation of computerized knitting machines and design software is being used by apparel and footwear designers to disrupt the manufacturing process.

Nike’s Flyknit trainers are made with an incredibly light-weight knitted one-piece upper, said to be knit on Stoll equipment (although Nike will not confirm this).

The flat-knit polyester upper not only feels like a sock, but reduces waste by 80 percent over traditional footwear manufacturing.

According to a Nike spokesperson, the process cuts costs to the extent that “eventually we could make these shoes anywhere in the world, which makes things very interesting.”

Another type of flat knitting, Shima Seiki’s WHOLEGARMENT® Technology, also holds the potential to radically disrupt the process of knitted garment formation. First commercialized in 1995, it creates truly seam-free, customized, on-demand, 3D knitwear without labor-intensive cutting and sewing, and without waste.
Fearing clothing manufacturing for the U.S. Military and other key personnel might be driven overseas, the Pentagon (through the U.S. Defense Advanced Research Projects Agency) has funded the development of robotic sewing machines by a Georgia Tech spinoff called SoftWear Automation.

Previewed at [TC]2’s Cool Zone at Techtextil North America in May 2014, the concept version of the system included a patented, thread count-enabled sewing machine that positions and moves the fabric under the needle, stitch by stitch, at the proper pace. A fabric manipulation robot is designed to transfer the fabric and garment parts into the automated sewing system.

According to SoftWear Automation, the system “has the potential to transform today’s labor-intensive sewn products manufacturing plant into a high-tech production facility. It would provide the associated benefits of reduced cost of production, higher quality sewn products, smaller production lots, increased degree of customization and faster turnaround times.”

**Demand-Driven Manufacturing**

IBM’s Brody believes that these technologies are more than a pipe dream. “Based on product roadmaps for 3D printers and robotic assembly systems, we believe the cost of manufacturing all of these products in a software-defined supply chain will become competitive with traditional manufacturing costs in the next five years,” he predicted. “More strikingly, the scale required to achieve a competitive cost structure will drop by about 75 percent in the coming five years, and by as much as 90 percent over the coming decade.”

The concept of achieving competitive costs in a manufacturing scenario anything short of mass production is anathema to most companies. Yet according to Bill Grier, CEO of Apparel Made for You (AM4U), the time is right for apparel profit based on value-based, personalized product made on demand for individual consumers and retail customers.

Through localized manufacturing of apparel on demand, profit is retained by reducing or eliminating unsold inventory, markdowns, carrying costs, tariffs, and transportation. In Grier’s world of purchase-activated manufacturing (PAM), nothing is made until the order is paid for. Inventory is as simple as griege fabric; and digital printing or dyeing is done to order, using a patent-pending technology called Active Tunnel Coloration (ATC).

While traditional textile dyes and pigments rely on chemistry, the waterless ATC technology uses physics—heat and photon stimulation—to infuse and seal colorants within the fibers of fabric. A digitally-designed pattern or allover color is applied to one or both sides of the fabric or cut pieces in about 30 minutes, with little environmental impact. The permanent process can be used for any synthetic polymer, and will not crock, wash out, or be damaged by bleach.

As part of an alliance with virtual pattern makers, digital designers and digital cutting, the AM4U business model integrates dyeing, printing, and cut and sew operations into prototype mini-factories of about 8000 sq. ft., according to [TC]2, which sponsored the startup’s exhibit at Techtextil NA. “PAM based on ATC moves the tipping point in the industry from the money made by mass production to the money made from adding value,” Grier said.

**Sustainability is Transforming the Industry**

In an industry that often uses hundreds of gallons of water and chemicals to process the fabric used in a single garment, the pressure to find more sustainable dyeing and finishing technologies is also driving innovation. Disruptive technologies that require little or no water, and reduce the release of toxic chemicals are beginning to transform the textile business.

DyeCoo Textile Systems, based in the Netherlands, is the widely-touted waterless dyeing system for polyester fabrics that is based on supercritical CO2.
The supercritical CO2 diffuses the colorants throughout the fabric in about half the time used by traditional water-based dyeing. There is no effluent, and 95 percent of the CO2 can be reused.

DyeCoo’s investors include the Yeh Group in Thailand, whose synthetic fabric division Tong Siang produces DryDye fabrics for Adidas and Nike, which has placed a machine at a supplier, Far Eastern, for its ColorDry line.

While the DyeCoo machines are pricy, costs are somewhat mitigated by lower water and energy expenses, the company noted, and DyeCoo anticipates additional economies of scale as the technology is further commercialized.

A related technology, TERSUS, has been launched as a waterless method of cleaning, disinfecting, and coating textiles and garments with liquid CO2. The process consumes less energy than traditional washing and generates very little waste. Developed by a Denver-based company called CO2Nexus, TERSUS has “the potential to revolutionize the manufacture of certain textiles and fabrics,” according to CEO Richard Kinsman.

Unlike DyeCoo, the technology is not confined to polyester fabrics. “In the value chain from raw fiber, textiles undergo a number of treatments where they need to be cleaned,” Kinsman explained. “This platform is capable of doing a number of these functions.”

The markets for the process are performance and spec-driven, Kinsman said, and will include industrial, clean room and uniform end uses. Items processed with TERSUS are said to emerge with minimal impact, exhibiting less fading or wear, and enhanced down loft and water repellency, compared to traditional water or solvent-based cleaning methods.

Patagonia has made a strategic investment in CO2Nexus, and plans to incorporate the company’s sustainable platform for textile and garment processing.

APJeT, based at the NC State College of Textiles in Raleigh, N.C, for the application of high-performance textile finishes is pioneering another concept. The process utilizes atmospheric plasma—the fourth state of matter to apply chemically-based finishes in a closed loop system that uses no water and no heat.

While most applications using plasma require a vacuum, the idea of generating plasma from highly energized helium gas with an atmospheric jet was the breakthrough that prompted the technology. Wade Tyner, APJeT’s manager of applications engineering, explained that the plasma reacts with the textile finishing chemistry to form a covalent bond with the fabric. Water, oil, and soil repellency treatments can be applied using reduced chemical consumption. The plasma does all the work and no effluents are released.

“That’s a big deal in the textile industry,” Martha M. Emrich, director of sales and customer development for the company said. The technology is designed to work on natural as well as synthetic fibers, and does not affect the hand, color, or strength of the fabric. Future applications may include finishes for wicking, antimicrobial, or UV resistance.

APJeT licenses the technology and supplies a turnkey package, which is manufactured by investment partner Morrison Textile Machinery.

A Manufacturing Revolution

It is clear that new textile technologies hold the potential to disrupt the infrastructure and the way apparel is designed, manufactured, sourced and distributed. Are today’s textile and apparel manufacturing companies ready for the changes ahead?

Some industry leaders are already wrapping their collective heads around the concept of modern manufacturing. In Nike’s latest Sustainable Performance Business Summary, the company promised a “manufacturing revolution” to include waste reduction and water efficiency, the innovation of entirely new manufacturing pro
cesses, and a commitment to more efficient, lean manufacturing principles. Nike’s embrace of disruptive technologies is one reason the athletic wear giant will remain on top of its business.

“To build a new supply chain or take advantage of the huge opportunities that will come with these new technologies, or simply to stay competitive, supply chain leaders will have to "unlearn" a century of assumptions and internalized concepts built on the foundations of Henry Ford’s work in mass production,” said IBM’s Brody. “Success in the future will require developing and adopting a new set of mental models, business processes, and enterprise technologies.”