

Innovations in knitting at ITMA 2019 Barcelona, Spain

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Introduction

ITMA 2019 was not as groundbreaking for knitting equipment as past years where there were new machines at every booth. This ITMA, however, was more focused on upgrades, add-ons, partnerships, technology integration, automation, sustainability, and digital 3D integration. So even though it was not the groundbreaking new machine development, it was full of ideas and positivity on how the knitting industry is moving forward and how collaborations are being formed. This report is broken down into different knitting machine configurations, which from the author's perspective are worth reflecting on; flat knitting, circular knitting for body-mapped garments, knitted shoes and warp knitting, with an emphasis on this year's ITMA innovations presented by each company and is not in any way a recommendation or a comparative study.

Flat knitting

Shima Seiki unveiled their "KNITify the World—Smart Solutions in Textiles." The theme illustrated the flexibility of Shima Seiki products to cater to various and varied industry sectors in addition to the traditional customer base in the apparel industry. Its approach was to propose knitting as an alternative manufacturing solution for non-fashion related industries.

Knits have inherent stretch and compression characteristics, which can be used in a variety of industries. New knitting techniques such as inlay is made possible with special loop pressers featured on their updated N.SVR-SP series machine adding further value to knitting and has gained particular attention for its ability to produce hybrid knit-weave fabrics that allow insertion of technical yarns considered incompatible with previous knit fabrics. These include carbon fiber, monofilament and even metallic conductive yarns.



Fig 1. Knitted CFRP (Carbon fiber reinforced plastic) turbine blade for jet engine joint development: Ryukoku University; I.S.T. Corporation Cooperation: JAXA © Shima Seiki



Fig 2. Muffer cover using heat-insulating material. With WHOLEGARMENT method, three-dimensional knitting that fits all shapes is possible. © Shima Seiki



Fig 3 and 4. WholeGarment knitting enables functional yarns to be incorporated seamlessly into smart garments and wearable technology. © Shima Seiki



Fig 5 and 6. 3D knitting provides fit, comfort, lightness, and mobility for wearable technology. © Shima Seiki

One of the other add-ons paired with Shima Seiki machines is a Yarn Unwinding Device for unwinding spools of technical yarn to ease yarn feed for such difficult-to-

handle material. This technology is allowing knitted technology to enter markets that previously were foreign to them, such as sport accessories shoes and wearable and

industrial applications for medical automotive and aeronautical industries. In addition, the new I-Plating option can alternate yarn colors in any pattern,

producing jacquard-like designs using plain jersey stitch. This I-Plating technique can be performed within the same course and for individual needles.



Fig 7. i-Plating offers inverse-plating capability in which different yarns can be shown alternately on the fabric surface for a jacquard-like effect in plain jersey stitch. © Shima Seiki

Shima Seiki WHOLEGARMENT knitting machines moved forward slightly with slight add-ons with the benefits of shaped knitting, by expanding that potential to 3 dimensions. WHOLEGARMENT knitting is capable of producing knitted items in their entirety on the machine and allows 3D preforms and tubing to be produced without sewing. Elimination of sewing allows for faster turnaround and high potential for on-demand knitting. The seam-free nature also ensures continuity of the fabric, allowing functional

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yarns such as those made from conductive fibers to wrap around the entire body without interruption for applications in smart garments and wearable technology. 3D knitting provides fit, comfort, lightness, and mobility the key factors that make seam-free so attractive. Three WHOLEGARMENT machines were on display, including the new MACH2VS machine making its debut at ITMA which is a two-bed half gauge machine.



Fig 8. MACH2XS and MACH2X present a technological breakthrough in modern computerized flat knitting, in its 4-needlebed configuration, featuring 2 extra beds on top of a conventional V-bed. © Shima Seiki

The benefits of WHOLEGARMENT knitting was further showcased in its ultimate form in the MADE2FIT area of the Shima Seiki booth, demonstrating a mass-customization. The concept beginning with scanning a body using a smartphone app,

then sending that data to a server that automatically adjusts preloaded data categories such as size, length, sleeve length, color, etc., and knitting on the MACH2XS103 WHOLEGARMENT knitting machine.



Fig 9. 3D knitting provides MADE2FIT concept. © Shima Seiki

Yarnbank by Shima Seiki is one of the most exciting ideas at ITMA. It is a first of its kind website for searching and downloading digital yarn data that can be used for virtual sampling on the SDS-ONE APEX series 3D design system, free of charge. Downloading yarn data reduces the need for scanning yarns manually, improving accuracy of simulations and efficiency of product planning. Yarnbank allows the entire supply chain from yarn companies and apparel companies to knit manufacturers to be connected digitally. Yarnbank also provides a brand new channel

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for sales promotion for yarn companies. Shima Seiki displayed digital yarn collections from Yarns & Colors, iafile, Toyoboshi, Tollegno 1900, Hasegawa, UPW, Xinno, Recover, Regal, Xinao, and Novetex (Shima Seiki, 2019).

Stoll, the German knitting machine company's new knitelligence machine generation is tailored to the specific needs of the digital world, facilitating work through process automation, more transparency, shorter response times, shorter production cycles, and higher productivity.



Fig 10. Functional aspects such as breathability, stretch, seamless feeling have to be combined with trend setting designs. The variety of STOLL flat knitting opportunities can be applied to various types of sports and its functional and aesthetic requirements. Fig 11. STOLL flat knitting technology realizes sophisticated flat knitted fabrics designed for various shapes and frames. Partial control of the fabric's stability by inlaid threads over the plane and in shaped areas gives various opportunities for textile supports. © Stoll



Fig 12 and 13. Technical textiles for medical fabrics. Functional requirements such as customized fit, controlled compression application, complex product layouts with mixed materials and jacquard patterning. © Stoll.



Fig 14 and 15. STOLL flat knitting technology creates a variety of upholstery structures. © Stoll

Covering fabrics and upholstery material can be knitted with woven optics and structure effects. Transparent mesh structures provide breathability. Surfaces can be designed with arbitrary combinations of structures to integrate functional and design requirements in one knitting process.

The most futuristic of knitting and wearables was shown undercover. Stoll-knitrobotic visitors had the opportunity to take a picture of themselves or create a

J graphic within their
 T Adobe® Photoshop® plugin STOLL-
 A artwork® and interact with STOLL
 T technology first-hand. As a key feature
 M during the showcase, a plastic stripe was
 inserted within the fabric during the knitting
 process. Without manual intervention, a
 gripping arm (STOLL-knitrobotic®) removed
 this strip from a magazine integrated into the
 machine and inserted it precisely between the
 needle beds.



Fig 16. Stoll's ADF 830-24 ki W Robotic Arm © Stoll

Another application was the knitted sensor glove developed in cooperation with BOSCH GmbH. The glove is made of conductive yarn to provide sensory and control functions on all fingers. The glove is

designed to give wearers the ability to interface with machines; control movement in augmented and virtual reality applications; and gain rehabilitative health care capabilities.



Fig 17. Knitted augmented and virtual reality sensor glove. © Stoll

STOLL Italia. Also presented a newly developed App solution to knit and wear (in cooperation with Fision) - creating the possibility to scan visitors and transfer their body measurements into STOLL's M1plus® to develop a ready-to-knit, customized program.

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The machine with all the features was the ADF 830-24 ki W knit and wear, which offers even greater flexibility in coloring and patterning and improved productivity. The key features include reverse plating, Ikat Plating, selective plating, and intarsia plating. In addition to weft insertion, which gives fabrics a woven like appearance, the ADF 830-24 ki W knit and wear also offers intarsia technique within the knit and wear range. (Stoll, 2019).

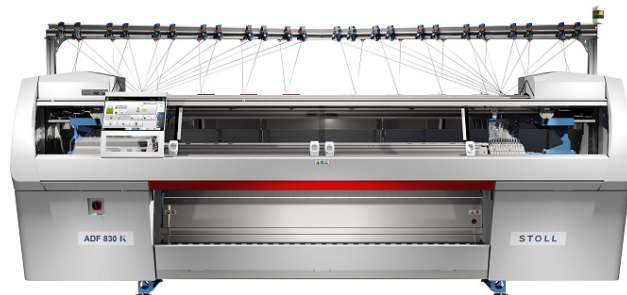


Fig 18.ADF 830-24 ki W © Stoll

Textile Computing came together with Myant, a collaborative company with Stoll that has trademarked the term Textile Computing. Trying to bring knitted sensors and actuators into everyday textiles, giving them the ability to sense and react to the human body. This continuous bidirectional interface to the human operating system will empower humanity to transform its

capabilities and performance, help people proactively manage health and deliver treatment, and allow us to build better connections to ourselves and those around us.

Created by STOLL and Myant, TT e-text is their newest cluster of Technical Textiles. TT e-tex represents the new industry of Textile Computing™, textile products embedded with technologies that

sense, activate, and adapt while generating and transmitting unique insights and personalized feedback. Textile Computing™

is the foundation that will ensure the company stays competitive throughout the Industry 5.0 future (Myant, 2019).



Fig 19. Some of the features STOLL and Myant want to incorporate into their garments. © Stoll

Circular knitting

Mayer & Cie. exhibited five machines, four of which focused on sport fabrics. The new MJ 3.2 E is an electronic single jersey machine that specializes in the production of mesh and body mapping structures. Because the new electronic jacquard flagship machine is based on a 3-in-1 body mapping structured mesh which is in demand in the sporting market segment and athleisure is currently a key growth driver for circular knits. Mesh is a net-like hole pattern. A finer basic thread, usually a monofilament yarn, is responsible

for the hole structure while the thicker plating thread, cotton for example, provides the requisite thick areas. Mesh structures require one-sided plating, the basic thread is invisible in the finished fabric. Mesh can serve as both a fashion and a functional element, such as by ensuring ventilation of selected body areas. Body mapping takes the different perspiration areas of the human body into account, but double-sided plating creates the patterns. Furthermore, body mapping structures almost without exception require elastomeric plating. (Mayer & Cie., 2019)

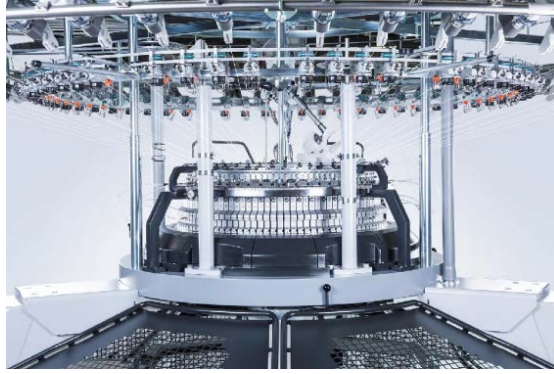


Fig 20. The MJ 3.2 E is Mayer & Cie.’s new flagship for single jersey electronic jacquard. © Mayer & Cie.

Santoni’s seamless technology, especially the TOP2 series of machines are in a class of their own. There has been significant advancement in circular knitting and has proven to be ideally suited for polyamide yarns because of available variants such as filament fineness, luster and filament shape, together with their high stretch and recovery. The technology is based on knitting tubular fabrics without seams and can apply different knit stitches, incorporating pre-shaped structures, limiting costs, such as workforce, waste, fabric stocks, and energy, which are associated with the alternative ‘cut and sew’ manufacturing method. High Productivity 8 feeds single jersey electronic circular knitting machine with two needle by needle selections on each feed with 3 technical ways (configuration

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with 16 actuators). The possibility to knit floated plating design and inlaid elastic yarn. The patented Santoni system enables the knitting of 8 feeds patterns with high definition and extremely sharp color. The machine allows the production of underwear, outerwear, sportswear, swimwear, and medical wear.

In a corner of the Santoni booth a SM8-TOP2V seamless machine was matched with Santoni’s new automatic finishing machine for boxers – creating a unique Boxer Process Station. This cut and sew machine applies a gusset into each boxer with a four-needle sewing head, completing the whole process automatically and offering the finished boxer ready for the final packing stage (Santoni, 2019; Santoni Cn 2019).



Fig 21 and 22. SM8-TOP2V Single Jersey electronic circular machine with 8 feeds with 2 points of selection needle by needle per feed. For the production of single seamless garments for underwear, outerwear, beachwear, sportswear, and sanitary wear. Knit terry loop possibility on request. © Santoni

Knitted shoes

A little history of the knitted shoe industry is needed to understand what has taken place recently. Before the previous ITMA in Milan Italy 2015 knit shoes was a fledging industry on the brink of exploding. The market for shoes with knitted uppers is projected to reach \$3.19 Bn by 2025 at 5.9% compounded annual growth rate (AMR). The knitted portion is the upper material of the shoe that is manufactured using a highly technical knitting machine. (Kadam, 2019). The two major knitted footwear brands Nike and Adidas, have fought over IP since 2012. Shortly after Adidas unveiled the Primeknit, Nike filed a patent infringement claim. Nike failed to meet its burden of establishing patentability of the proposed substitute claims on February 11, 2016. (Foley & Larder 2016).

This has all happened since the 2015 ITMA in Milan opening up the floodgates. Now knit shoes were everywhere at ITMA 2019 in just three years flat computerized machines, circular machines, warp knit machines and the most newsworthy, the traditional sock machine manufactures now have the technology to produce a sock/shoe combinations turning the whole market on its head.

These shoes provide sock-like comfort and maintain a trendy yet athletic look. The shoe with a knitted upper has become increasingly popular among the younger generation owing to the high influence of sports. The knitted upper shoe requires little to no manual labor while manufacturing, the only labor required is to affix the knitted part to the shoe. This allows footwear manufacturers to move production closer to their larger markets, reducing or possibly eliminating the costs of shipping and tariffs. Circular-knitted shoe uppers for sports and

leisure footwear have been an option since 2012 when they debuted at the Olympic Games. Since then fabric shoe uppers have mostly been flat-knitted, with circular knitting and warp knitting running neck and neck a fair distance behind.

When the three techniques are compared, however, circular knitting leads the field for productivity. In addition, setup times are shorter, with the result that smaller batches can be manufactured profitably. Then we have the sock manufacturers that had the technology but not the know-how of how to turn a sock into a shoe upper.

One of leading Italian circular knitting machinery manufacturer is Colosio.

In 2015, after 60 years of experience on intarsia knitting, the company developed the first circular intarsia machine ever patented for the production of knitted, seamless shoe uppers. The S1+, the machine's name that has been acknowledged by the most important international brands with more than 600 machines installed since 2016. According to Colosio, the S1+ machine is not only '100% sustainable', allowing the elimination of waste of material throughout the whole manufacturing process, but it is also extremely versatile. The machine produces uppers for multiple applications, from technical and sports footwear to casual and fashion shoes. Additionally, with an average production capacity per machine of 4 pairs of uppers per hour, manufacturers can minimize industrial costs and times. The S1+ can create seamless uppers made of different and independent yarns and, as a consequence, different and independent areas depending on the final result that the producer wants to achieve (Colosio, 2019).

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Fig 23 and 24. S1M Sock/ shoe designs © Colosio

In a similar vein also on display Santoni's XT Machine. Santoni, an Italian leader in the production of sock and pantyhose machines and part of the Lonati Group, celebrated its 100th anniversary at the show. The company presented its brand-new, patented XT Machine with its ingenious intarsia technology for efficient production of the shoe uppers. Single-cylinder intarsia electronic knitting machine with 4 reciprocating feeds and 2 selection points (3 technical ways) per feed and per rotating sense for the production of intarsia products with breathable mesh areas with cushioning

and/or transfer stitch areas knitted in sculpted terry.

The machine knitting head is equipped with cams as well as a special-patented chain linking system, which allows only preselected needles to be driven to the stitch cam for knitting.

Santoni has applied for a series of new machine patents in order to be able to knit 4-feed high-definition colored logo patterns as well as 3D patterns on the same course as intarsia, sculpted terry and transfer stitch areas (Santoni, 2019; Santoni Cn 2019).

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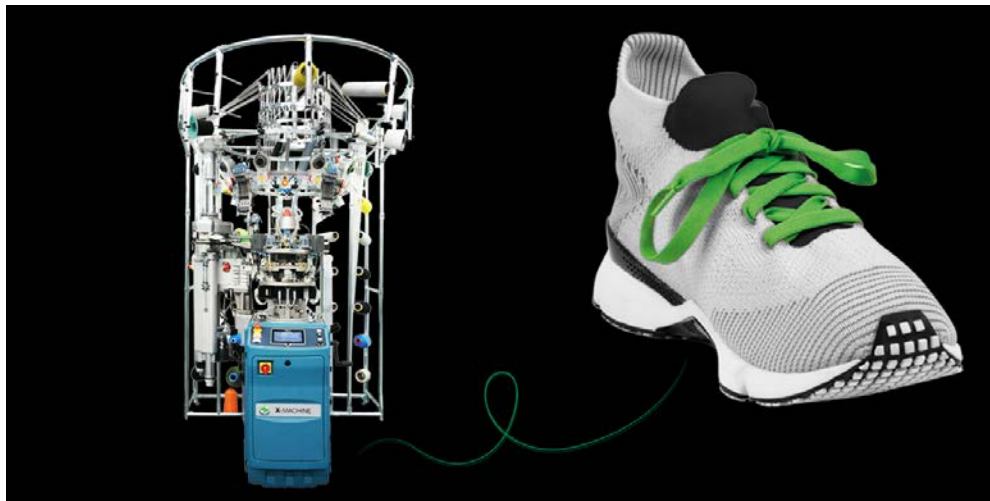


Fig 25. One of the X Machine Sock/ shoes © Santoni

Nearly all the large circular knit companies now have large circular jacquard machines such as Mayer & Cie.'s machine OVJA 1.1 EETT to compete with the traditional Santoni Mec-Mor, which in various forms has been around for years but is now focused on the manufacture of shoe

upper fabrics. They combine double jacquard selection on the cylinder and dial electronics and bidirectional transfer selection and can knit an almost infinite variety of patterns, including hole structures (Mayer & Cie., 2019; Santoni 2019).



Fig 26. Mayer & Cie.’s double jacquard OVJA 1.1 EETT machine knitting shoes. © Mayer & Cie.

Spin knit

Last but not least on the weft knitting sphere is the Spin Knit revolution allowing the spinning from ether roving or sliver. Mayer & Cie. Terrot and Pai Lung offered different variations of this technology 4 years ago at ITMA 2015. Although though these machines were focal points of the booth there does not seem to be much movement in the direction of adoption .However, an established machine with new features is the Spinit 3.0 E, which Mayer & Cie. exhibited at its third ITMA in Barcelona this year. The Spinit 3.0 E now also processes polyester, is capable of a higher working speed and is linked to the Knitlink digital platform making the spinning and knitting machine an even more attractive proposition. The 3-in-1 Spinit systems concept of combining three processes – spinning, knitting and cleaning – in one machine and thereby saving time, space and energy has earned Mayer & Cie. several awards, most recently in 2017 the IKU Innovation Prize for the Climate and the Environment, awarded in alternate years by the Federal Environment Ministry (BMUB) and the Federation of German Industry (BDI). Visitors to this year’s ITMA in Barcelona observed the new, “Enhanced Performance” Spinit 3.0 E.

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These fabrics can now be designed with thick and thin yarns such as Ikat designs allowing this to be a design feature rather than just a cost-savings. There may be hope for this technology if the sportswear brands see their potential (Mayer & Cie., 2019).

Warp knitting

One of the major problems with warp knitting is the amount of mechanical changes that need to take place on the machine to run a new pattern. Karl Mayer, the leader in warp knit machinery have a new model that is directly on line. The HKS 3-M-ON is the first three-bar HKS model with electronic guide bar control, which allows for immediate pattern changes without any mechanical modification and no delay in production. You only have to download the required information from a secured cloud to the machine and you can immediately start to work on the new fabric design. In times of rapidly changing market requirements, it is an asset to be able to react quickly on such demands and be able to access a library of designs making previously short runs impossible.



Fig 27 and 28. The HKS 3-M-ON is the first three-bar HKS model with electronic guide bar control that allows immediate pattern changes © Karl Mayer

Karl Mayer also introduced a new generation of warp knit fabric technology, the double needle bar technology is opening a new chapter by offering, besides the usual 3D-Spacer fabrics, also new 4D-KNIT.SOLUTIONS produced on their RDPJ 6/2 EL.

This ingenious bar arrangement and technical configuration combined with their established high quality Piezo-Jacquard technology, enables this double needle bar

T machine to open up a new dimension
A producing fabrics with diverse malleable
T patterning on both fabric sides. The 3D
M motifs can be completely variable in shape, positioning, and height. Small and flat reliefs or deep and bulky forms with cushioning are possible. Further, the design can contain freely placed holes, for even more possibilities. The openings can be used for directed air flow or lighting effects.

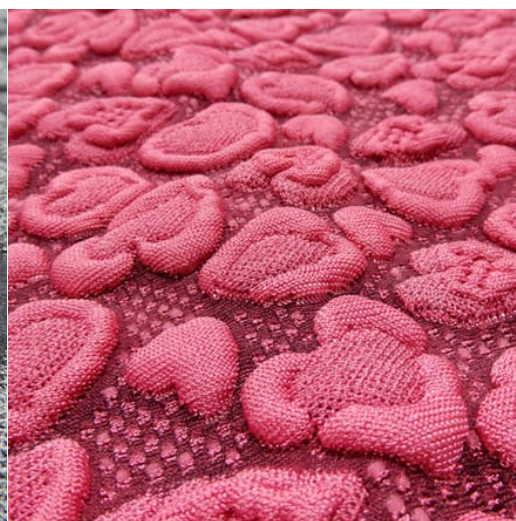


Fig 29 and 30. 4D-KNIT.SOLUTIONS produced on the RDPJ 6/2 EL. © Karl Mayer

Knitted body mapping on warp knit is the future. Rascheltronic® Karl Mayer's RSJ line are a series of high-speed jacquard raschel machines for producing jacquard-patterned, stretch and non-stretch fabrics. These high-speed jacquard raschel machines have jacquard patterning that enables a virtually unlimited range of designs to be worked with electronic guide bar. The computer controls permit rapid lapping changes and long-repeats on pre-made-up fabrics and also enables functional zones to be incorporated.

These machines are capturing the market. Innovative, warp-knitted seamless components can be produced in a single sequence, without any seams, for the toes, fingers and even the head. They can be used in functional sportswear, underwear, hosiery and fashionable outerwear (Karl Mayer, 2019).



Fig 31. Machine: RDPJ 6/2 open warp-knit jacquard design is both comfortable and feminine. © Karl Mayer



Fig 32. Sports bra is made of different functional zones without disruptive seams: strong fabric zones for support, high elastic zones for free movement and mesh structures where breathability is needed. © Karl Mayer

Conclusion

The knitting industry has come a long way in the last 4 years with shoes and wearables leading the charge. Robotics and AI are finally on the way and it is yet to be seen how these technologies will be integrated fully into a garment let alone the human body. However, we can expect there to be a lot more trial and error over the next 4 years as some of these companies try to navigate this integration. What seems apparent is that this technology integration is haphazard at best and just because the technology is there, it does not always make it to the market place. In the meantime, fashion is still going to lead the way, so whatever is new and exciting in an aesthetic sense may have more chance to lead technology forward and the big iconic brands need to play their part to support the technology as long as the design and technology are twinned.

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