

Seamless Technology

By Kim Anderson, Ph.D., [\[TC\]²](#)

There has been great interest in the development of seamless knit garments. A seamless knitted product has a number of advantages over the traditional cut and sewn product.

- The process of cutting and sewing is labor intensive.
- There is a concentration of stress where the seams are located which can jeopardize performance properties and ultimately result in premature product failure.
- Cutting and sewing is often manually executed which introduces the potential for human error.
- The sewing process can create needle holes in the fabric which can damage the yarn.
- Fabric scraps produced from the cut process are discarded, resulting in fabric waste.
- Eliminating the cut and sew process allows for “quick-response production.”

In addition, seams in a garment create bulkiness especially at the shoulders and underarms which can adversely affect the comfort. For these reasons, the development of seamless shaped knitted structure has been an area of interest.

There are a number of different machines that can produce shaped knit products. Some of the machines totally eliminate the cut and sew process to produce a seamless garment. Other machines minimize the cut and sew processes to produce a garment with fewer seams than a traditionally made garment. Machines can be divided into three categories—each having a different level of sophistication.

Some machines produce shaped panels such as the front and back bodice and sleeves. After knitting, the shaped panels are sewn together to produce a garment. Other garment details such as collars and pockets are added during the sewing process. This type of process is known as shaping or **full-fashion**.



Courtesy of Shima Seiki

Integral knitting is similar to full-fashion knitting. In integral knitting shaped pattern pieces or panels are formed on the machine. However, unlike full-fashion knitting, trims, pockets and other details such as button holes can also be added during the knitting process. Both the full-fashion and integral knitting processes reduce the amount of cutting and sewing necessary to produce a completed garment.



Courtesy of Shima Seiki

The last and most sophisticated process is referred to as **whole garment knitting**, a term coined and now registered by Shima Seiki. In this process a whole garment is produced directly from the machine. No cutting or sewing is necessary. A Computer Aided Design System (CAD) is utilized to create the garment pattern. The pattern information is saved on a diskette and transferred to the knitting machine.



Courtesy of Shima Seiki

To knit a sweater, three shaped tubes are knit simultaneously. A front and a back needle bed are utilized to knit the tubes. Loops are knit and transferred between the front and back beds to create shape. Three yarn carriers are used—one to knit the right sleeve, the second to knit the body and the third to knit the left sleeve. Once knitting reaches the under arm area, the tubes are combined. The two carriers knitting the sleeves are taken out of the knitting zone. The carrier knitting the body begins to knit one tube—combining the three tubes. Garment details can be added during the knitting process.

Since whole garment knitting debuted more than a decade ago, there have been continuous improvements in machine design. Some of the improvements have been increased productivity and design capabilities and better fabric quality.

Whole garment knitting machines have unique design capabilities. Although there are conventional circular knitting machines that have some of the design capabilities of whole garment machines, they are complicated to program and very expensive. One unique feature of a whole garment knitting machine is individual stitches within a course can be controlled, allowing for increased design capabilities. Traditional circular knitting machines do not have this capability.

Today's whole garment machines are capable of knitting a wide variety of constructions. Everything from a sheer to bulky knit fabric can be produced. Needles can be taken out of action to knit fabrics of different weights. Machines come in different gauges, allowing for a wide variety of yarns to be used.

Whole garment knitting machines can be equipped with intarsia carriers. Intarsia carriers can be programmed to knit in designated areas only, as opposed to knitting the full width of the machine. Using intarsia carriers, multi-gauge looks and combinations of design structures can be seamlessly incorporated within a garment. Multi-gauge looks are not only used as design elements but are also used to enhance comfort and performance. Open structures can be incorporated in specific areas to give the wearer additional ventilation.



Multi-Gauge Look Within a Garment

Courtesy of Shima Seiki

The transfer mechanism used to create shape can also be used to produce elegant knit constructions such as pointelles—a knit fabric with a pattern of holes or openings made by using transfer stitches.

Warp insertion is another technique that can be used in whole garment knitting. The weft yarn is controlled by a conventional yarn carrier while a second yarn, referred to as the warp yarn, is inserted to produce interesting color combinations and patterns. Warp knit patterns such as vertical stripes and jacquards can be combined with intarsia patterns to provide a range of fashionable garments.

Shima Seiki and Stoll are the leading machine manufacturers of flat bed whole garment knitting machines. Their latest machine design updates will be reviewed. In addition, Santoni's latest design updates will also be reviewed. Santoni is a leading manufacturer of circular knitting machines capable of producing shaped panels.

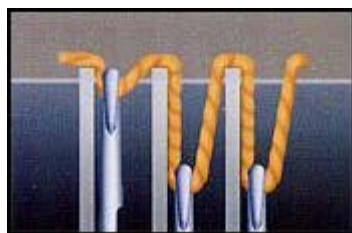
SHIMA SEIKI

Since the introduction of whole garment technology in 1995, Shima Seiki has made continuous improvements to the machine design. Researchers have concentrated on increasing design capabilities, improving fabric quality, and increasing productivity. Today, Shima Seiki's WHOLEGARMENT® knitting machines come in gauges ranging from 5 to 18 needles per inch and widths ranging from 50 to 80 inches.

In order to create shape, loops are transferred. For latch needles to be able to complete the transfer process on a flat bed machine, a transfer spring is needed. When a transfer spring is present, needles cannot be located in the center of the needle groove. The displacement of the needle results in an asymmetrical loop formation. To improve quality and productivity Shima Seiki redesigned the traditional latch needle.

The SlideNeedle® uses a flexible two-piece slider mechanism instead of a conventional transfer clip. During knitting the mechanism extends beyond the needle hook to aid in the stitch transfer process. In the absence of the transfer clip, the SlideNeedle® can be mounted in the center of the needle groove to produce perfectly symmetrical loops. When used in combination with the Contra-Sinker, the movement of the SlideNeedle® is reduced—distributing yarn tension more evenly, reducing scuffing and preventing yarn breaks. In addition, a wider variety of yarns can be utilized when the SlideNeedle® is used in combination with the Contra-Sinker.

It should be noted that when loops are transferred using a SlideNeedle®, an additional transfer bed designated to transfer stitches is needed. The machine also requires an extra cam system to control the slider on the SlideNeedle®.



**Conventional latch needles
offset in grooves**



**SlideNeedles®
centered in grooves**

The Intelligent Digital Stitch Control Device (IDSCS) was designed to provide superior and consistent loop formation. The IDSCS is inconspicuously equipped to the knitting machine. The IDSCS predetermines how much yarn is required for each stitch. The device is programmed to knit the desired loop length. The IDSCS reduces yarn stress. After each course the yarn consumption is monitored and the yarn feeders and tension are adjusted accordingly, yielding consistent loop formation throughout the fabric. Uniform quality is achieved among different production batches, as well as for repeat orders.

An air splice designed by Murata is used in conjunction with the IDSCS. As yarn color is changed during the formation of a multi-colored knit design, a powerful jet of air splices together the end of the old yarn to the end of the new yarn. The elimination of knots greatly improves fabric quality, especially in garments containing multi-colored stripes or intarsia designs.

Knitting machines are now equipped with a 4-cam system. Each system has the capability to simultaneously form knit, miss or tuck stitches as well as transfer stitches. Therefore, 4 courses can be knit in one pass of the carriage or 8 courses can be knit in 2 passes or a full revolution. The 4-cam system allows for greater production.

Recently, Shima Seiki created a pattern structure database. In the database users can choose from a variety of collars, plackets and cuffs as well as other garment details.

STOLL

Stoll manufactures flat bed knitting machines with the capabilities of knitting seamless whole garments. Stoll refers to their machines as “Knit and Wear®.” Stoll machines can knit up to 32 colors, come in a range of gauges and have knitting widths ranging from 72 to 84 inches.

Martin Legner, involved in marketing, sales and technical applications at Stoll, says the unique feature of Stoll’s Knit and Wear® machine is flexibility. The machine has the capability of knitting different constructions, and coarse and fine areas within the garment. The versatility of the machine allows it to “cope with almost any application.” Cotton Incorporated, a research company in Cary, NC, primarily uses the Stoll CMS 340 TC Knit and Wear® machine to knit design-forward fabrics to be used as samples for the FABRICAST™ Collection. The machine is ideal for product development because of its design capabilities and versatility. In addition, just a few yarn packages are used.

Stoll’s CAD system is known to be one of the most straightforward systems available.

Two computer screens are utilized during the garment development process. One screen displays the technical information, while the other screen displays a representation of the fabric design.

The yarn tensioning system has been designed to be versatile and reliable. With an improved weight control lever, yarn can be knit under low tension. Low tension means low stress, which reduces the likelihood of disruptions during the knitting process. Yarn tension can be changed easily by adjusting one screw on a fixed guide. Even yarns that can be difficult to handle such as strong yarns with lots of knots are knit with ease. The yarn tensioning system can be used in combination with any gauge machine. Positive feeders can be added to knit fine or stretchy yarns.

Stoll now offers a machine with an extra wide knitting width. The 84 inch machine is designed to produce extra large garments. The machine comes in a range of gauges and is equipped with intarsia carriers for more complex design capabilities.

Stoll has recently introduced a new take-down system. With the modified take-down system, a “French shoulder” can be knit. The shoulder has an excellent appearance and good elasticity.

With the addition of special equipment and some slight modifications the machine can perform weft insertion.

Other machine updates include:

- The Power-RCR (Rapid Carriage Return) speeds up the knitting process. It is also more economical and reliable.
- A patented holding-down sinker

Future research will focus on increasing productivity, more flexibility and ease of handling.

SANTONI

Santoni and Sangiacomo, both owned by Lonati, have the capabilities of producing shaped tubes. Santoni machines are more prevalent than Sangiacomo machines in the market place. Unlike the flat V bed configuration of the Shima Seiki and the Stoll machines, the Santoni and the Sangiacomo have a circular knitting bed. Although some sewing is required to complete the garment, knitting cycle times are comparatively fast. A ladies shirt can be completed in approximately 2-4 minutes, whereas a seamless shirt knit on a whole garment knitting machine can take a number of hours to produce.

Shaping is accomplished by utilizing different knitting techniques. Shape can be created by incorporating combinations of floating, tucking and knit stitches within the fabric. Incorporating different constructions within the fabric, such as false ribs, will also cause the fabric to bunch up, ultimately creating shape. Shapes are also produced by knitting stitches of varying lengths or unbalanced stitches. With this technique specified needles are programmed to pull a longer stitch while others knit a shorter stitch.

Santoni has recently designed two new machines, one with advanced design capabilities and the other with the capability of producing shape via a reciprocating motion.

The SM4TR2 machine is capable of true stitch transfer. Stitch transfer is used to incorporate combinations of design structures within the fabric. The technology is being utilized in high performance garments and undergarments. An open mesh construction is utilized in areas where additional ventilation is desired.

The SM4TL2 machine accomplishes shape via a reciprocating motion. The machine swings in opposite directions, similar to a sock machine. With each swing the machine engages a specified number of needles depending on the desired shape. Unlike previous shaping methods, the SM4TL2 machine produces fabric with consistent density.

The Santoni machines have the capabilities of knitting 16 colors per course; however, this is rarely done. Most fabrics are knitted and subsequently piece dyed.

TECHNICAL ISSUES

The main obstacle to the commercialization of whole garment knitting has been designing the appropriate fabric take-down mechanism. In traditional knitting, tension is applied to the newly knitted fabric coming off the machine. Tension is kept equal across the width of the fabric. The tension serves to keep the newly formed stitch securely on the latch needle. The fabric coming off the machine in full body knitting is often asymmetrical, therefore equal tension cannot be obtained across the width of the fabric. Conventional fabric take down systems had to be redesigned to accommodate full body knitting.

APPLICATIONS BESIDES APPAREL

With the ability to produce almost any seamless shape the technology has potential in a variety of markets other than apparel. A number of upholstery companies are exploring the opportunities seamless knitting has to offer. The inherent stretch in seamless fabric gives seat covers an excellent smooth appearance. The Teknit Company has produced a three-dimensional seat cover constructed with polyester yarns. The cover provides an alternative to the traditional woven covers produced via the cut and sew process. Teknit reports that lead times are substantially lower than the woven product. The three-dimensional knit cover is currently their fastest selling line.

There are a host of opportunities in the medical market for seamless knit products. Shaped tubular constructions have been used for bandages, orthopedic supports and compression stockings. With the onslaught of high performance fibers and the development of micro-sized sensors it is expected that the medical industry will continue to explore seamless technology.

Protective clothing is another area in which seamless garments have enormous potential. There is the potential for harmful substances to penetrate a garment in areas where seams are located. A seamless garment would give added protection to the wearer.

CONTRIBUTORS

Wonseok Choi, Ph.D. Student, College of Textiles, NCSU.

Tony McBryan, General Manager, Shima Seiki U.S.A. Inc.

Martin Legner, Marketing/Sales and Technical Applications, Stoll

Alan Parker, Pam Trading Corporation

Jimmie Grow, Director of Fabric Development, Cotton Incorporated

Emmett Hylton, Manager of Knitting Operations, Cotton Incorporated

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