ITMA 2023 – trends and innovations in weaving

Hans-Jürgen Bauder
German Institutes of Textile and Fiber Research (DITF), Denkendorf/Germany

The motto of the leading European trade fair in textile machinery manufacturing was transforming the world of textiles. The weaving machine halls accordingly showcased many enhancements to tried-and-tested technologies that take particular account of the central theme of efficiency and sustainability. The motto was flanked by the incessant statements on more intelligent machines and ever more extensive performance optimization. These topics are not entirely new; however, they were focused on the processing of recycled yarns and were implemented in Milan in the form of new weaving machine generations based on the familiar development approaches and concepts of previous fairs. Machines were obviously demonstrated in series-production or special applications, equipped with useful features. Thus, the exhibitors did not show any major technological leaps, but rather mature developments with successful advances in a package of practical details for the customer.

General trends

What can be observed in the latest generations of weaving machines is an unbroken striving for higher energy efficiency, consistent waste avoidance with progressive performance optimization, related to the respective product-related application or the materials to be processed. Accordingly, in addition to components and setup tools for reducing weft waste, machine design for processing recycled yarns in particular is also a consequent response to increasing resource conservation in production of fabrics. Another aspect is the conceptual revision of the machine components with regard to potential savings in the electrical and pneumatic energy of a weaving machine. Finally, resource conservation was evident in the design of the machines themselves, in that retrofitting of more modern drives, control systems, sensor technology or digital communication platforms increasingly helps to upgrade older machine generations for future tasks.

Digitalization and connectivity of machinery is also advancing to make the weaving process more reliable, safer and a bit more autonomous through more sensor-based monitoring. Wherever necessary, sensors are used to make analytical assessments directly at the machine in real time, to either improve the process in a self-learning manner, to react in a self-adjusting manner, or at least to suggest the best possible settings to the operator. By networking machines of the same type or at least of the same manufacturer, a great deal of process information is thus recorded in a company's own data room in order to monitor individual steps in networked production and to be able to manage them more easily. Through a secured link with the machine manufacturer, predictive service or spare parts support for the production facility is often implemented.

As a result of digitalization, the intuitive operation and control of weaving machines is becoming easier for less technically trained personnel. The new machine designs are increasingly visually appealing, user-friendly and easier to maintain and clean. Easier to recognize displays, self-explanatory operating instructions and recommendations from a database of expert knowledge on woven articles, maintenance tasks and optimized performance specifications improve product quality while maintaining high production output.

A look at the performance development of the various weaving machine types over the many years of the exhibitions provides information in many respects about the developments in weaving processes. It can be seen very clearly, for example,

→ Next page

that up to around the turn of the millennium at the Paris fair in 1999, there was a general competition between the different weft insertion systems in terms of the machine performance achievable under ideal conditions. Since then, however, a largely constant level of insertion performance has been observed, although one important fact remains unnoticed for the time being.

Thus, rapier, projectile, water-jet and circular weaving machines settled between 1,500 and 2,000 weft insertion m/min, while air-jet weaving machines with higher energy consumption due to compressed air generation, settled at around 3,000 insertion m/min.

Based on the data from this exhibition, the performance is achieved either by high speeds, such as on the OmniPlus-i Connect air-jet weaving machine from Picanol with 1,500 rpm and a weft insertion rate (WIR) of 2,505 m/min, or by machines with a large fabric width, such as the Phoenix projectile weaving machine from IQ-SPS: nominal width (NW) of 460 cm and a WIR of 1,518 m/min. Toyota combined both at the fair on its JAT910 air-jet weaving machine: 900 rpm with NW 340 cm and a WIR of 3,060 m/min.

However, what is not apparent from the performance chart is the fact that these consistent performance values remain at this high level despite the fact that weaving machines are consuming progressively less energy, guaranteeing more reliable production conditions and having to meet much more difficult operating conditions due to the processing of more difficult materials such as recycled yarns.
The following are specific examples of individual machines that illustrate these trends.

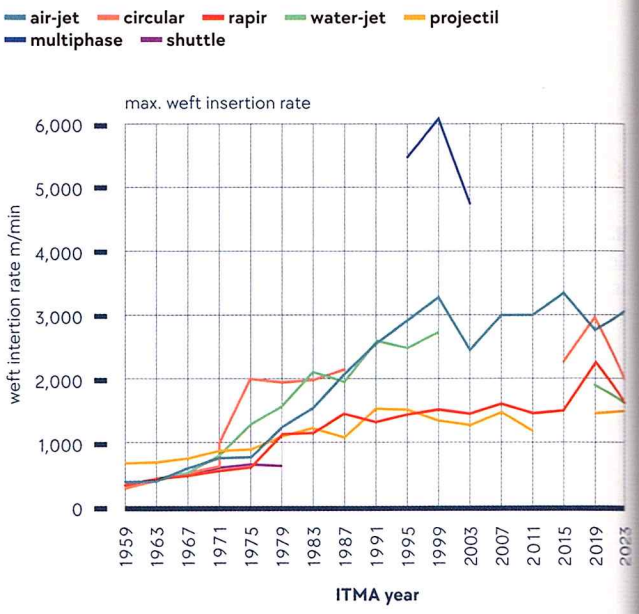
Air-jet weaving machines

For manufacturers of air-jet weaving machines, the focus of development was on optimizing the main and relay nozzles, sensor monitoring of weft insertion, and improving the valve technology and tank systems - all improvements with energy efficiency and more precise setting of the machine in mind. These innovations are accompanied by measures to reduce vibrations through stiffer machine structures, lighter moving parts and improved and more economical direct drives. In addition to new model generations with new naming at Dornier, Toyota and Tsudakoma, Picanol and ITEMA under familiar names highlighted detail improvements and enhanced digital connectivity of the machines. Vuts Liberec showcased the leno weaving machine GS 980 leno, and the spacer weaving machine DIFA with air-jet insertion for special technical fabrics.

Lindauer Dornier GmbH, Lindau/Germany, presented for the first time the new air-jet weaving machine A2 with numerous innovations compared to its proven predecessor A1. Weft insertion has been made even more precise by components such as the new electronically controlled compressed air monitoring of the main nozzles and the improved EcoValveControl+ electronics (EVC+) for exact relay nozzle timings. This achieves more intelligent production monitoring and further reduces the consumption of compressed air and energy. In addition, the novel Electronic Filling Retraction system (EFR) was introduced,

↓ FIG. 1

Insertion performance at the exhibition in 2023 at a consistently high level even for yarns that are more difficult to process, such as recycled yarns



↓ FIG. 2

Premiere of the A2 air-jet weaving machine with the EFR yarn retraction option in the main nozzle (Source: Dornier)

which pulls-back the weft yarn from the blowing zone of the main nozzle during active holding times to minimize the damage of delicate yarns. This ensures a higher fabric quality on the right side of the fabric. A newly developed synthetic oil also ensures smoother machine running and reduces the energy consumption of the machine, while extending the oil change intervals to 3 years. The scope of digitalization has been significantly extended by networking several well-known data systems and customer portals via DoXNet, making it even more user-friendly. Process data on machines, articles, and weft materials can be better monitored centrally in the customer's own portal, and reproducible settings shorten changeover times.

Toyota Industries Corp., Kariya/Japan, presented the new JAT910 air-jet weaving machine entirely under the motto of sustainability. With enhanced functionalities and IoT sensor technologies that measures a wide range of data, this newcomer was demonstrated with a nominal width of 340 cm and a weft insertion rate of 3,060 m/min at 900 rpm. According to the manufacturer, the machine communicates directly with the compressor and is thus better capable of regulating the compressed air requirements for specific products. As a result, the machine achieves its output even at a lower inlet pressure of 6 bar. Many components of the air injection system for weft insertion have been improved. The vertically arranged air tanks, a direct connection to valves and the nozzles, and an improved flow path design all add up to a more precise regulation of the compressed air consumption. Compared with the predecessor machine, the air pressure requirement is thus said to be reduced by 10% and the air consumption by 20%. Another notable innovation is the function and location of the i-sensor. The sensor, which has now been transferred from an earlier concept study to series production, can determine the arrival time of a weft yarn already during insertion process in the right half of the shed. In the further course of insertion, the pressure and blowing times of the relay nozzles are readjusted so that the arrival of the weft yarn lies within a very narrow time window. The use of a new main drive and inverter also reduces power consumption by 10%.

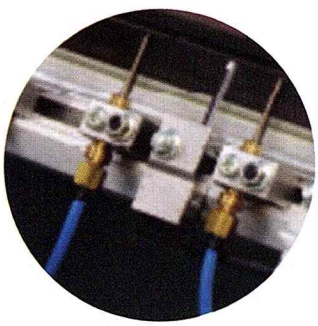
Tsudakoma Corp., Kanzawa/Japan, also presented its new air-jet weaving machines of the ZAX001neo generation on a stiffer TAP machine platform. The special feature of this model series is a modified shed geometry with a forward-shifted heald frame position, whereby the same shed angle is achieved with a smaller shed stroke. Furthermore, the sley movement is also reduced, which leads to an increase in performance with less stress on the machine and yarn. With the help of a tubeless connection between the valve and the main nozzle, air consumption and pressure could also be reduced in these models under the same weaving conditions. The manufacturer claims a 30% lower air consumption and 15% lower air pressure requirement compared to the previous model.

Rapier weaving machines

Developments in rapier weaving machines have focused on improvements in the design of rapier heads, rapier guides for contactless weft insertion, and rapier gears. To reduce weft wastage and avoid left selvedge, many manufacturers have upgraded yarn clamps for a greater number of insertion colors. For more transparent monitoring of settings on the machine, pre-winders with digital weft tension displays or adjustments have come back into focus. The P2 models from Dornier were exhibited with a heavy-duty version for sailcloth and as Jacquard weaving machines at the Bonas and Stäubli booths. Rapier machines from denim to terry fabrics, as well as jacquard versions were shown by Picanol, ITEMA and Smit. Schlatter Jaeger and ITEMA also presented heavy-duty designs for technical textiles and filter fabrics in nominal widths of 5.40 m and 3.80 m, respectively.

The eye-catcher at the stand of Picanol NV, Ieper/Belgium, was the new Ultimax rapier weaving machine, which illustrated through 4 application examples the 3 development priorities of the manufacturer: Improved performance, sustainability and ease of adjustment. New components and sensors were installed on a completely new machine platform and provided with a futuristic-looking housing. Lighter gripper components, such as a 3D-printed titanium gripper head and a gripper stroke measurement system, contribute to the performance improvement. The latter automatically recommends the maximum production speed for any article changeover. A new take-off roller ensures uniform tension distribution across the fabric width. For the processing of recycled yarns, measures have been taken on the entire machine structure to counteract the contamination caused by the increased amount of dust generated by recycled materials on the machine surfaces by means of the smooth machine design and easier accessibility. In addition, an integrated compressed air tank in the upper beam provides the possibility of attaching blow-off elements along the insertion and shedding area to keep the weaving zone largely dust-free. Weft thread control and sensors for waste prevention are integrated at both fabric edges. Also integrated as standard is the Picascope, a small stroboscope positioned above the left fabric edge, which can be used to monitor the thread clamping at the gripper and check the weft waste while the machine is running. With PicConnect, all digital data of the integrated sensors from the weaving machine are collected, processed and networked for central monitoring. The recommendations and setting specifications derived from this make it easier for the operator to make the right decision.

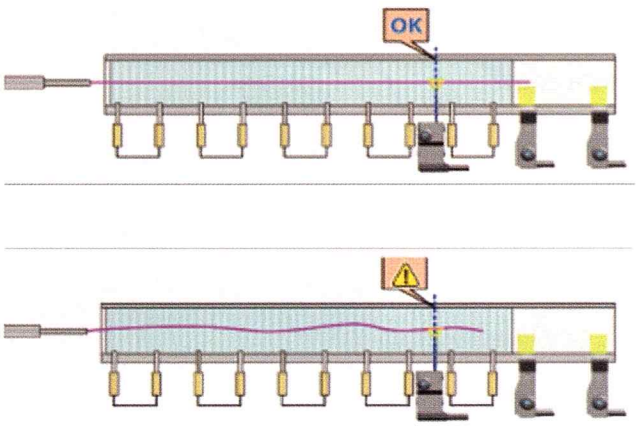
→
Next page



↓ FIG. 3

i-Sensor for controlling the insertion process within the insertion zone

(Source: Toyota)

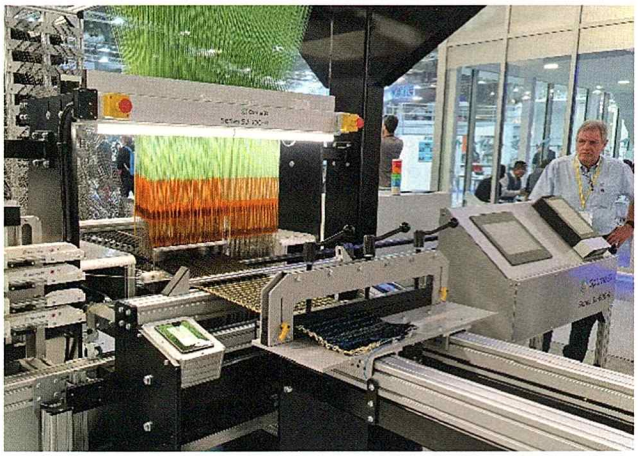


Itema SpA, Colzate/Italy, exhibited its new weaving machine generations of rapier and air-jet weaving machines under the name extension EVO. The main developments in rapier technology were demonstrated on 5 weaving machines. The so-called propeller gearbox of the rapier drive has been designed for higher speeds and extends the flexibility of the machine for the 2 available rapier systems with and without guiding teeth. In addition, the machine structure and the shuttle drive have been reinforced. The iSaver, a clamping device on the left to reduce the selvedge, has been extended to 6 colors and can be used with both guided and unguided grippers. The weft insertion is monitored by the tension-controlled TENS pre-winding unit from LGL Electronics SpA, Gandino/Italy, and the yarn tension can be held to set values and permanently shown on the display. Via the EVO data portal, further digital information on the weaving machine can be monitored centrally, settings and performance parameters can be output from the iKnow expert pool, and spare parts can be requested directly.

The second Italian weaving machine manufacturer Smit Srl, Trissino/Italy, presented the 2fasti Concept, a development based on the existing 2fast rapier weaving machine with the fastest free-flying rapier. With 800 rpm at a nominal width of 1.9 m, the operating performance was demonstrated on a shirting fabric as an example. It was not possible to find out to what extent the design of the machine will be adopted in series production.

Projectile weaving machines

While 4 years ago in Barcelona the attention was focused on the world premiere of Itema's Discovery concept design, which presented a new era of projectile weaving by means of controllable linear drive, it was announced by the manufacturer that this technology is not yet ready for the market. Out of consideration for other innovations, no project machine with conventional picking mechanism was exhibited on the stand,



↑ FIG. 5

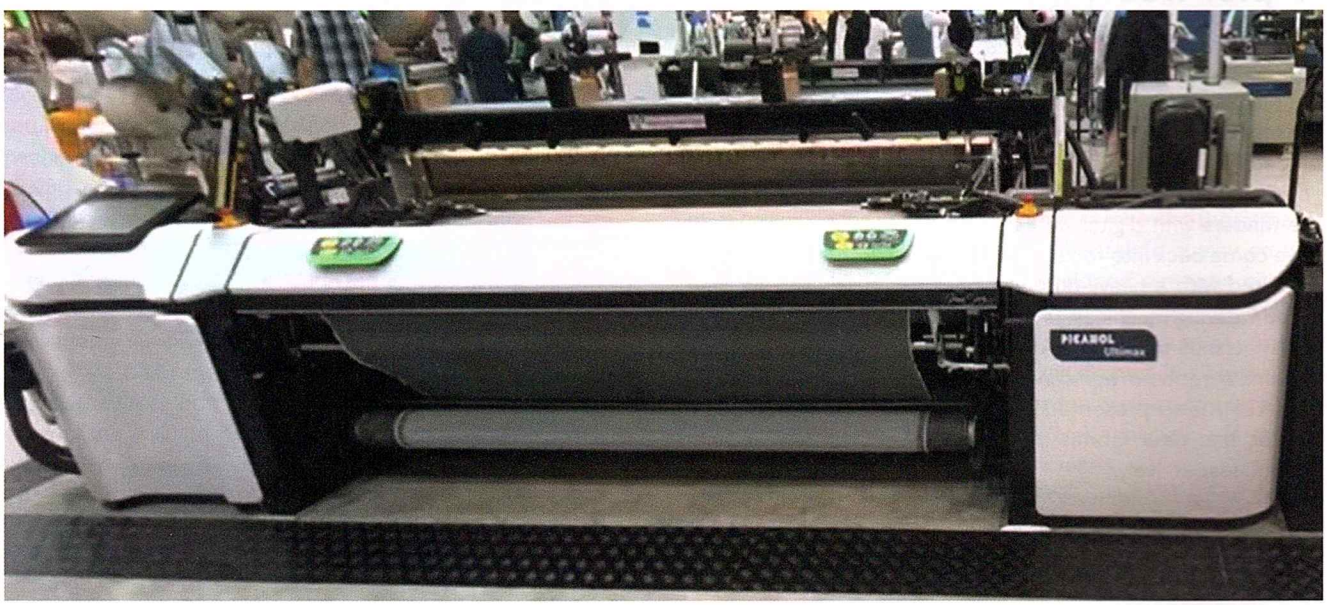
Plug-in shuttle weaving machine of the SJ series for near-net-shape fabrics (Source: Optima3D)

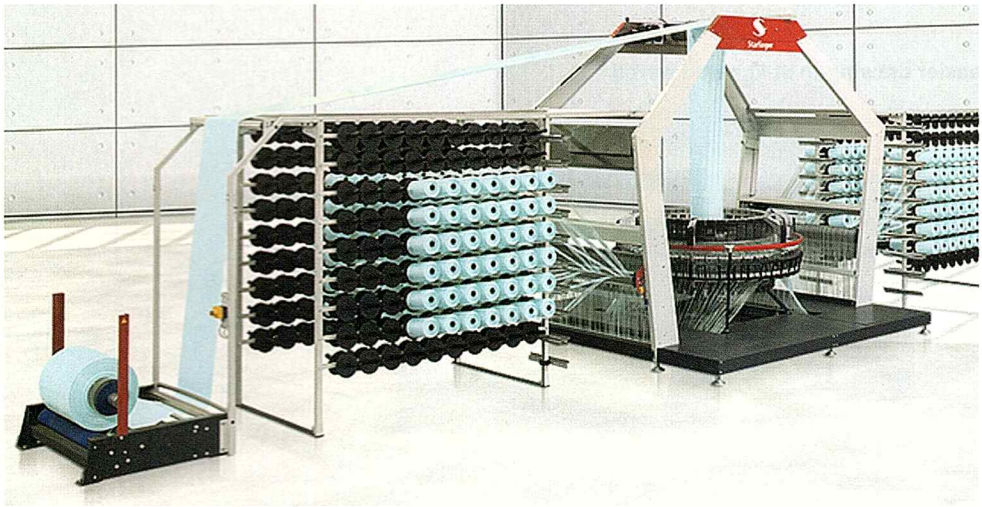
rather Itema referred to the possibility of viewing the projectile weaving technology in the showroom at the nearby company site in Colzate.

IQ-SPS GmbH, Wettringen/Germany, was the only exhibitor to display the new projectile weaving machine Phoenix in accordance with the philosophy of a comprehensively sustainable conception of proven machine technology. Under the slogan of rebirth, the company's philosophy is to upgrade projectile weaving machines to the technological state-of-the-art according to individual customer requirements. Discarded Sulzer machines are upgraded to wide and powerful new machines. The company claims that the use of raw materials is very environmentally friendly, as retrofitting can save up to

↓ FIG. 4

Ultimax rapier weaving machine in a modern design (Source: Picanol)





← FIG. 6

FXa 6.0 6-shuttle circular weaving machine with 1,200 weft insertions per minute (Source: Starlinger)

5 tons of steel and 10 tons of CO_2 compared to the production of a new machine. Furthermore, the weaving system with 6.5 kW at an insertion speed of 1,600 m/min is inherently a machine with very low energy costs. The reinforcement of the main beam and the fundamental rebuild of all elements of the projectile insertion system result in machines with nominal widths between 4.6 and 12 m, which are offered for the production of heavy technical textiles.

Special weaving machines

The growing market for composite materials and technical textiles for applications in the automotive, aerospace, filtration or medical technology sectors requires increasingly complex fabric constructions. These include multilayer, spacer or tubular fabrics, ideally in near-net-shaped production. Special weaving machines based on the principle of multilayer insertion systems in rapier or plug-in shuttle design are required to realize these structures.

The carpet weaving machine manufacturer Vandewiele NV, Kortrijk/Belgium, which refrained from exhibiting large carpet weaving machines at this trade fair, did, however, provide information on the VSi 3-gripper weft insertion principle, which is implemented on a loop weaving machine. This allows carpets with combinations of pile loops and cut piles to be produced in one process. Other functional equipment such as the new Fast Creel or the controlled pile yarn feeder cleverly simplify the process of picking and feeding yarns from the creel to the machine.

QMatex bvba, Harelbeke/Belgium, announced a very compact rapier weaving machine with 4 insertion shuttles one above the other. However, the QS-S-2-300 plug-in shuttle weaving machine with two plug-in shuttle units was exhibited. The double shuttle insertion was combined with a 3-position jacquard machine. The weft tension could be controlled in the shuttle during insertion, thus providing very defined fabric structures. Weaving widths of up to 50 cm can be realized with the machine.

Mageba International GmbH, Bernkastel-Kues/Germany, did not exhibit a plug-in shuttle weaving machine, but referred to this system for larger weaving widths with a revised plug-in system and the option of regulated weft tension for technical and medical articles.

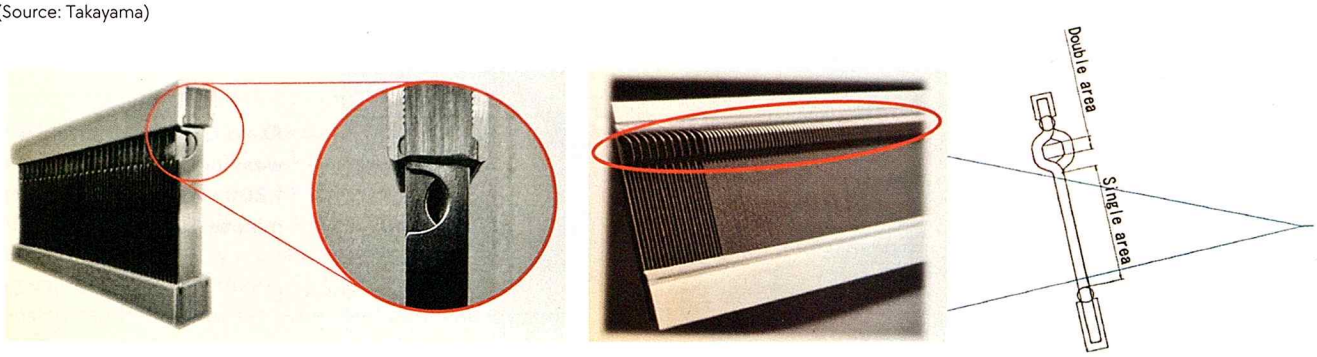
Optima3D Ltd., Meltham/UK, presented a plug-in shuttle weaving machine SJ-600-4 with 4 shuttle levels. The machine has a modular design. With 4 vertically stacked shuttles on the left side, an insertion bar which moves in from the right to carry the shuttles, and a tangential take-up, the machine shows good capabilities for versatile 3D woven semi-finished products. With jacquard shedding mechanism, independent warp yarn feed from the creel and a parallel beat-up with height-adjustable sley, multi-layer, near-net-shaped woven structures with width up to 1 m and thickness of 10 cm can be realized from raw materials such as carbon, glass, ceramics, aramid and organic fibers. The machine has servo drives for all main functions and is suitable for small batch production. The only limitation to the flexibility of the 3D weaving is that the insertion bar must first set the shuttle back again in the appropriate position in the left-hand magazine before another shuttle, and thus another weft material, can be activated.

In circular weaving technology, Starlinger & Co. GmbH, Weissenbach/Austria, represented its latest machine. The 6 shuttles of the FXa 6.0 circular weaving machine, which rotate in multiphase wave shed technology, process film tapes in twist-free quality at around 1,200 weft insertions per minute. This machine, which is used to produce big bags, is part of a plant concept that, together with other partners, offers a closed-loop system for packaging. Among the innovations on the circular weaving machine were the new shuttle rollers that roll over the warp yarns with less wear and are quieter, making them gentler on the warp material. In addition, weft bobbin monitoring is integrated on each shuttle, which indicates yarn breakage or empty bobbins in good time. A control of the yarn tension of the warp tapes entering from the creel also ensures a reduction in warp breakages and a more uniform fabric quality.

→
Next page

↓ FIG. 7

Magic Knot Drawing-in Reed for easier drawing-in of knotted warps
(Source: Takayama)



In general, the machine operates at a very low noise level with a low power consumption between 3.8-4.0 kW relative to the respective fabric circumference of 110–170 cm.

Weaving accessories

In terms of accessories, the weaving reed sector received a fair share of attention at this trade show. Groz-Beckert KG, Albstadt/Germany, expanded its portfolio of technical reeds with a new ultra-fine reed with a reed pitch of just 0.071 mm, or 14 gaps/mm. Accordingly, the thickness of the dent is only 40 µm, leaving gaps of 31 µm each for the warp threads. With a maximum reed width of 160 cm, 22,400 yarns can be drawn in.

Weaving reed manufacturer Takayama Reed Co., Ltd., Kanazawa/Japan, introduced a variety of special weaving reeds, including new reeds designed to facilitate the drawing-in of knotted warps at fine pitches. Under the name Magic Knot Drawing-in Reed, a clearance has been created at the upper reed area to allow several thousand threads to be passed through. This solution is offered in 2 versions. The reed dents are alternately provided with a semicircular recess at the front or back at the upper end, or they are U-shaped, which creates sufficient space for the knots to be passed through.

Schlatter Jäger GmbH & Co. KG, Münster/Germany, presented a special reed for heavy fabrics with impact forces of up to 30 kN/m on its C-Tec rapier weaving machine with nominal widths of up to 5.4 m. With the free-flying rapier option, the machine was equipped with a special boomerang weaving reed, which is L-shaped at the lower reed area. This creates a horizontal guide plane on the reed on which the rapiers can glide as if on a guiding track, while the warp yarns in the lower shed position dip below this guide plane and are thus spared damage from the rapier.

Software

In the field of fabric design and development of weave pattern, EAT GmbH "The DesignScope Company", Krefeld/Germany, introduces the 3D Yarn-Creator software, a new program tool for yarn designs that can be transferred to existing weave and fabric editors to simulate the look of real fabrics. Thus, the fabric simulation starts one step earlier with the yarn optics. This enhancement makes it possible to predict the fabric appearance even more realistically. The structure of the yarn design starts with the type and selection of fiber, fineness and dyeing, and also considers the spinning process, be it a staple fiber or continuous filament yarn, and allows structural characteristics of a textured yarn, a twisted yarn or even exotics such as loop and chenille yarns to be simulated. This data, integrated into the fabric weave, allows a representation of the surface in which the effect of light on the fabric can be expressed in a much more differentiated way.

Summary

The demand for more sustainable use of resources can no longer be ignored and is deeply anchored among weaving machine manufacturers. Thus, the trends for the transformation in the textile industry towards sustainability and digitalization have been systematically implemented in the new machine generations and will demand further development efforts in the future. The results of this trade fair were reflected in many detailed developments or sensory and digital innovations that can be optionally integrated or are already installed as standard in the weaving machines. Some suppliers have geared up their entire machine concepts to address the issues of transformation and are taking due account of the wishes of customers and producers.