Technical Embroidery

The ZSK TECHNICAL EMBROIDERY SYSTEMS Magazine

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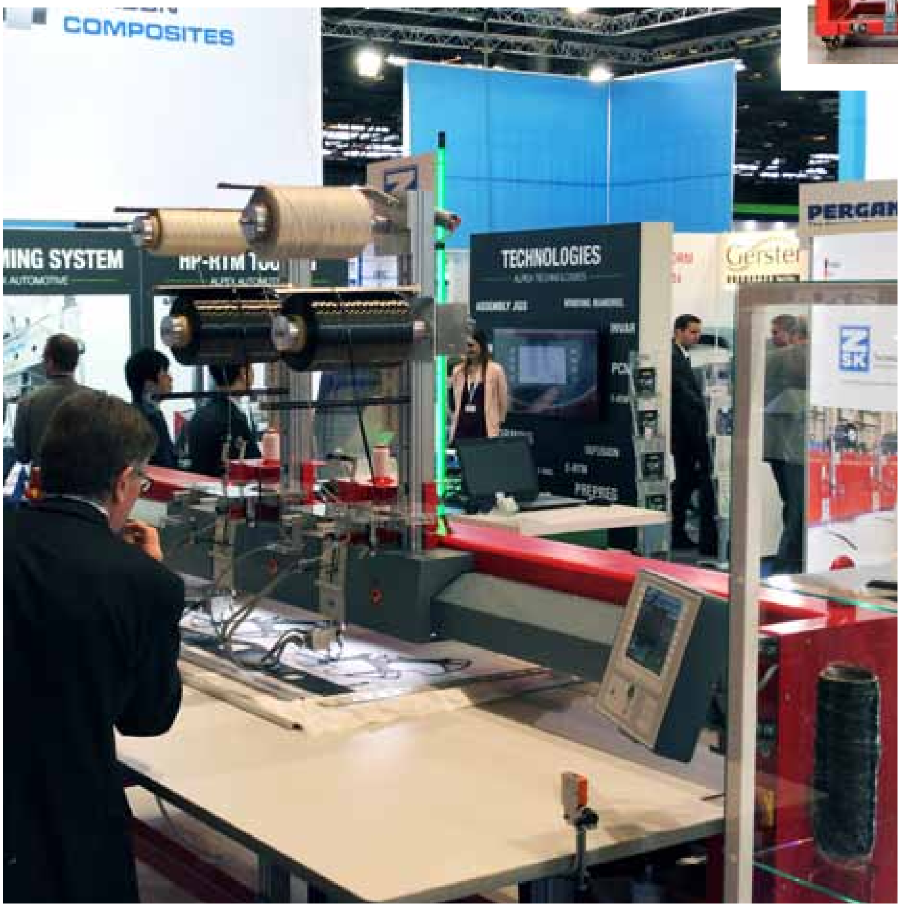
JGW 0200
An Introduction



JGW 0200 stands for a 3.44m wide and 1.84m deep versatile sampling and small scale production machine.

This machine for technical applications is equipped with two W laying heads with a head distance of 550mm and a laying field of 550 x 600mm per head.

The machine is further equipped with a drive system that allows one head (with the second head switched off) to lay designs up to 1.100 x 600mm.

The machine can be equipped with all typical options that ZSK offers for technical embroidery machines.

The specialty of the machine is the capability to lay relatively large components considering the compact size of the machine.

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6 Methods of Optimizing Carbon Fibre Composites with Tailored Fibre Placement

While the price of carbon fibre has been rapidly decreasing in recent years, it still remains an expensive and highly sought-after material.

Dr. Christopher Anderson
Editor

Carbon fibre composite material properties such as a high strength to weight ratio, are increasingly being sought to be applied to the next generation of fuel efficient transportation. Decreasing the weight of a vehicle, plane, or spacecraft, can significantly impact its fuel efficiency over its expected lifetime. Increasingly, carbon fibre is being researched as a replacement to some aluminum structures specifically due to the weight savings it holds. However, the high upfront materials cost of carbon fibre composites can dissuade potential users from adaptation.

Additionally, the manufacturing of traditional carbon fibre composites has required more processing involvement than aluminum. In one traditional process, woven carbon fibre fabrics have been traced in CAD, cut to scale, wetted with matrix material, and allowed to cure to shape in processes such as Resin Transfer Molding (RTM). However, these processes are often more labor expensive, and lack the automation seen in competing processes such as metal milling or sheet metal bending.

The technique of tailored fibre placement can be applied to the creation of new carbon fibre composite parts in a material and process efficient manner to significantly reduce cost. Tailored fibre placement allows for the reduction of waste carbon fibre material reducing material costs. It also allows for the combination of other fibrous materials in select locations, allows for the fibres to be tailored to the specific loading applied, allows for variable thickness through the parts, and can easily be used with new classes of fibrous technical materials. Additionally, tailored fibre placement machines require little to no retooling to produce vastly different parts from batch to batch allowing a more versatile manufacturing process. The optimizations provided by tailored fibre placement can help carbon fibre composites increasingly become more cost competitive.

Optimization one: reduce waste material

One of the leading material costs of many traditional carbon fibre composite construction techniques, includes the large amount of waste material generated. In many hand lay-up processes that use carbon fibre woven material, waste materials can easily account for 50% or more of the total weight of carbon used. This waste is generated as the fabric is initially cut before impregnation with the matrix material. Additional waste is generated after the composite has cured during the post processing steps where the shape is further refined.

Tailored fibre placement is unique in its ability to reduce waste material and thereby optimize material cost. By controlling the path of the tow material as it is stitched into the desired geometry, material is only placed where it is needed in the final preform. Areas of fabric that would have to be cut out in traditional laminate design are simply left unstitched. This process reduces both the initial waste produced when cutting woven fabrics to shape, and also reduces post processing waste due to the ability to conform to complex geometries.

Optimization two: hybrid carbon fibre and glass fibre composites

An additional drawback of traditional laminate processes is the inability to rapidly change materials volumetrically to benefit from their combined advantages. Tailored fibre placement is a method for quickly and effectively creating these multi-material composites.

For example, when a structural analysis is performed on a part, it might be discovered that the part only requires areas of localized stiffness. In this case, carbon fibre, with its properties of high stiffness, can be placed exactly at the areas and geometries of the part requiring high stiffness. It would be cost-inefficient to fill the entire part with highly stiff carbon fibre, especially when that stiffness is not required in certain locations. Therefore, to further reduce cost, the areas around the carbon fibre stiffened geometry that do not require high stiffness can be filled in with lower cost materials such as glass fibre or even hemp fibres. Tailored fibre placement allows these material transitions to seamlessly occur.

Optimization three: tunable fibre alignment and geometric tailor-ability

Once of the largest benefits of using tailored fibre placement to optimize a design, is the ability to precisely control where each tow of carbon fibre is placed in a design. This allows the composites designer to further optimize the materials properties, reducing the need for additional material.

For example, complex tow paths of carbon fibre can be embroidered to perfectly resist the applied loads. By aligning fibres to their principal stresses, additional mechanical support is provided without using additional material. Further optimizations can occur by selectively reinforcing holes and circular drill points. In traditional laminate design, these holes can serve as areas of crack propagation due to the orthogonal nature of the woven fabric used. Tailored fibre placement can be used to selectively reinforce around these holes with curvilinear patterns reducing the effective initial crack propagation locations. This can allow for a thinner material at the hole's location, and even potentially the removal of metal reinforcing washers.

> Carbon fibre is being researched as a replacement to some aluminum structures specifically due to the weight savings. "

Optimization four: tunable localized thickness

Another interesting optimization that can occur when using tailored fibre placement in carbon fibre composites utilizes tunable thickness of the process over a given area. In traditional laminate design, carbon fibre composites are presumed to have even thickness. However, tailored fibre placement does not have such a height restriction. In combination with well designed molding and fixtures, carbon fibre preforms can create localized thickness in highly complicated and varied geometries.

In classical beam theory, the moment of inertia for a rectangular beam can be calculated by:

$$I = \int y^2 dA = b \int_{\frac{-h}{2}}^{\frac{+h}{2}} y^2 dy = \frac{bh^3}{12}$$

Where the height of the material (h) is shown to have cubic influence on the moment of inertia when compared to the base (b) length. This means that localized areas of height can be created with tailored fibre placement that significantly can help to better resist bending at that location. This optimization allows for decreased material usage to achieve the same, if not improved, bulk material properties when compared to other composite processes.

ZSK offers machines that can lay fibres up to 8 mm thick. This averages out to about 8 layers of 50 K carbon fibre roving. This thickness can be uniform over the entire surface of the preform part, or can be selectively placed in key structural areas for additional material conscience mechanical support.

Optimization five: comingled fibrous materials

One of the drawbacks of traditional composite laminate manufacturing can be the long cycle times required to properly cure a thermoset resin. New materials, called comingled fibres, have been created to decease the processing time. In comingled fibres, a carbon fibre tow has additional thermoplastic matrix materials added directly into its fibre structure.

These comingled materials can be stitched in the same manner as other tailored fibre placement composite materials. However, these preforms can quickly be thermocycled in heated presses to rapidly reduce the cycle processing time. Traditional thermoset composite materials using resin transfer molding can require between 30 minutes to 40 hours to properly set and cure a single piece.

Tailored fibre placement of comingled materials allows for the placement of both the reinforcing fibre, and the matrix material in the same preform. As the preform is heated, the liquid matrix is distributed directly into the carbon fibre allowing proper wetting. The tailored fibre placement of comingled fibres eliminates the need for additional resins and can significantly reduce materials cost. Additionally, the desired fibre to volume fraction is created during the comingling step, increasing the uniformity of the composite material from batch to batch.

Finally, these comingled fibre composites are a step towards a more sustainable carbon fibre composite due to their ability to be re-melted into new forms at the end of their lifecycle.

Figure 1:Thickness is built around the perimeter and in the center of the part above. This additional thickness allows the part to better resist an applied bending moment while reducing material cost by not reinforcing areas that do not require additional support. Additionally, curvilinear placement of carbon around the holes helps to minimize crack propagation often seen in orthogonal woven sheet laminate design while also reducing potential post processing and waste material.

Optimization six: machine versatility without retooling

Another significant process optimization that occurs with tailored fibre placement when compared with other composite processes, is the ability for the production machine to rapidly change its production from one design to a completely different design without any additional retooling of the machine. This can allow the same machine to seamlessly transfer from producing car parts in the morning shift to sporting equipment in the afternoon shift.

Additionally, tailored fibre placement can allow the same machine to produce one prototype design at a time to investigate a process and troubleshoot it without wasting excess material, to creating a full production run simultaneously. This rapid prototyping to production capability, in combination with the ability for a machine to run many different types and geometries of parts in rapid succession, allows for more versatile projects to be run on the same machine. This reduces the cost of setting up a new machine each time a new design is generated.

In conclusion, the six methods of optimization for carbon fibre composites briefly presented show some of the advantages of tailored fibre placement over traditional composite processes. It is hoped that the combination of these optimization methods, in conjunction with a trend of decreasing carbon fibre material costs, will allow a new class of ubiquitous and highly engineered materials to further improve consumer use cases like fuel efficiency.

ZSK offers machines for tailored fibre placement (or TFP) for a variety of part sizes and base case scenarios. Prototyping machines are available with 1 head to quickly produce new prototypes with minimal setup time or material commitment, while production machines are available with up to 11 heads that can simultaneously lay fibres for mass production. The usable machine field area for an 8 head machine is 900 mm x 1,900 mm per head. This means, as long as the part fits within the 900 mm x 1,900 mm area, it can be created and duplicated 8 times simultaneously per run. For larger parts that do not fit within this area requirement, an 8 head machine can be reconfigured to a 4 head extended machine within a few minutes on-the-fly. This allows a maximum part size of 1,800 mm by 1,900 mm. Other customizable solutions exist including roll to roll, and specialty placement machines for even larger parts.

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The HV-TFP Technology

Exclusive on ZSK TECHNICAL EMBROIDERY SYSTEMS

TFP for industrial mass production

Tailored Fiber Placement or **TFP** is still at the beginning of its possibilities. Especially if you see the great potential for use in mass production markets like automotive, sports and consumer goods. For efficient use on an industrial scale, this promising technology must be further developed.

In order to unlock the enormous growth potential, **NOBRAK** has filed a first patent. With the claimed development, it is possible to improve the productivity of **ZSK TECHNICAL EMBROIDERY Systems** for TFP with what **NOBRAK** call **HV-TFP** or **High-Volume Tailored Fiber Placement**.

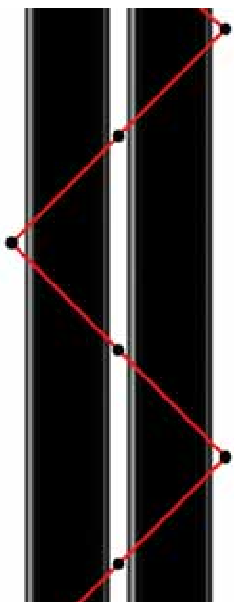
The HV-TFP Technology

First filed HV-TFP technology allows multiplying the productivity of ZSK TECHNICAL EMBROIDERY Systems for TFP by a factor of two or more at a slightly higher invest. ZSK TECHNICAL EMBROIDERY Systems and NOBRAK are pleased to officially present HV-TFP during JEC World Paris 2019 with a new laying technology allowing to feed two or more rovings in parallel.

The principle of HV-TFP technology is rather simple, and illustrated by the picture below where two rovings are laid down simultaneously, each being stitched with a linear density two times faster than in the actual process, thus leading to a two-fold productivity increase.

This new functionality could be combined with other options like "Fast Laying" in order to multiply the productivity of the machines of **ZSK TECHNICAL EMBROIDERY SYSTEMS**, thus increasing the benefit and potential of TFP. **The HV-TFP technology is exclusively available on ZSK technical embroidery machines.**

Standard Technology for laying one roving



New HV-TFP Method for laying multiple rovings

About NOBRAK

NOBRAK is a tech-based company located close to Toulouse. The company develops innovative technologies for technical textiles and composite materials. **NOBRAK** is using these technologies to design, produce and distribute personalized objects. **NOBRAK** also proposes its technologies to third party companies to produce textiles and/or composite parts.

NOBRAK is doing its best to limit the environmental footprint of its products/activities by using natural fibers and bio-based/renewable/recycled materials when possible but also by using energy-efficient technologies.

NOBRAK was founded end of 2016 by two co-founders Aymeric Azran and Bertrand Laine, both engineers and Doctors in mechanics and material science with a strong background in composite, technical textiles, aeronautic and innovation.

In its framework, **NOBRAK** has chosen TFP technology together with **ZSK TECHNICAL EMBROIDERY SYSTEMS** because of the growth potential of this technology combined with the know-how and vision of **ZSK TECHNICAL EMBROIDERY SYSTEMS, Germany**.

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World's first 'Embroidered' Composite Bicycle Saddle

using ShapeTex™ Manufacturing Technology

The pedal bike has now become the eco-friendly mode of transport of choice, and over the past 10 years the sector has seen an unprecedented growth alongside technological development of various aspects of push-bike design from cutting edge aero frames to lightweight components such as handlebars, wheels and saddles to name a few.

In October 2017, design and research work in the area of bicycle saddles was started by two mechanical engineering students in the School of Engineering and Computing at Oxford Brookes University. Industrial collaboration with Shape Machining Ltd. based in Witney has led to the development of a lightweight bicycle saddle over seven months that makes use of the ShapeTex™ composite manufacturing method whereby carbon and nylon commingled yarns are embroidered onto a nylon film to produce a net-shaped preform which can then be press moulded in under 5 minutes.

The initial phase of the development included some research on aspects of saddle shape that provides comfort, for example inclusion of a central cut-out that helps reduce perineal compression. Studies involving the effects on stability of different shell geometries were also considered. Four different preform designs were modelled in ANSYS FEA software using composite modelling tools. This stage helped gain an insight into an optimal shape and fibre orientations in order to maximise shell strength and inform laminate design. As part of the modelling process some of the mechanical properties were determined experimentally by means of simple pull-tests of unidirectional carbon fibre test specimens that were manufactured using the ShapeTex™ process.

In parallel, an extensive two-part press-tool mould design process was carried out by the students with limited guidance from SHAPE's experienced engineering team. This process did pose some challenges due to some complex geometrical features of the saddle shape such as curved surfaces, central-cut out etc. The metallic moulds were CNC machined out of an aluminium billet alloy by another project partner, Borga Cycles based near Milan in Italy. The high curing temperatures for the preforms were taken into account of as part of the design process. To further the visual aesthetic and provide a consistent surface contact in the mould, a non-woven fabric blend of recycled short carbon and nylon fibres was stitched onto the 2D preform. The finalised preform was placed inside the mould and subjected to high pressures and temperatures.

The use of MarkForge 2 composite 3D printer was used to produce composite filament saddle rails. In this instance this proved more cost effective and less complex as opposed to producing moulds. A combination of an appropriate continuous carbon fibre percentage infill, and optimal fibre orientation within the rails provided the required stiffness and strength. The printed rails were bonded to the shell

using acrylic adhesive 3M DP8405. Prior to this a number of lap shear tests were carried out using the aforementioned acrylic adhesive in order to assess its strength.

Finally, the bonded prototype saddle was attached to a bicycle seat post for some preliminary testing. Four different cyclists rode the bike and the saddle structure remained integral. Although the testing was very limited in scope it did demonstrate the potential of using such manufacturing technology for load bearing applications.

In summary, the bicycle saddle project has proved to be an excellent example that demonstrates the potential of academic and industrial collaboration to further explore the ShapeTex manufacturing technology and produce tailored composite preforms for specific applications.

About SHAPE

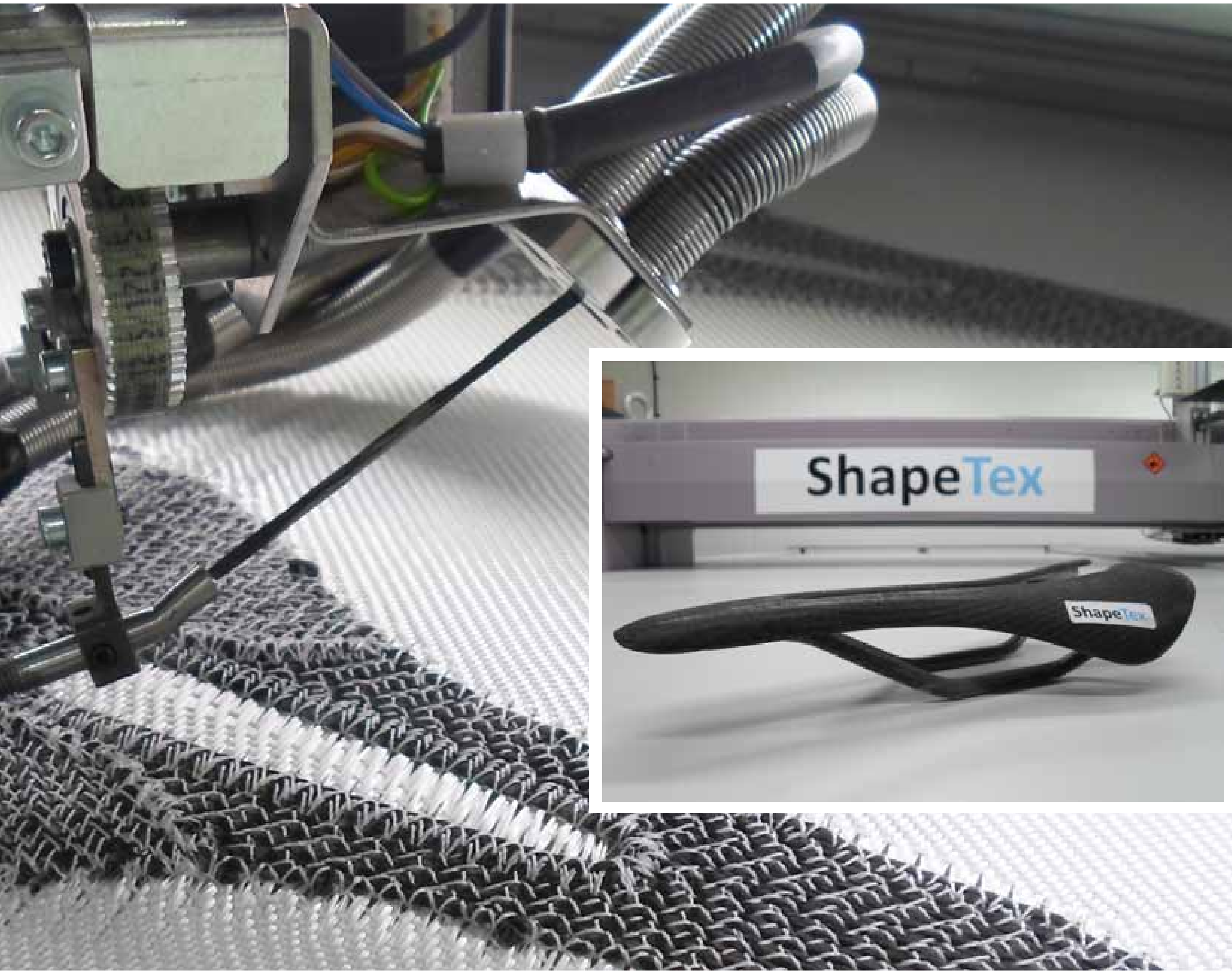
SHAPE Machining specialises in machining metallic tools, epoxy tooling block patterns, Rohacell foams and the trimming of carbon fibre parts for the automotive, motorsport, and aerospace industry.

SHAPE Engineering offers a full range of design, analysis, and project management services to support composite part and tool manufacturing projects.

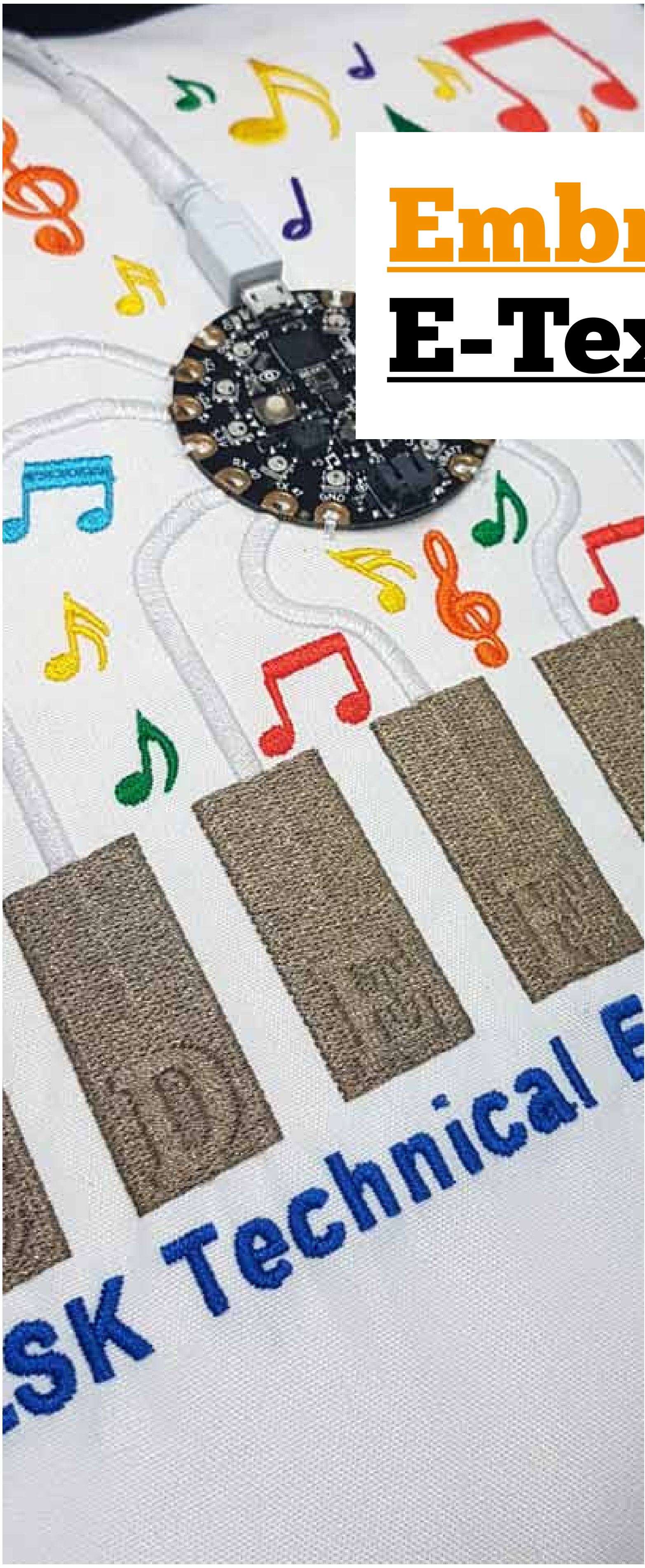
SHAPE Composites supplies thermoset and thermoplastic composite preforms and parts ranging from bespoke autoclave cured carbon parts to larger volumes of hot pressed formed carbon parts.

ShapeTex – Optimised carbon fibre preform design & manufacture.

Contact info@shape-group.com for more information.
www.shape-group.com



Fotos: SHAPE, UK



Embroidered E-Textiles

A playground for everyone

Nowadays, the integration of electronics into textiles is a playground for textile, electronic and mechanical engineers as well as for people in the textile & fashion industry. However, the most prominent question asked by these developers regards how to integrate the electronics into the textile in a production efficient way. Embroidery is the answer!

Through a single embroidery process, the electronic boards can be placed on the fabric and connected with conductive threads. The connection is reliable and fully automatic. Existing electronic boards like the Adafruit Playground boards (see Piano) or the especially for embroidery developed ZSK-E-Tex-Boards (see Dashboard) can be integrated into the textile to functionalize the fabric.

The piano example shows a prototype for the integration of an Adafruit board into a textile embroidery design. The piano keys are embroidered with conductive thread (Madeira HC 40) and each piano key is connected by embroidery with the Adafruit Playground board. Once you touch the piano keys, the Adafruit board plays the corresponding tone of the music scale. This way you can use it like a small textile piano. All connections are automatically embroidered by a ZSK embroidery machine.

The conductive paths between the piano keys and the board connections are covered with a non-conductive embroidery thread to protect the conductive material against mechanical stress and to integrate even the connections into the design by using a color similar to the fabric color.

Even the USB cable, necessary for power supply, is integrated in the design by embroidery. A covering satin stitch over the USB cable integrates the cable into the design and protects the cable against unplugging. If you want to play with your own embroidered textile pianos, you can buy a piano for 175 € which includes cord, board, sensors and connections.

The Adafruit boards are electronic boards created for hobbiest and developers. Their design is especially practical for manual connections through hand sewing. Therefore, the Adafruit boards are very rigid, thick, and not optimized for an embroidered electrical connections. Furthermore, many applications require an electronic board that can control more capacitive touch sensors or motion sliders than the Adafruit boards. Furthermore, the sensors must be electrically designed in a way that they work even through foam and leather to control integrated LEDs.

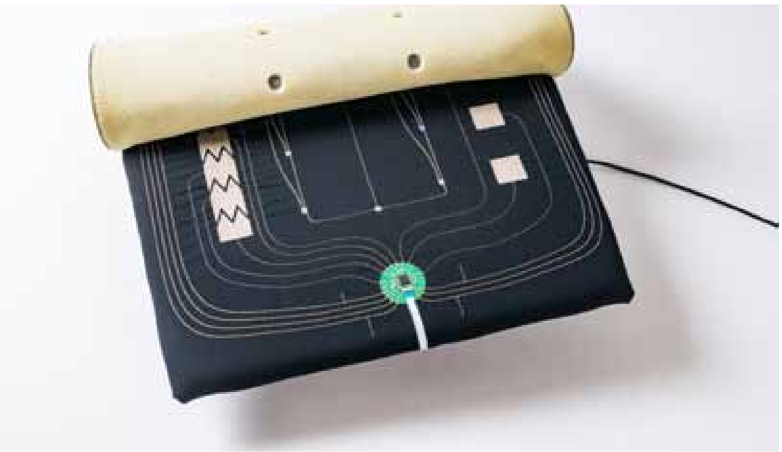
Because of the mentioned limitations of the existing boards, ZSK developed its own ZSK-E-Tex-Board. This board is especially designed to be used for embroidery. With its small size of Ø 40 mm and 2 mm thickness, the integration into a fabric is easier than ever. The power supply (Mini USB) and programmer port is on a separate board which can also be attached to the fabric by embroidery. The flex data cable between these two parts can easily be covered over and hidden with standard embroidery as well. The E-Tex Board can control up to 19 LEDs depending on how many of the 14 sensors for control you have in use.

If you are interested in creating your own prototypes by using the ZSK-E-Tex-Board, you can buy this boards for 150 € at ZSK.

A sample prototype obtained with the ZSK-E-Tex-Board is used in a demonstration piece for a car dashboard with integrated LEDs.

Functions: By sliding a finger over button 1 (Navi), 2 (Tel) or 3 (MP3), the LED 1, 2 or 3 will light up.

By using the slider on the left side by sliding over it the LED 4, 5 and 6 will light up. These sensors inputs can be easily modified by the purchaser to match their own custom project requirements.



The electronic elements are on a separate layer under a leather and a foam layer.

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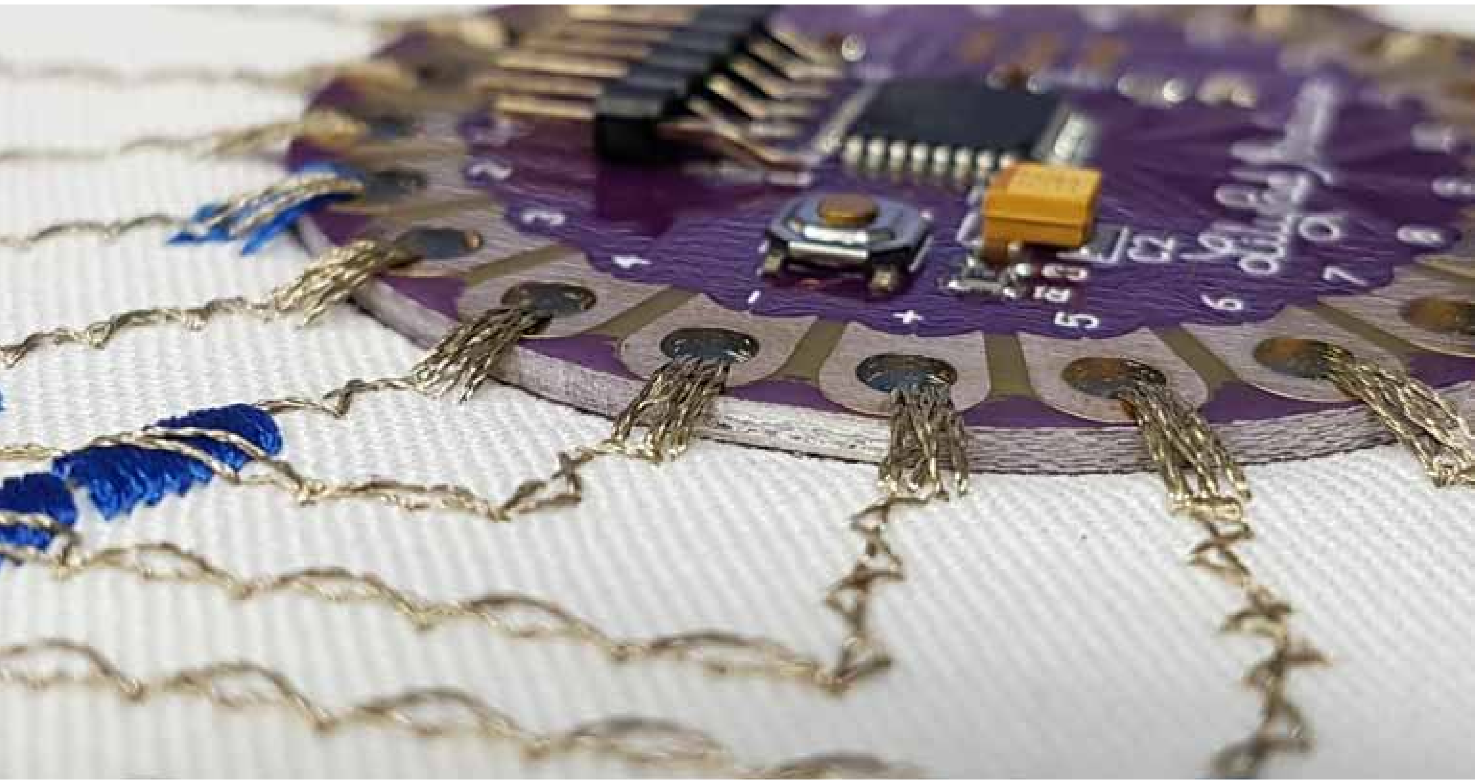

Technical Embroidery for E-Textiles

The missing stitch

Recently, a class of technical textiles called e-textiles has begun to emerge as a way of further functionalizing traditional fabrics. E-textiles, or the ability to embed electronics and their electrical properties into fabrics, allow for a new class of self-aware materials. These materials can have internal sensing capabilities as well as the ability to adapt themselves to various changing environments opening doors to data collection that was not previously economic or even possible.

Technical embroidery offers a host of methods to create new e-textiles and push the entire field forward. Due to embroidery's high maneuverability, quick adaptability to new designs, and established scalability, embroidered systems are increasingly being sought after to create prototypes and solutions for this ever-growing e-textiles market.

Technical embroidery can allow traditional circuit boards to be mechanically mounted to fabrics, while automatically creating conductive textile connections them. Aspects of traditional circuit board design such as creating conductive traces can also be incorporated using technical embroidery. Sensors can be integrated exactly where they are needed in an automated process. Furthermore, due to the ever-decreasing size of electrical components, a renewed interest in mounting components to embroidered sequins has opened up design possibilities.

Embroidering full boards mechanically

One of the most direct uses of technical embroidery is to quickly attach and stitch traditional printed circuit boards into fabric carriers. Stitching boards directly into the structure of the textile reduces mechanical strains on the connectors while allowing the control and processing electronics to be physically closer to their supporting electronics. This can have a range of benefits such as increased signal to noise ratio, decreased mechanical fatigue based failure, and reduced need for additional connectors.

If looked at from an electronics manufacturing standpoint, fabrics offer a new host of materials that not only carry the electronics, but also provide functional advantages over traditional materials and processes.

Embroidering connections to boards

Another advantage of technical embroidery in e-textiles manufacturing is the ability to embroider electrical connects automatically to the host board using various conductive threads. This process allows for the quick connection of potentially hundreds of electrical connections from a board to their fabric-hosted sensors. By registering the board during its embroidery to the host fabric, electrical connection points on the board are also registered for stitching. This can allow for a single stitched board to merge data from many sensor types into a single output.

Embroidering traces

By using techniques such as tailored wire placement, highly conductive materials can be placed into the structure of the fabric in order to create low resistance traces that better mimic traditional circuit board function. Size AWG 10 to AWG 40 wire has been successfully laid in this process.

Additionally, wire coatings such as enamel or PVC are unaffected by the embroidery process, opening a wide variety of insulative and coating materials. Furthermore, customized wires such as multicore and multifilament wires can be used to run multiple signals through a single conductive pass. Up to 32 signals in a single multicore line can be run, with the capability of going much higher.

Embroidered sensors

Traditional sensors such as temperature sensors can be embroidered into a textile by embroidering their host circuit board into the textile, or by including the sensor into a fibre carrier. Embroidering additional sensor boards into the fabric is a straight forward method of quickly integrating capability and function. Embroidering sensors within a fibre carrier can allow for a more elegant and compliant solution

However, more form fitting and haptic-sensitive textile based sensors are increasingly being investigated for their inclusion into a functional fabric. By using the properties of the conductive fibres themselves such as large surface areas, variable resistivity, and geometric conformability, solutions such as textile electrodes, stretch sensors, and sweat sensors can be reliably created.

Embroidered LED sequins

Another method of functionalizing fabrics is the inclusion of embroidered LED sequins. By mounting the required electronics onto a traditional sequin carrier, LED's can robotically be sewn into a garment in automatically during its creation. This has significant advantages over other e-textile processes as it does not require post-process soldering or additional conductive epoxies. In this way, the embroidery machine serves as a hybrid between traditional pick and place machines to select a component sequin off of a reel and a sequin machine as it stitches the component into the fabric's structure.

Embroidered antennas

Technical embroidery can additionally be applied to radio frequency engineering through the use of new and geometrically tunable antennas. As the shape of textiles in garments can vary dramatically from when the textile is being stored to when it is being worn, limitless possibilities generated by embroidering antennas of various tunable shapes exist. These designed textile antennas can have uniquely directional properties that traditional hard antennas do not have. As our world becomes increasingly wireless, textile antennas are an open and exciting area of research.

Scalability

Finally, one of the more important thoughts to have when evaluating any e-textile prototype is its ability to quickly and cost effectively scale. As embroidery is a well-established textile process with many configurations for production machines, the risk to scaling is much lower than when compared to other less known e-textile processes. In fact, many traditional embroidery companies can even utilize their existing equipment setup to turn their machines from traditional embroidery to technical e-textiles embroidery.

Technical embroidery offers multiple solutions that can help to advance the field of e-textiles. In combination with electronics manufacturers, new boards can be designed that best take advantage of the embroidery process. Additionally, the inclusion of new functionalized conductive threads and materials can rapidly speed development time and electrical source-ability.

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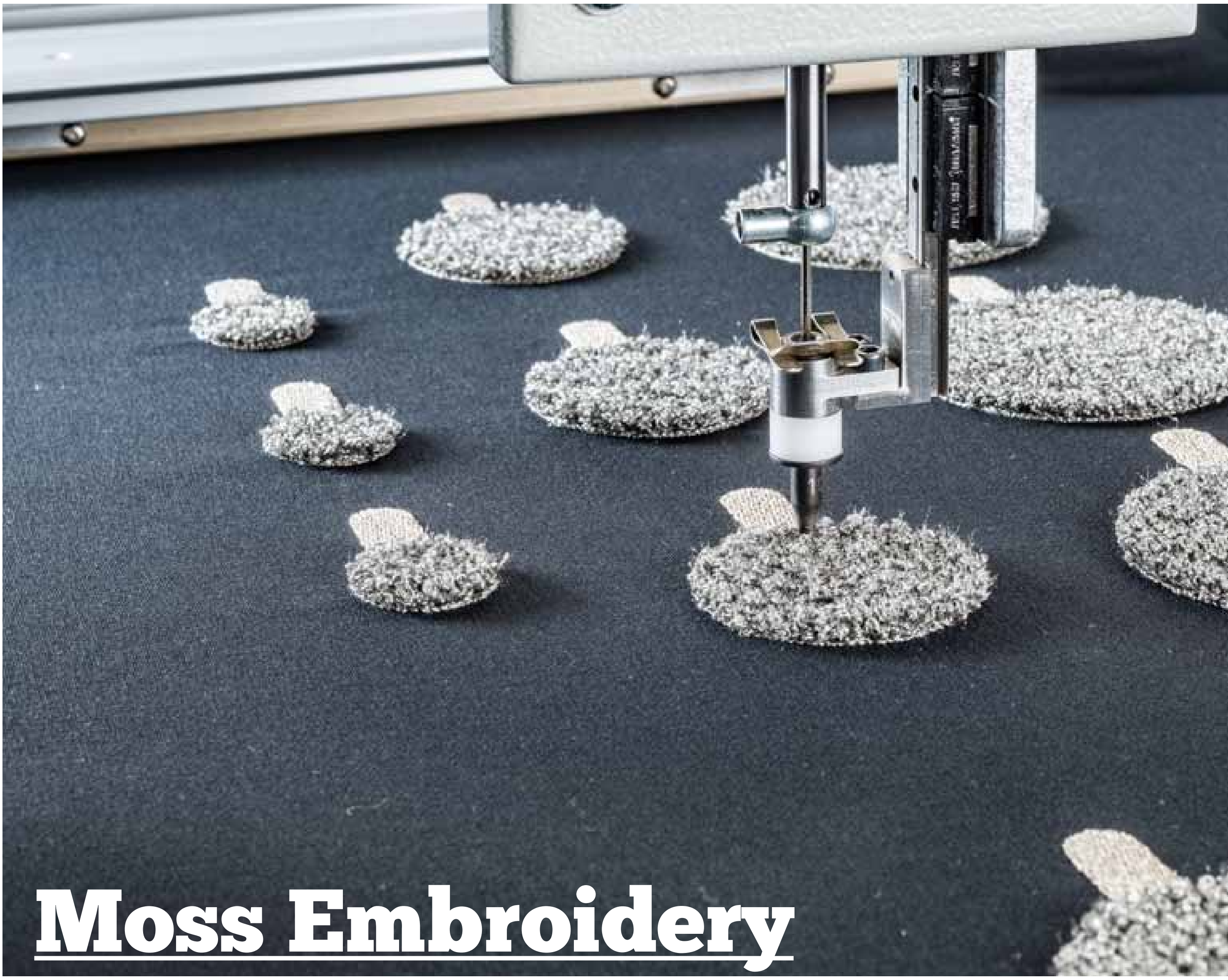


Moss Embroidery

Methods and applications for biomedical signal collection

Moss embroidery has increasingly been used as a method of collecting biomedical signals from patients. Its versatility and use for eclectic signal types and biometrics has further inspired interest in the technology. Additionally, due to its low cost, high customization, and automatic embroidered production, moss electrodes are increasingly relevant in biometric signal collection.

Traditional electrodes utilize a conductive pad, usually copper, as the electrical receptor with a thin layer of saline gel between the pad and the skin in order to boost interfacial conductivity. Often, the perimeter of traditional electrodes includes an adhesive to help hold the electrode against the skin. While functional, this traditional method of electrode placement has significant drawbacks.

The first drawback observed in longer electrode tests, reveals that the saline gel can begin to dry thereby decreasing the conductivity over the course of the test. As the material dries, it can also cause skin irritation under the electrode. This is particularly undesirable in tests where the patient takes the equipment home for an extended period of time. Another drawback of traditional electrodes is the geometry of the wide copper pads, which can decrease the available electrode density. This is particularly important with infants and high-density multi-signal technologies like electroencephalograms. Finally, the adhesives used to secure the electrode to the skin can occasionally cause skin irritations for some skin types.

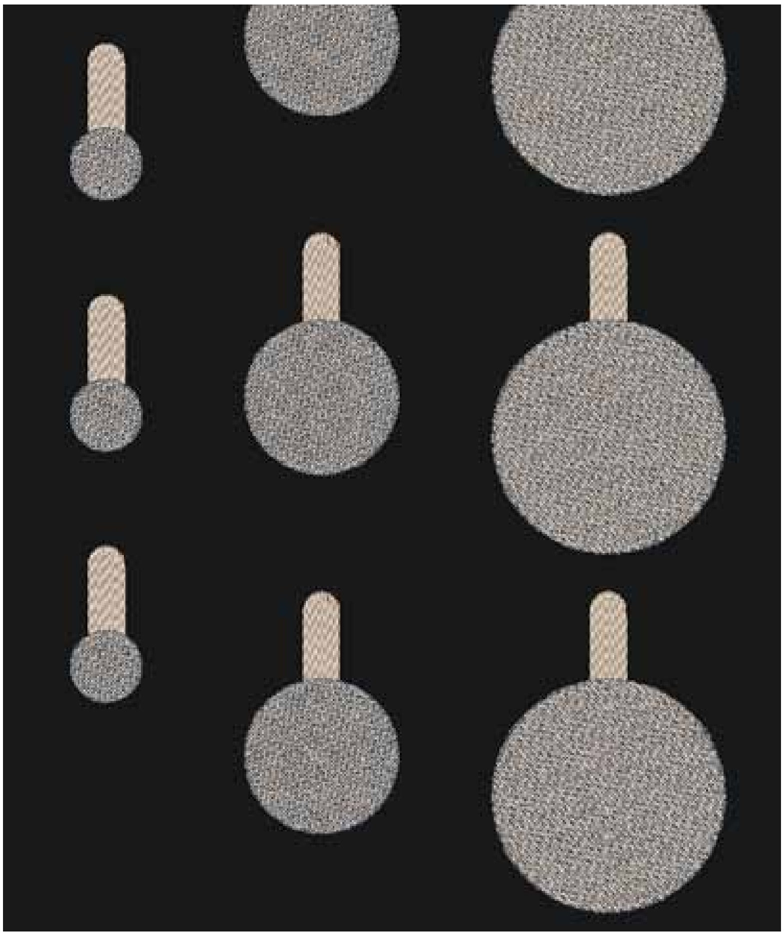
Moss embroidery techniques are derived from traditional chenille fabric techniques where tufts of thread were

used to create thicker materials such as towels and piled carpet. By creating long loops of material protruding from the base material, different textures and geometric compliance can be controlled. This creates a form-fitting electrode within an additional stabilization structure.

Moss embroidery with conductive thread is particularly useful when applied as an electrode due to its high surface area. As the conductive fibres are compressed against the tissue, they spread across the surface compliantly. Conductive thread already has an extremely high surface area, however its conductivity is increased as the individual thread tufts are compressed against the skin's surface conformingly. This creates a robust and form fitting electrode that can be incorporated into a garment or additional carrier structure.

Textile based electrodes do not require additional saline or conductive gels due to the thread's high surface area. Furthermore, adhesives are not required as the sensor can be directly embroidered into a compressive garment that comfortably holds the sensor in the correct location. This can be particularly useful with infants.

Furthermore, the application field of moss embroidered electrodes is not limited to body signal monitoring and input. They can also be used as an output device for electro-stimulation therapy of muscles and nerves for physical theory and tissue rehabilitation.



Light Grey: Conductive connection area | Dark Grey: Moss embroidered electrodes

ZSK offers a development kit of moss embroidered electrodes to allow potential customers and users to test the electrodes and their function in specific applications quickly and reliable. The following development kits are currently available:

Development Kit Textile Moss Embroidered

Electrodes - round – 33/10 with embroidered connection area

Content: 3 x Ø 20 mm • 3 x Ø 43 mm • 3 x Ø 65 mm

Material: STATEX Shieldex® 33/10

Price: 200€ + Tax & Shipping

Development Kit Textile Moss Embroidered

Electrodes - round – 78/18 with embroidered connection area

Content: 3 x Ø 20 mm • 3 x Ø 43 mm • 3 x Ø 65 mm

Material: STATEX Shieldex® 78/18

Price: 200€ + Tax & Shipping

Contact Details

ZSK TECHNICAL EMBROIDERY SYSTEMS

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LED Sequins

Shine bright like a diamond

The robotic and automated placement of shiny plastic sequins onto fabric is a well known and well documented process. Integrating sequins into fabric for increased visual and design properties has been implemented for over 50 years.

However, recently new developments in electronics have re-invigorated this old technique.

By redesigning and functionalizing the sequin from ground up, new garment capabilities are being discovered that never existed before. Instead of the sequin being just a shiny piece of plastic, new developments have utilized the area and space on a sequin to serve as a host material for new electronics. In a sense, the sequin becomes a micro-circuit board. As the size of electronics decreases, it becomes easier to put more of them onto sequin-based circuit boards. These small circuits add exciting electrical and sensor possibilities to fabrics.

Currently, LED sequins have been developed that can each hold an LED and some of the corresponding electronics. Each sequin contains a 2.7 volt 20 milliamp high Lumosity white LED with corresponding electronics, however the technology can quickly be adapted further for additional design specifications. By utilizing ZSK's existing optimized sequin placing technology, adding sequins is fast, time efficient, and automated. LED sequins are stored on rolls that are fed into the embroidery machine. When the design calls for an LED sequin to be placed, a fresh sequin is chopped off of the spool, placed onto the fabric, and embroidered down.

With the newest generation of the LED sequins the mechanical fixation process is completed with conductive thread. Importantly, this means the additional step of mechanical fixation is no longer necessary before the electrical connections are made. By combining these two steps into a single production step with a single conductive material and single machine, the quality, repeatability, and speed of production is dramatically increased. This further supports the increasing trend of automated e-textile production methods.

Left:
Embroidery with Functional Sequins.
Design by Jacky Puzzey, UK.
Developed for ZSK STICKMASCHINEN.

Even more excitingly, the electrical connections required to provide power to the LED sequin, can also be automatically embroidered with conductive thread. This step is critical when moving from a prototyped solution to a scalable product. Eliminating the need for hand soldering, or application of conductive epoxies, greatly reduces the amount of labor required and risk of human error. Automation allows for the LED sequin fabric to come off the machine functioning without additional steps.

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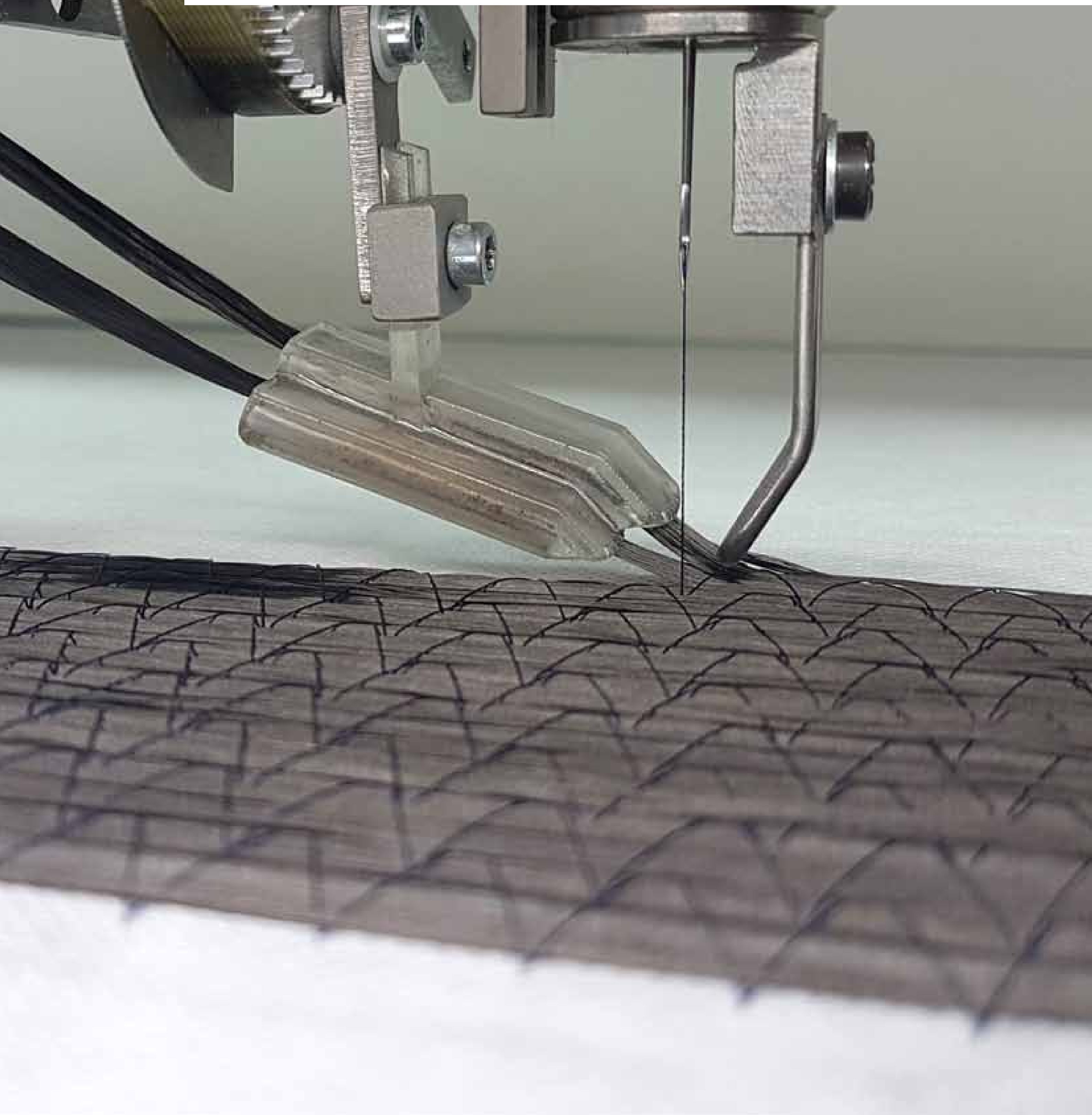
The key to success using Tailored Fiber Placement

By Matteo Moretti, Project Manager for ZSK TECHNICAL EMBROIDERY SYSTEMS



This article aims to be a guide towards highlighting the advantages in using TFP Technology, explaining when and how this technology should be considered to fully replace standard manufacturing, or how the technology could be integrated to existing processes.

In the recent years, the growth of Technical Embroidery Systems has been exponential. Technical Embroidery Machines developed by ZSK are now well established and largely used into the automotive, aerospace, sport and leisure industries. Among the wide range of technical embroidery technologies (i.e. Tailored Wire Placement, Smart Textiles, E-Textiles, Functional Sequins), Tailored Fibre Placement (TFP) is particularly experiencing the greatest interest and demand in the composite industry.

Arranging and stitching a fibre tow on a compatible backing material exactly where reinforcement is most needed for structural performance, TFP embroidery machines allow the user to create nearly net-shape preforms that serve a unique role in the manufacturing process. By implementing net-shape preforms, composites parts are increasingly becoming more cost competitive, while waste material is reduced and the structure is highly optimized.

How and when should one implement this technology for composites manufacturing parts? What materials should be used? This knowledge is the key to success and innovation for most of ZSK's technical customers.

TFP using Thermoplastic Commingled Fibre Yarns

Commingled yarns consist in a mixture of thermoplastic and reinforcement fibre. While the latest reinforcement fibres are usually carbon or fibre glass, the thermoplastic fibre could be Nylon (PA6), Polypropylene (PP), Thermoplastic Polyurethane (TPU) or Polyetheretherketone (PEEK). The type of thermoplastic to use is mainly chosen depending on the structural requirements of the final product application. For the same reason, the desired fibre to volume fraction could be varied during the commingling process, increasing the uniformity of the composite material from batch to batch.

Preforms constructed using commingled yarns, do not require any extra resin to be injected in the moulding process; the thermoplastic fibre, which normally matches the thermoplastic backing material, will melt and act as the bonding matrix in the composite structure.

Fig.1: A batch of commingled thermoplastic preforms.

Fig. 2: The moulded preforms, after
a compression moulding cycle of under 3 minutes.

This results to speed up and automate drastically the entire composite manufacturing process; appositely designed and shape-optimized TFP preforms are simply placed into the moulds and therefore consolidated into the finished parts through heating and cooling stages as part of the compression moulding cycle for thermoplastic materials.

Post-processes simplicity is strictly dictated by the part's geometry and the mould's design; more complex parts would eventually require the edges to be CNC-trimmed; flatter components instead (such as composite inner shoe sole shown in Fig.1 & 2), would be net-shaped consolidated in closed moulds, manually and quickly deburring the edges.

The sport and leisure industries are demonstrating enthusiastic interest in implementing TFP technology using thermoplastic commingled yarns, which allows companies to bring on the markets innovative, lighter and performant products at a competitive price. Finally, the resulting products tend to be more sustainable due to their ability to be re-melted into new forms at the end of their lifecycle.

TFP using 'Pure' Fibre Yarns

Preforms constructed made out using Pure Fibre yarns (i.e. carbon, glass, aramid glass fibre, aramid fibre) should be thought as reinforcements for the final composite product, to be appositely integrated within the existing manufacturing process such as Resin Transfer Moulding (RTM) or Resin Infusion Moulding (RIM).

A great example is represented by E2's Five Spokes Carbon Fibre Wheel, developed by ESE Carbon in USA. Carlos Hermida, CEO at ESE Carbon, in one of his most recent interviews stated

> The technology has allowed the company to reduce ply consumption by up to 50%, thereby creating a simplified layup process and minimizing waste.
>
> **Carlos Hermida**
> CEO ESE Carbon, USA

Fig. 3: ZSK Technical Embroidery System CZCW 0800-900D creating wheel reinforcement preforms

Fig. 4: The E2's five spokes Wheel

that „the technology has allowed the company to reduce ply consumption by up to 50%, thereby creating a simplified layup process and minimizing waste. Carbon fibre waste was reduced from around 40% with traditional carbon fibre fabrics to less than 10% by adopting TFP. In addition, the technology has led to improved layup quality, optimized fibre orientation, and increased design flexibility“. Figure 4 shows respectively 'the wheel reinforcement preform' created by using ZSK TECHNICAL EMBRODERY SYSTEMS TFP technical machine, and the final moulded E2's Five Spokes Carbon Fibre Wheel. The same use and application case of the technology is widely adopted by many of major ZSK customers in the automotive and aerospace industries.

Nevertheless, if the lower productivity rate has been the main concern when using TFP technology, ZSK Embroidery Systems has now brought its TFP technical machines to the next level through a number of patented innovations that speed up the deposition of fibre, making the technology even more suitable for larger reinforcement preforms. Less than a year ago, ZSK has launched the HV-TFP technology.

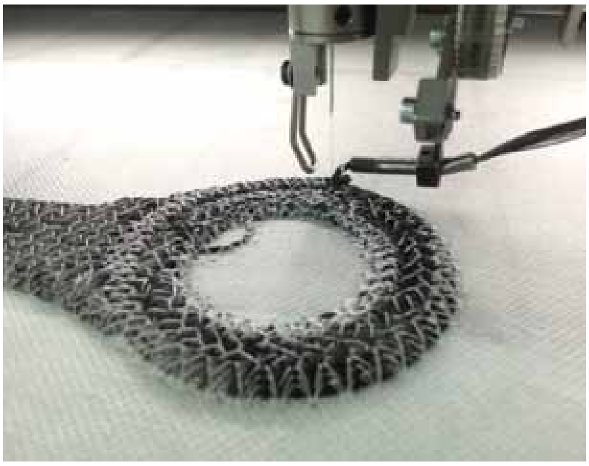


Fig. 5: Standard TFP

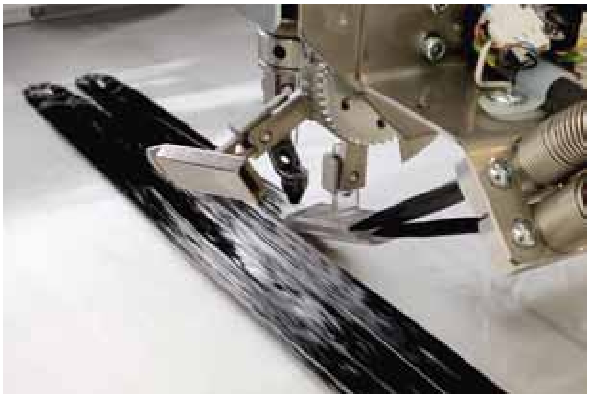


Fig. 6: Fast Fibre Laying + HV-TFP on ZSK Technical Embroidery Systems

The principle is rather simple, where two rovings are laid down simultaneously, each being stitched with a linear density more than two times faster than in the actual process. This new functionality, combined with Fast Fibre Laying, allow the manufacturer to increase the productivity of the machine, thus increasing the benefit and applicable use of TFP even for large structural parts.

To summarize, depending on product's dimensions, materials, and structural requirements, TFP provides a valuable resource to the composites design and manufacturing community. If considering thermoset based composite parts, TFP then should be seen as a 'plus' when compared to the existing manufacturing processes, and suitable for the production of small to large reinforcement parts. On the other hand, when it comes to thermoplastic-based composite parts, TFP could be considered to fully replace standard manufacturing processes for the production of small to medium size composite products. In either case, even though production is completed in different scales and in different industries, the evident benefits brought by TFP technology supported by ZSK STICKMASCHINEN's technical innovations are the reason of its considerable and constant growth in the recent years.

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ZSK TECHNICAL EMBROIDERY SYSTEMS

EXHIBITION DATES

03.03. - 05.03.2020
JEC World
Villepinte Exhibition Centre
Joint stand of the state of NRW
Hall 5 A • Booth G55
Paris • France

31.03. - 02.04.2020
Aircraft Interiors EXPO
Hamburg Messe
Hall 7 • Booth A21
Hamburg • Germany

05.05. - 06.05.2020
SAMPE 2020
Washington State Convention Center
Booth F50
Seattle • WA • USA

12.05. - 14.05.2020
Techtextil North America
Georgia World Congress Center
Atlanta • GA • USA

13.05. - 14.05.2020
IDTechEx Show! 2020
Estrel Convention Center
Booth H07
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