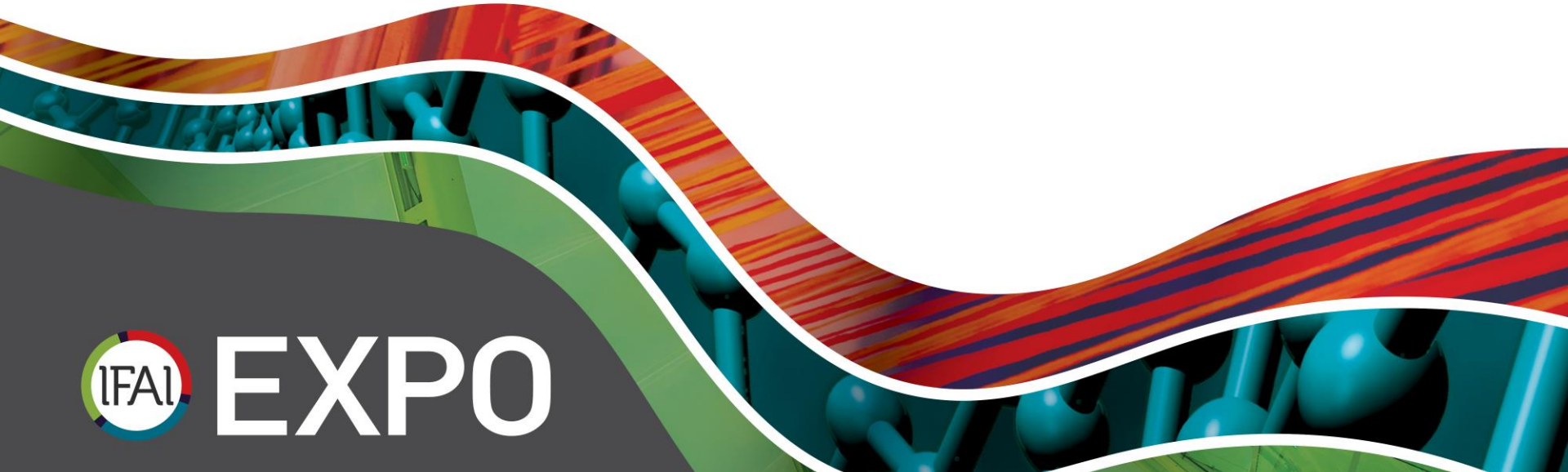
Digitalized Manufacturing:

Will The Fourth Industrial Revolution Transform Flat Knitting?

Connie Huffa



Background

First Industrial Revolution - 18th to 19th centuries in Europe and America. The shift from agrarian economy to industrial and urban. Iron and Textile industries grew. Invention of the Steam engine.

Second Industrial Revolution- 1870 and 1914 before WWI. The shift to steel. Oil, and electricity. Mass production and major technological advances: Telephone, light bulb, phonograph, and internal combustion engine.

Third Industrial Revolution - 1980's and ongoing. The shift from analog, basic Electronics, and mechanical to digital: The PC, the internet, cell phones.

Fourth Industrial Revolution - ongoing. Shift to embedding technology within society and the human body. Robotics, AI, Nanotechnology, Quantum computing, Biotechnology, IoT, 3D printing, Autonomous vehicles.

INDUSTRY 4.0

What does it mean to Knits?

Industry 4.0, IoT (The Internet of Things), the smart factory, and digitalization of manufacturing are some of the buzzwords being used to describe how technology wizards are grappling with connecting the moving dots in many industries, including knitted textiles.

Background

Background: There have been many advances benchmarking manufacturing best practices of producing products in better and more efficient ways, streamlining the design, and connecting supply chains with PLM, ERP and WMS systems. Linking:

- internal design and manufacturing departments
- vendors
- supply chains

have been powerful game-changers in organizing manufacturing processes, which are needed to feed the mass-production, every warehouse, and every shelf.

Background – 1970's and 1980's

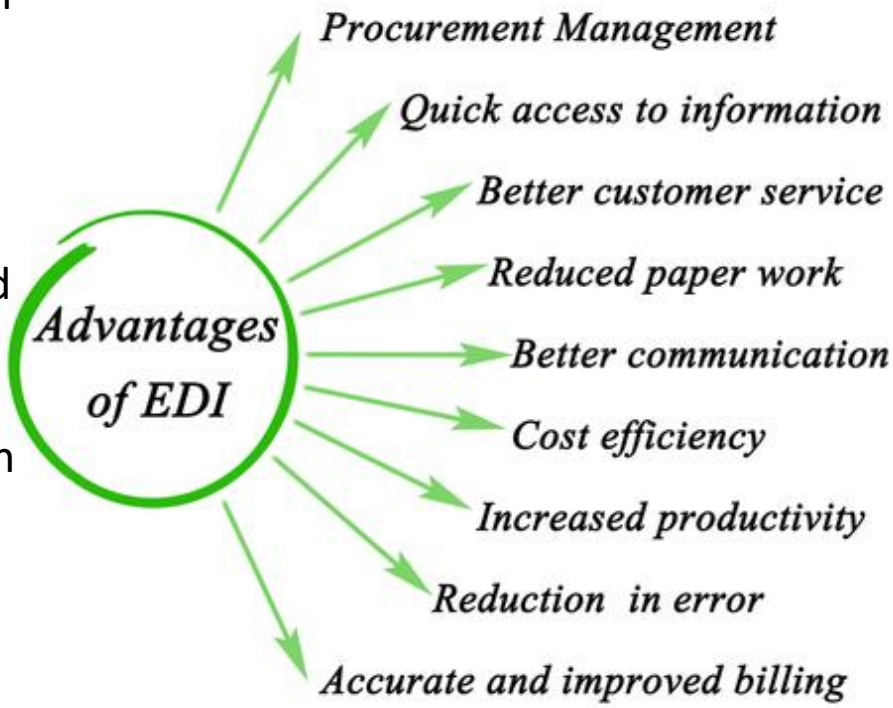
Manufacturing Strategies: Managing resources, components, and the production floor such as:

- JIT (just-in-time manufacturing – 1970s),
- Kaizen (1985),
- Six Sigma (1986), ISO 9001 (1987)
- LEAN manufacturing (2007)

All have all improved agility, profitability, and competitive edge in working with demanding retailers, getting closer to consumers, and the pulse of buying trends.

Background - 1990's

CRM: Getting closer and more focused on the end consumer and adapting to the pulse of buying trends have been key to many brands' and manufacturers' retail competitive edge. They built loyalty programs, leveraged retail data, credit card data, and built internal information channels linked from POS (point of sale) at individual store registers, which drills down to who is buying what, where and when. That information is then passed directly to warehousing and supply chain through Electronic Data Interchange, known in the industry as EDI.



Background - 2007

Disruption: Just when manufacturing seemed to be a well-oiled machine, something happened. Around 2007, smart phones digitally connected what is now over 2.1 billion mobile phone users. The internet became the main artery, connecting buyers from every corner of the world, sellers of all sizes, and commerce in small and large transactions Taking pictures, communicating, banking, shopping and doing business online would never be the same again.

Background - 2007

Disruption: In 2007, Amazon got publishers to digitize a chunk of their books, but none of the publishers realized they had no control over the price. Amazon had 650,000 users at the end of 2007. Amazon launched Kindle in 2007. Book editors' job of getting books into retail stores was eliminated. In 2014, e-books accounted for 27% of all adult books sold and Amazon controlled 2/3 of a $3 billion e-book and print markets. In 2017, Amazon's share is 45.5% and 41.7 % respectively. Platforms like Amazon, Etsy, eBay, and Shopify made it easy for small brands and individuals to go direct to consumer.

https://www.vanityfair.com/news/business/2014/12/amazon-hachette-ebook-publishing
http://authorearnings.com/report/january-2018-report-us-online-book-sales-q2-q4-2017/

Background - 2008

Connectivity: The internet became the main artery, connecting buyers from every corner of the world, sellers of all sizes, and commerce in small and large transactions. Consumers, especially young consumers, became digitally connected to real-time technology that gave them the ability to competitively shop in store or online, browsing thousands of items at hundreds of online sellers before making a purchase. The 2008 ‘bubble’, with restricted credit and tightened belts, taught consumers to spend wisely. Stores became showrooms, with customers checking features and quality but making purchases elsewhere.

Background - 2008

Disintegration: 2008 bricks-and-mortar store closures threw a huge wrench into the gears of making and selling. The 'bubble' restricted credit and taught consumers to spend wisely. Stores became showrooms, with customers checking features and quality in store, competitive shopping in store on their phones in real time, and making purchases elsewhere. Store became showrooms. The biggest shift in sales and marketing over the past five to eight years has been sales direct to consumers.

Background -2014

Background: Since then, companies of all sizes experienced a shifting from wholesale relationships with bricks and mortar to online sales. Corporate relationships have been shifting from big buyers to individual consumers, meaning their accountability and accounting has swung to numerous small and individual transactions.

Why? Because each customer has a new voice in the new evolution of marketing (social media, influencers, product placement, celebrity), which has left traditional forms of marketing on the wayside with bricks and mortar.

How have Flat Knitting Manufacturers Reacted to Change?

In our textile industry the only constant is change, in both fashion trends technologies.

Background – 1970's and 1980's

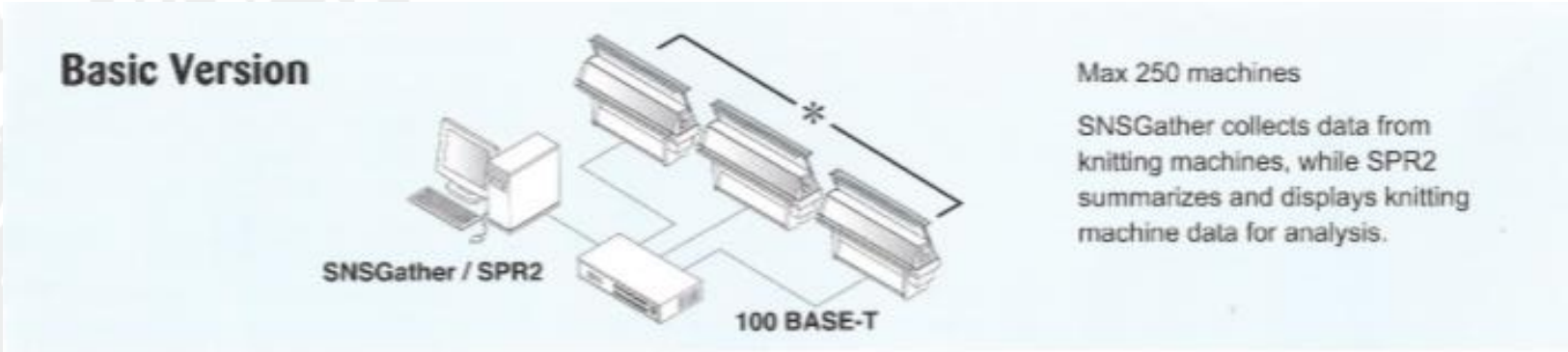
Background: If we back up a little bit, in the late 1970s, about the same time JIT manufacturing was starting out, there was another technology shift underway. Most textile machinery and testing equipment were mechanical (analogue), and the first electronics were being introduced.
In the 80s, computers started making an impact. Factories were vertical: design, management, sales, operations and logistics were under one roof; most produced for local markets; only the largest exported around the world.

Third Industrial Revolution

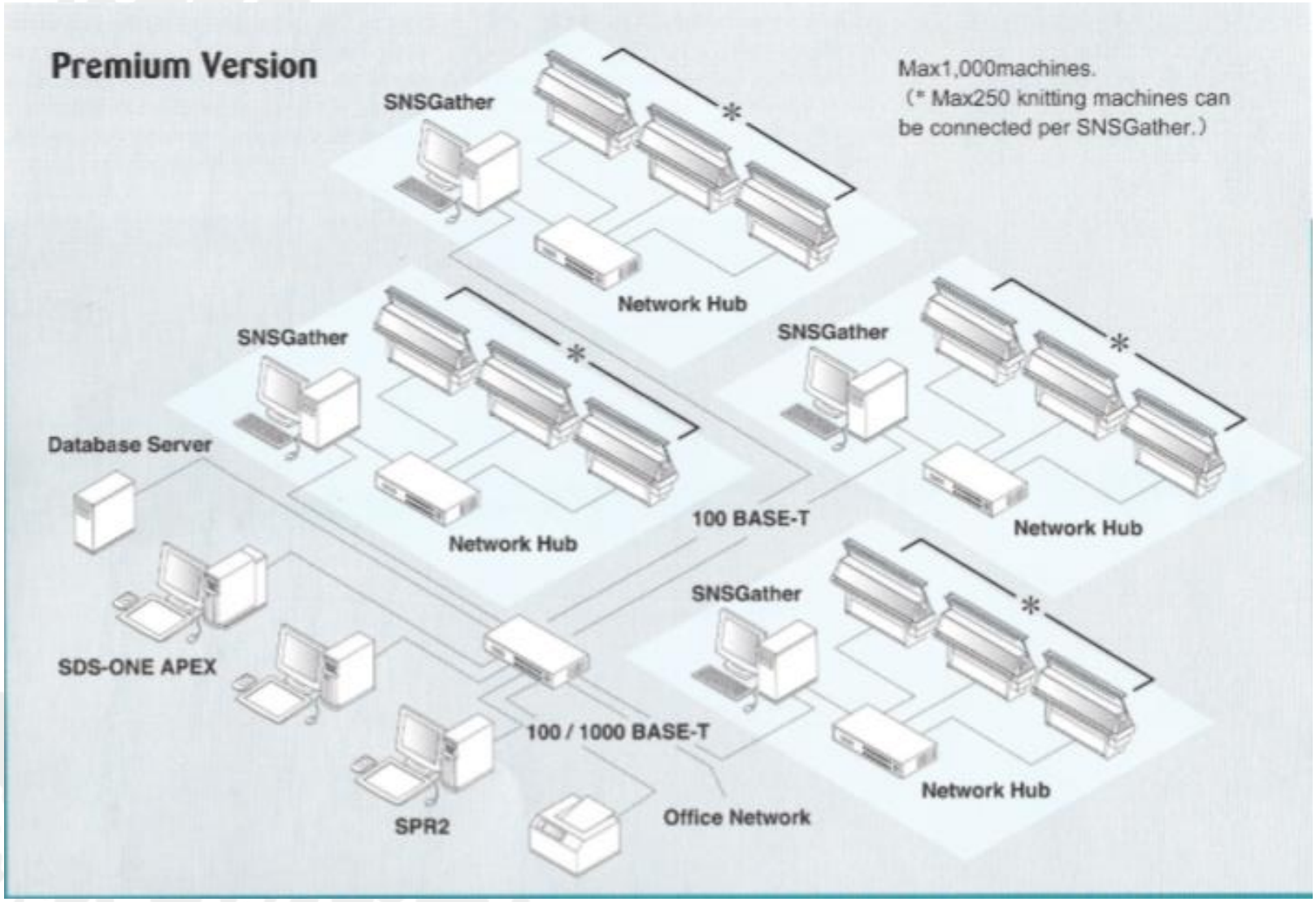
Background 1980's

Background: Computerized flat knitting machines, such as the Shima SEC, SET and Stoll ANVH machines and CAD systems – including the Stoll VDU system and the forerunner of the Shima APEX system – gave designers and engineers creative control of their products beyond binary punch-cards. Adding computers to machinery gave mills an agility the mechanical machinery did not have.

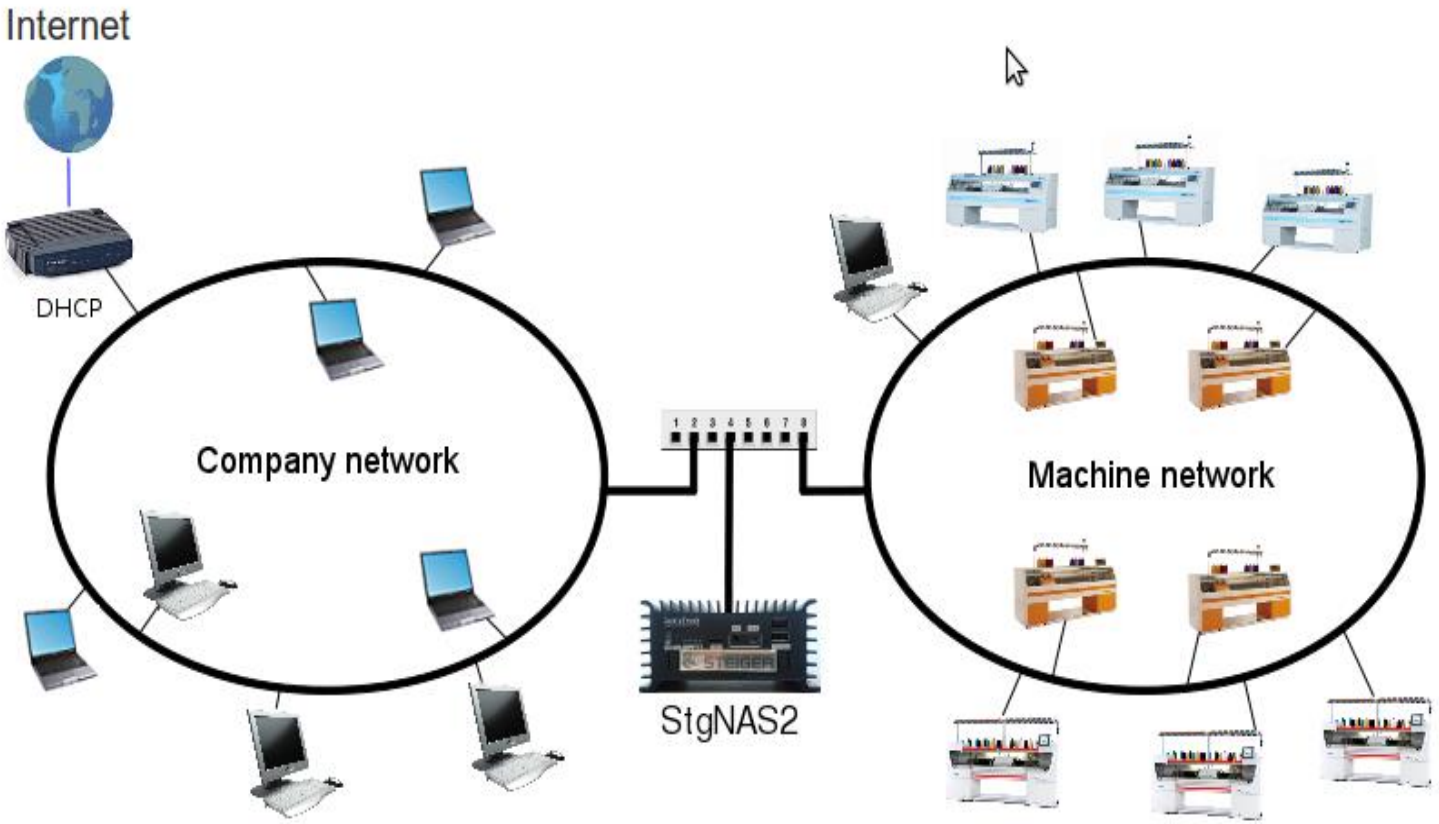
Networking: Distribution of Knitting Data



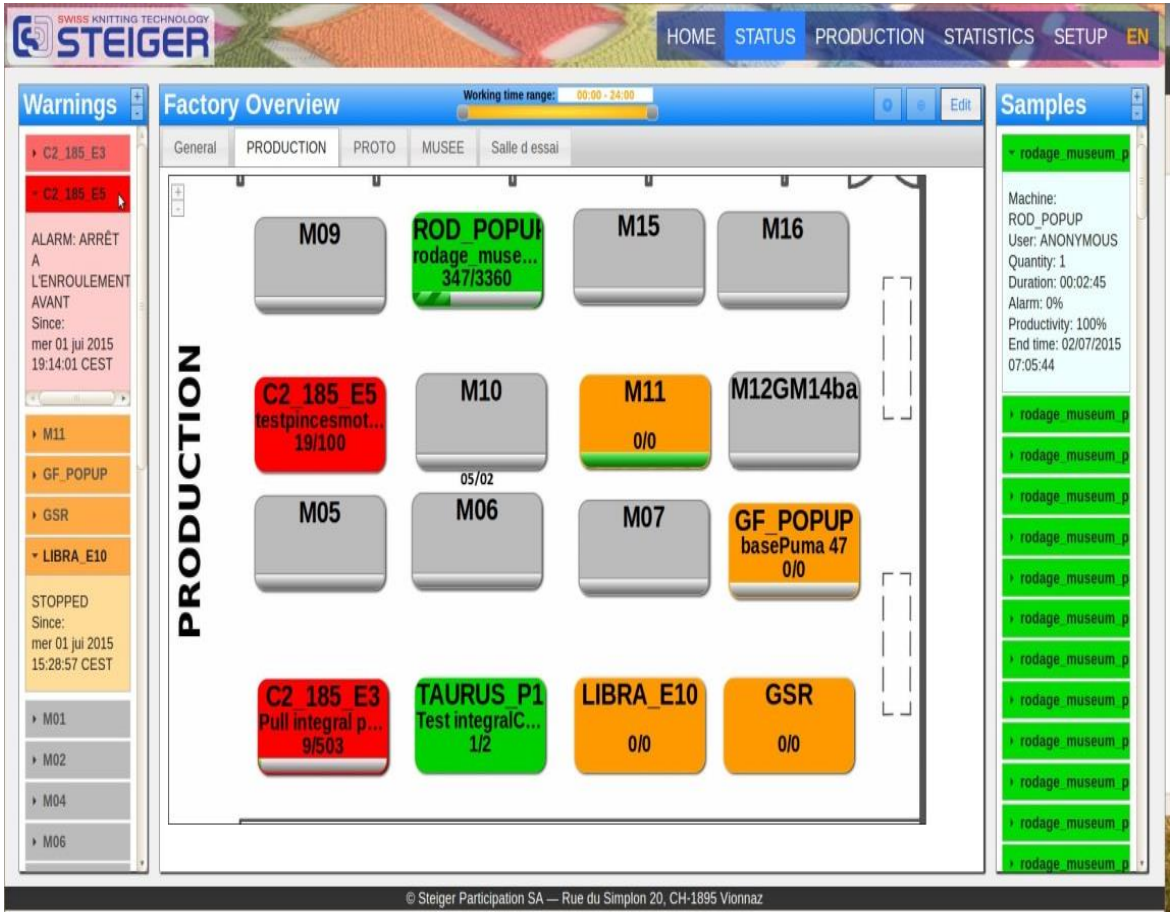
Networking: Distribution of Knitting Data



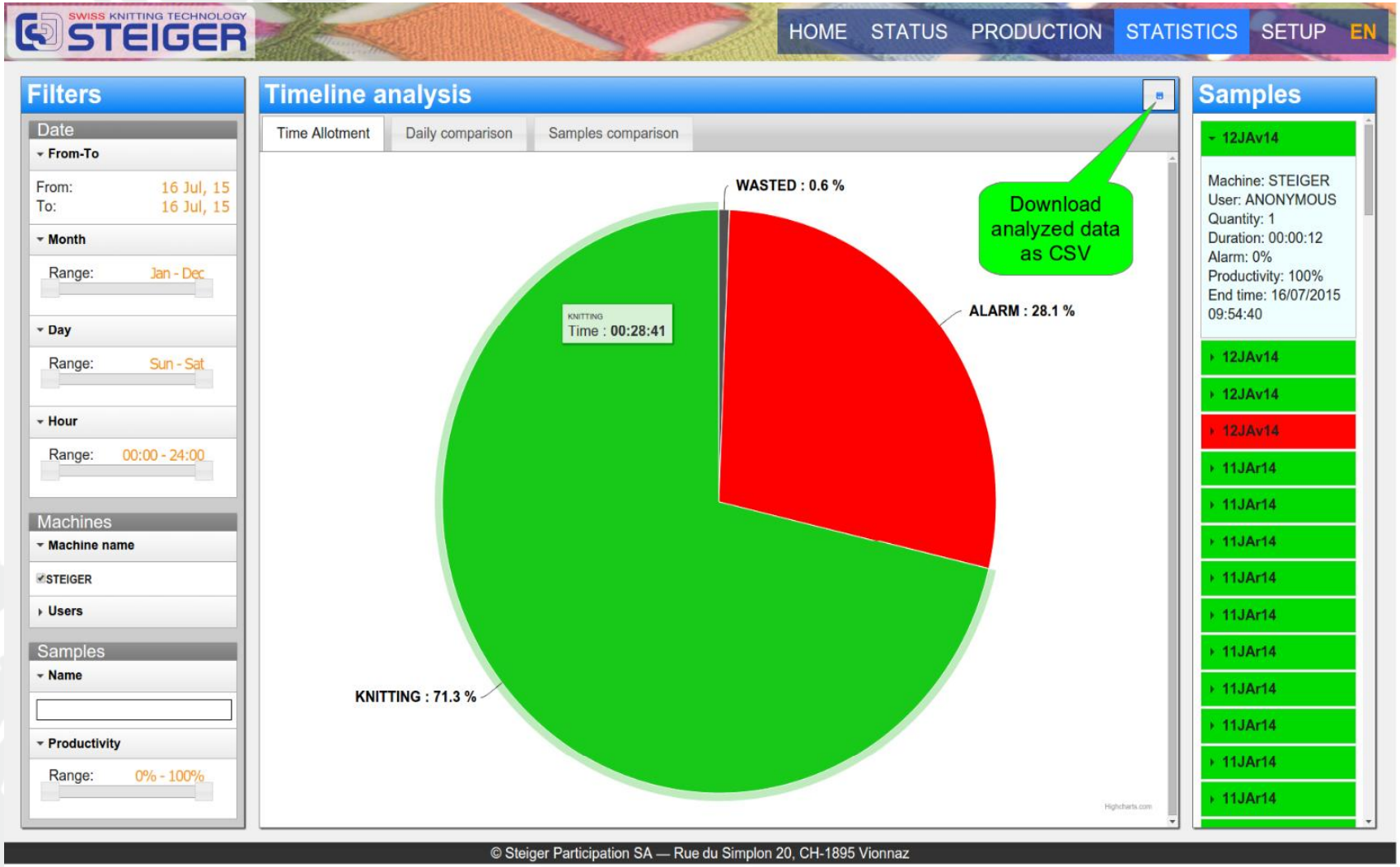
Networking: Integrating Front End Sales with Knitting Data



Networking: Knitting Data to a machine battery

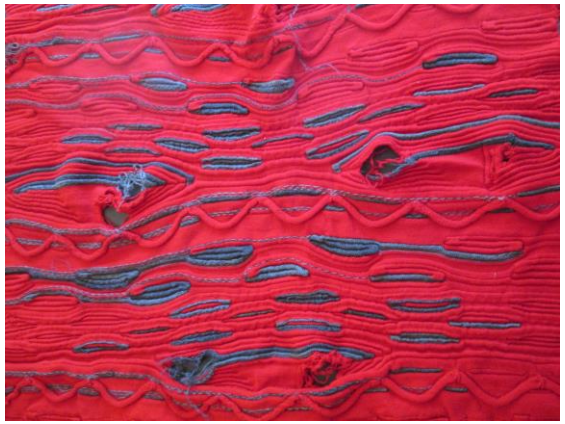


Networking: Report & Analysis of Knitting Data



Background 1980's and 1990's

Background: In 1987, the belt drive took over the knitting industry, allowing the machine's cam box to knit only where the selection was on the needle bed. This was a revolution, giving birth to those crazy multi-textured fabrics, the most famous being Coogi, and 3 dimensional knitting. While at the same time, many mechanical machine builders such as Dubied could not compete and faded away, along with the analogue factories and mechanics who couldn't embrace the change.



Third Industrial Revolution
Belt Drive System

Background – 1980 and 1990's

Background: In the 80s and 90s, flat knitting specifically, only a few companies such as medical companies, mass-customized products like children's blankets, and high-end designer knitting facilities utilized the digital features of machine builder software that enabled automation of the entire production process, including sequential knitting, order compilation, order cueing, production and efficiency reports direct from each machine. For example: Shima Seiki uses a USB or a LAN cable to send information to the production machinery.

Third Industrial Revolution
Custom & Sequential Knitting

https://personalbabyproducts.com/us/

Background – 1990's to 2000's

Background: Combining belt drive technology and computers, plus online capabilities allowed for Mass customization. The most famous of these companies in Flat knitting was French Rags – created by Brenda French.

Mass Customization

http://edwardlowe.org/giving-the-people-what-they-want-how-mass-customization-is-taking-advantage-of-the-customer-revolution/

Background – 1996 onward

Truly Seamless Technology

Background: Knitting Garments all in one piece without cutting or sewing debuted in 1996. There are many pros and cons to this type of knitting, which speaks to why it has never been adopted by mass markets in the past. However, future on-demand manufacturing may utilize it yet.

https://qz.com/949026/brands-including-adidas-uniqlo-and-ministry-of-supply-see-the-future-of-fashion-in-on-demand-3d-knitting/

Background – 2000's – 2010's

Background: Thanks to a running shoe, three dimensional knitting became main stream. Embedding cables became the precursor to commercialized Smart Textiles.

3D and 4D knitting

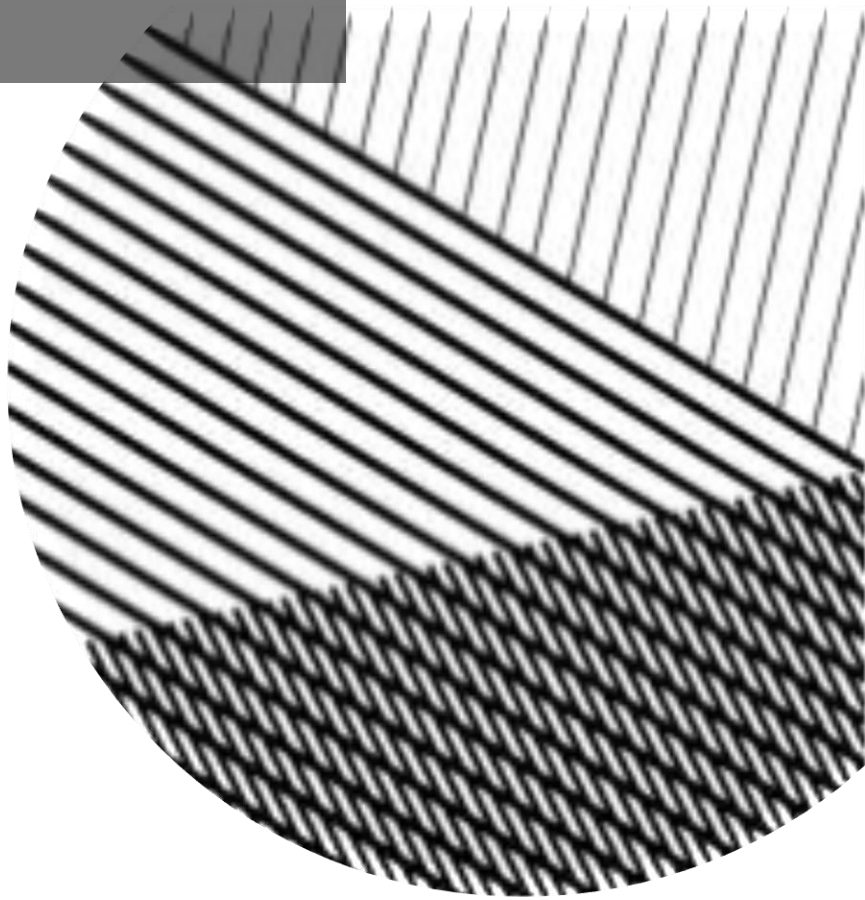
https://www.knittingindustry.com/are-you-ready-for-4d-knitting-exploring-new-dimensions-in-advanced-textiles/

Background - 2008

3 DIMENSIONAL INTEGRATED KNIT TECHNOLOGY

What is it?

3 D integrated Knit Technology is a modern innovative textile manufacturing format that precisely engineers yarns and fabric variations solely where they are needed for creating load, comfort, or performance mapped features in products with a virtually seamless fit. The knits are specially engineered for performance to create light weight designs that minimize excess materials and feature only the essentials. It's a system of mapping added strength, stretch, compression, padding, pockets, and dimensionally stable regions are easily built into the fabric digitally and produced efficiently and consistently with minimal sewing or finishing.



Background - 2013

Market	Applications	Functions	Products
Security/ Safety	-EMT -Military -ID Validation -Rescue/GPS Tracking -Environment Surveillance	-Real time -Remote -Secure -Hazard Detection -House arrest	-GSW detection -Sensor gas mask / light reflector -Personal locator -First responder gear -Biometric insoles -Interactive weaponry gloves
Medical	-In vivo implant monitor R&D -Chronic pain mgt -OA relief -Disease mgt -Brain / eye movement -Vital signs -Compliance	-Diabetic care -Remote Patient Monitor -Passive patient monitor -Remote pulse Ox, ECG, EEG, EMG	-Insulin pump patch -Wireless ECG headset -Biofeedback patch/band -Hearing Aid -Diabetic biometric insoles -Interactive therapy brace
Wellness	-Weight monitor -Energy monitor -Physiology -Gait correct -Posture correct	-Personal Coach -Stress Monitor -Weight monitor -Interactive therapy	-Wireless sensor band/bracelet/belt to smartphone app
Sports/Fitness	-Performance monitor -Fitness monitor -Coach -Navigation -Cool/warm body	-Optimize performance -Activity Tracking -Goal monitor -GPS share	-Personal climate jacket -GPS Snow/Cycling/Hiking wrap around glasses -Training shoes with an IQ

The Future of Wearable Tech

We are used to controlling the world around us, to find the settings that suit us best and harmonize our environments.

- Security & Privacy
- Safety
- Protection
- Early Detection
- Entertainment - VR
- Wellness
- Medical
- Sports

- Communication
- Home
- Aerospace
- Architecture
- Transportation
- Infrastructure
- Energy Harvesting

The Future of Wearable Tech

MARKET DATA: COMPANIES IN THE WEARABLE TECH MARKET

The landscape of wearable tech is populated with companies focused is 4 primary markets: **Infotainment** – real-time data transmission for entertainment; **Fitness and wellness**-monitoring of activities and emotions; **Military and industrial** – real-time data transmission in military or industrial environments; **Healthcare and medical** – monitoring of vital signs and sense augmentation

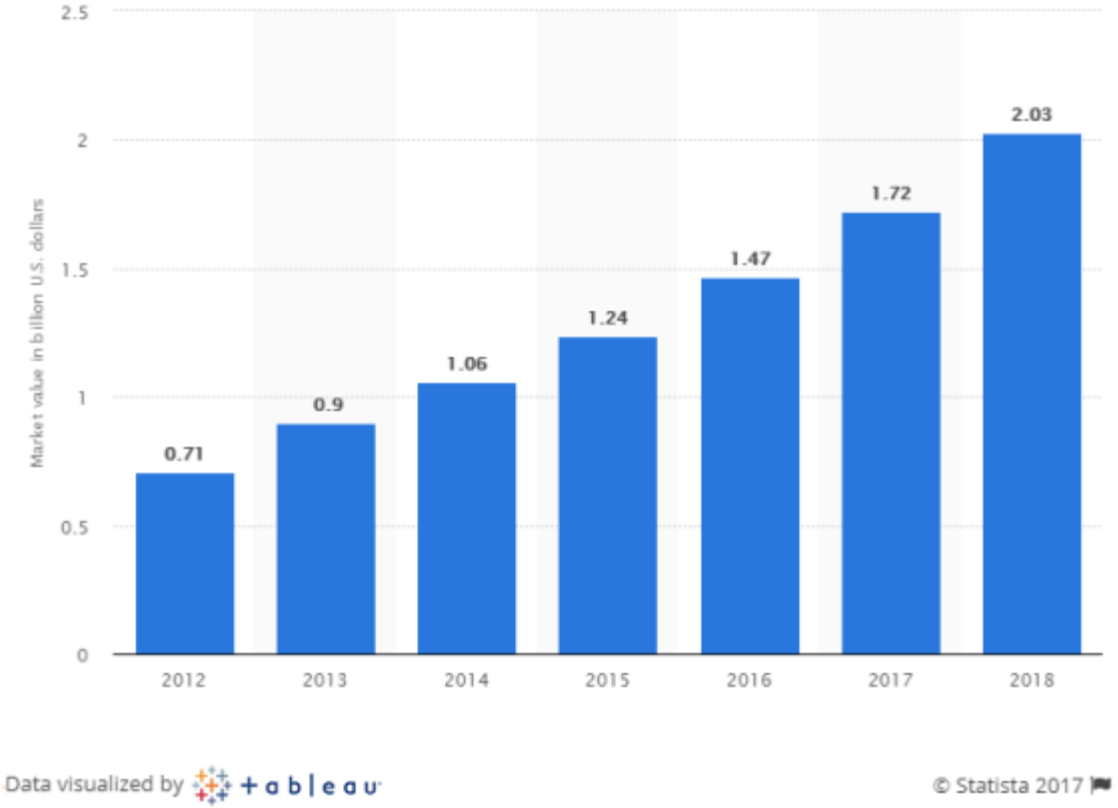
http://scet.berkeley.edu/wp-content/uploads/Smart-Clothing-Market-Analysis-Report.pdf
"Wearable Technology – Market Assessment." 2015. 17 Apr. 2016
http://cdn2.hubspot.net/hub/396065/file-2568104498-pdf/Blog_Resources/IHS-Wearable-Technology.pdf?t=1427903372862

The Future of Wearable Tech Fabrics

MARKET DATA:

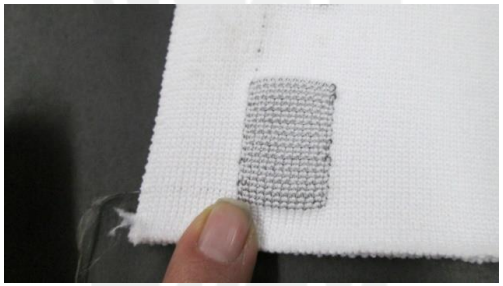
GLOBAL SMART, INTELLIGENT, DIGITAL & INTERACTIVE FABRICS/TEXTILE

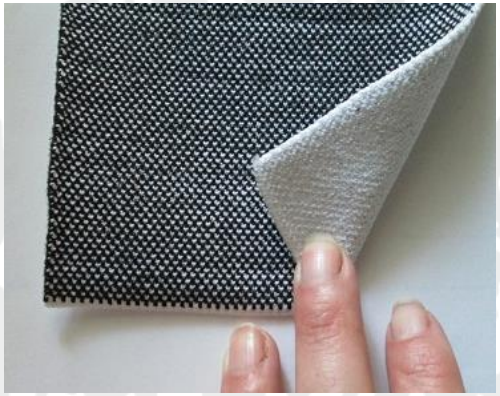
REVENUE FROM 2012 TO 2018 (IN BILLION U.S. DOLLARS)*



The statistic shows the projected growth of the global market for smart, intelligent, digital & interactive fabrics and textiles from 2012 to 2018. The global market for smart fabrics is forecast to grow to around two billion US dollars by 2018

The Future of Mobility is Knit

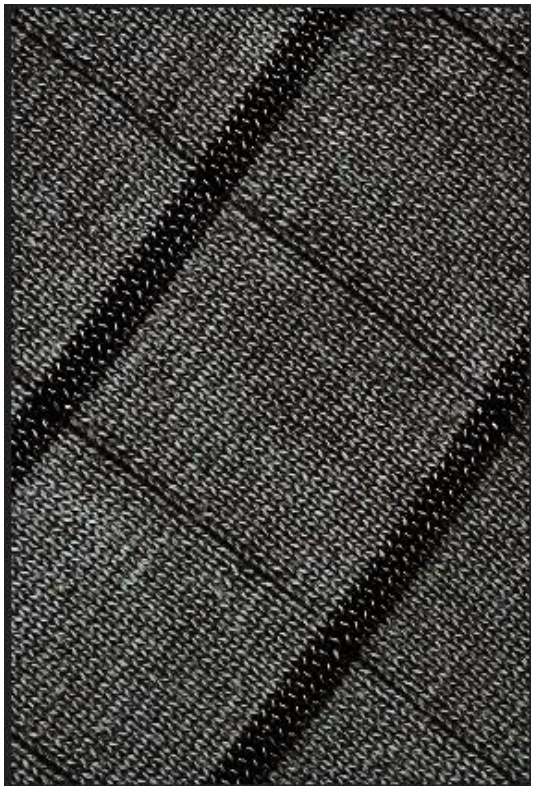




- Smart Materials – engineered to respond to stimuli
- Hybrid materials- combination fibers or composites
- Multiple materials – multilayer & multifunctional
- Combining systems
- Integrating multiple needs into one fabrication

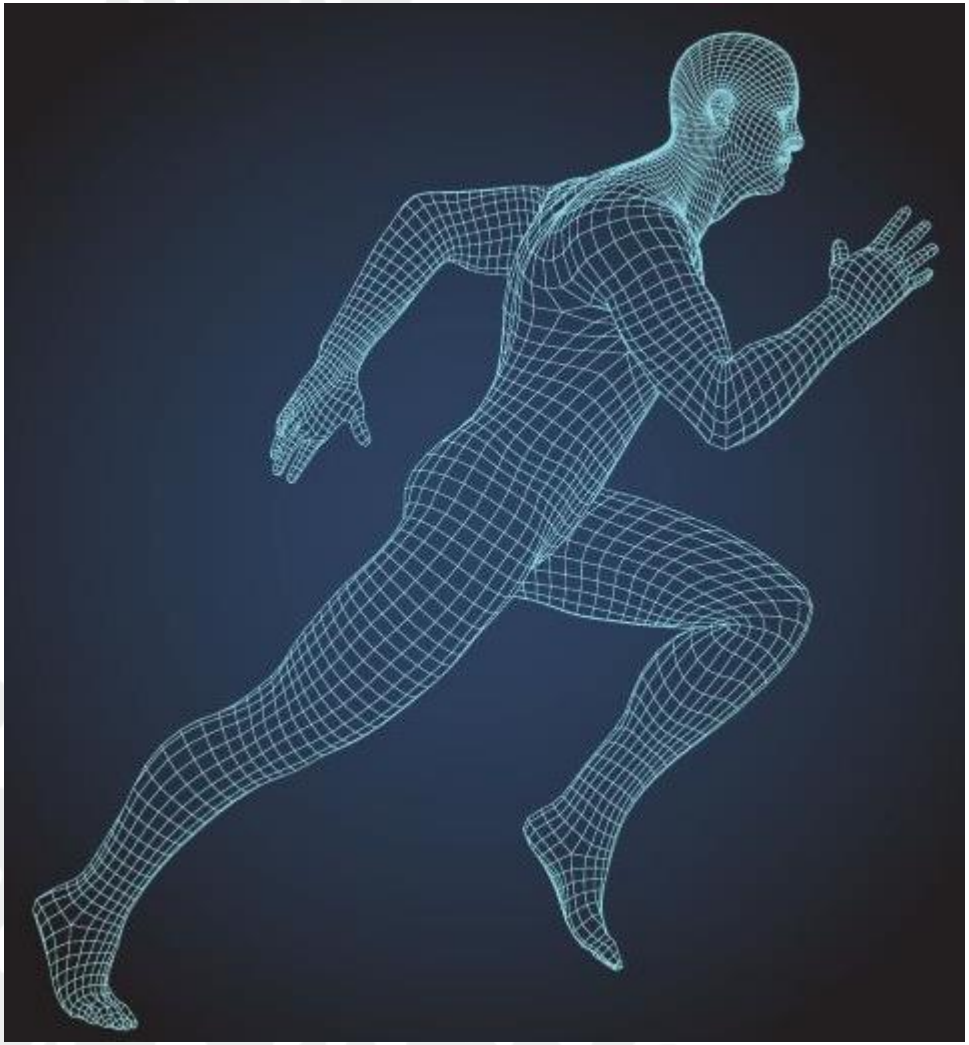
The Future of Mobility is Knit

- 3dimensional Carbon fiber is strong, especially when reinforced with other materials like Dyneema, Kevlar, Stainless Steel and Resins.
- Specific points can be built up or made as shaped spacer composites.
- Structures can be modified by zone for engineering and safety requirements.
- Integrating smart materials like SMA NiTinol, which can change shape on demand or when sensed & actuated for better aerodynamics



How? Carbon fiber knitted to shape with 'prepreg' resin yarn, wiring for sensors, and other structures integrated into the fabric in the knitting process.

The Future of Apparel



Personalized Products

On Demand manufacturing and

Mass Customization of:

- Smart Materials – engineered to respond to stimuli
- Hybrid materials- combination fibers with compression
- Multiple materials – multilayer & multifunctional to shift from one environment to another
- Combining systems – heating and cooling
- Integrating multiple needs into one fabrication

PROS of digitalizing flat knitting manufacturing:

1) Small makers compete effectively, leveraging online marketing and selling platforms, while also utilizing WYSIWYG machine builder software, producing in small micro-factories, or not owning manufacturing at all. In our industry people no longer need to know how to knit top make products with WYSIWYG.
2) Large companies may realize economies of scale, regardless of location, and therefore can 'make' closer to customers.
3) Tracking materials, processes, products, and performance in real time to gain insights for continuous improvement.
4) Transparency of supply chain and view of materials flowing through the manufacturing network.
5) Automation of redundant tasks that typically result in the most defects from human error and optimize factory operations to cut costs and improve efficiency.
6) Use of robotics and smart labelling in shipping.
7) Connecting finance and data exchange.
8) Developing data on customer preferences and making products customers want to purchase, by sending consumer experience data directly to project managers.
9) Today's WYSIWYG machine builder software generates machine knitting programs. The same programs can be sent to networked production cues.
10) Workers on the floor do not need any programming skills to tie up yarns, change needles, and perform quality control (QC) and other basic maintenance.

CONS of digitalizing flat knitting manufacturing:

No dishwasher?

1)Large factories vs several smaller factories : flexibility and local
2) Adapting product changes is tedious. (SAP?)
3) Factories require designated lines for market-specific products.
4) Smart devices are needed for human interface throughout.
5) Streamlining products to fit into an automatic configuration may mean those products are not made as efficiently as possible. (Sintral, writing line-by-line code vs WYSIWYG automatic CAD. WYSIWYG takes away control from the knit engineer, and the resulting production may not be the most efficient. Novice or seasoned professional make the same equally inefficient programs) Designs need to fit WYSIWYG parameters.
6) Without knowing how to knit, everyone gets the same WYSIWYG library and the country with the willingness to take the lowest price wins, regardless of quality, efficiency or environmental issues caused by the waste
6) Digitalizing opens vulnerabilities to unauthorized access
7) Companies may lose control of data & trade secrets, as info is exchanged.
8) For technical textiles, machine builder WYSIWYG libraries do not apply. Therefore, knitting expertise is required to create products that are applicable to the specific market, and which are efficient. So, then what?

Questions textile manufacturers should be asking :

1) How might digitalization disrupt my corner of the industry in the next five to 10 years?
2) Where is the value of digitalization for my company?
3) What technology should my company invest in?
4) In what skills do we need to train our existing employees?
5) What talents should we be looking for in the future?
6) What happens if we do nothing?

As in the past, there is no one-size-fits-all for our industry, but one thing seems certain: as technology advances, consumers are demanding change. The days huge orders from big retailers may be numbered. AI will be a fact of life as countries race to automate manufacturing, the top three being South Korea, Singapore, and Germany. Automation levels the competitive field for products that are labor intensive, especially in countries with growing environmental and employee safety concerns.

Thank You

Fabdesigns, Inc. is a world-class textile design and engineering firm, which has been in business since 1988. www.fabdesigns.com

“We liked to knit before it was cool.”

IFAI EXPO