Preface

The International Conference on Intelligent Textiles and Mass Customization (ITMC) meets every two years, where the organization rotates among the 5 coordinating countries (Belgium, Canada, France, Japan and Morocco). The 7th edition of the International Conference on Intelligent Textiles and Mass Customization-ITMC 2019 was held at the historical city of Marrakech (MOROCCO), from the 13th to the 15th of November 2019.

The ITMC 2019 conference invited guests from various industries and disciplines related to the textile industry. The purpose of the conference is to explore new ideas, effective solutions and collaborative partnerships for business growth throughout the creation of a beneficial synergy between designers, manufacturers, suppliers and end users of all sectors and making full use of this potential. ITMC conference themes are axed on intelligent textiles and mass customization. For 3 days, inspiring speakers from industries, academies, governments and societies shed the light on new chances and challenges, via global statistics and success stories about cutting edge science and technology. The innovation brought to the table of discussion has bloomed through cooperation, policy, education and training and rose via an outstanding interaction between speakers and participants, which has been assured through new IT tools.

On behalf of the Conference organizers, we would like to thank all the participants coming from compagnies, universities and research institutions of all around the globe for greeting us with their presence and the lively exchange of ideas and experiences at the ITMC2019 Conference. We are looking forward to seeing you again in the next edition of ITMC 2021 in Canada!
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Keynote Speakers

Keynote 1

“E-textiles for medical and industrial applications”

Prof. Vladan Koncar: Distinguished Professor at ENSAIT (Ecole Nationale Supérieure des Arts et Industries Textiles) textile engineering institute in Roubaix, France.

Abstract: Smart and E textiles play a significant role as well in the European textile sector and assist the textile industry in its transformation into a competitive knowledge driven industry. Numerous materials and systems are available together with devices for sensing and actuation, but they are not compatible with textile substrates or with the textile production processes. They could be transformed into a textile compatible structure or even in a full textile structure. Smart textiles can be defined as textiles that are able to sense and respond to changes in their environment. They are able to detect different signals from the environment (temperature, light intensity, pollution…), to decide how to react and finally to act using various textile based, flexible or miniaturized actuators (textile displays, micro vibrating devices, LED, OLED…). The “decision” can be taken locally in case of embedded electronic devices (textile electronics) to smart textile structures or remotely in case the smart textile is wirelessly connected to clouds containing data base, servers with artificial intelligence software etc. and may be a part of Internet of Things (IoT) concept. This keynote focusses on latest research results within GEMTEX smart and E textiles research team given below:
- PHOS ISTOS, FP7 EU Project in the field of light emitting textiles structures used for a Photo Dynamic Therapy of skin cancer in its initial phase;
- @HEALTH, B2B project, concerning ECG monitoring in real time, with the system embedded into underwear aiming at the development of the predictive medicine concept;
- CONTEXT, ANR, French collaborative scientific project, in the area of textile metamaterials for energy harvesting and data transfer, using high and low frequency (2,4 GHZ and NFC frequency 13,56 MHz) textile antennas; and
- LITEVA, FUI, French industrial project dealing with the new generation of autonomous vehicle dash-boards.

Keynote 2

“Complex 3D Woven Textiles: A Sustainable material”

Prof. Bijoya Kumar Behera: Professor and Head, Textile Technology Department, Indian Institute of Technology, India.

Abstract: Reinforced composite materials open up completely new skylines in an assortment of mechanical applications, compared with traditional materials. They are most useful in structures where the critical issue is how well the final product performs. Their superb properties such as mechanical strength, fatigue resistance and chemical resistance combined with the greater flexibility offer to design near net shape complex structures like solid, hollow, profiled, auxetic and aerodynamic structures result in cost effective solutions in advanced composite industry. Over and above, light weight load bearing structures open up unlimited possibilities of energy saving measures. In composite making, woven fabrics are the preferred type of reinforcement other than fiber mats. Woven fabrics are made by joining two or more yarns in an orthogonal framework with great steadiness in the
twist and filling bearings and offer the most noteworthy cover or yarn pressing thickness in connection to fabric thickness. As of now the greater part of the woven fabrics utilized as a part of composites are straightforward developments, for example, plain, satin, twill and basket weaves. The weaving standard is additionally equipped for making structures that have significant measurement in the thickness heading shaped by layers of fabrics or yarns, termed as the threedimensional (3D) fabrics. A large portion of these structures can be made on the ordinary weaving machines with some modifications. The quick preferences of fabrics with an outstanding thickness measurement incorporate the basic respectability of the woven structure, the fulfilment of the geometric shapes, and volumes that are needed for some end-use applications. At present, both the traditional and uniquely made weaving machines are utilized to make different 3D fabrics, mostly for the structural composite applications in the field of aerospace, marine, automotives, sports, medical, wind energy and civil construction. There have been effective endeavours in growing new weaving gadgets, especially to make 3D woven solid, spacer and profiled structures. These new advances mastermind use of both flat tows and twist yarns in a 3D structure and permit weft yarns to be embedded at diverse levels. Another clear favourable position is that the weaving technology can make 3D fabrics that are much thicker than the routine innovation.

Efforts are also being made to develop innovative 3D structures with various geometrical configuration. The importance of woven spacer fabrics, their properties and process optimization along with the advantages they carry with them have been studied in great detail. Spacer fabrics are proved to be strong for the structural applications due to their light weight and presence of reinforcement along their thickness direction. They have a promising future in the lightweight application areas and can be the real substitutes for aluminium and other metal alloys. In this way there dependably exists an interest on more creative structures to fulfil the requirement for present lightweight situated innovation. Improvement of complex preforms from a straightforward weaving innovation would dependably be a genuine test for a textile technocrat. Some new structural sandwich composites have also been developed using 3D woven spacer structures for their excellent properties, especially complete molding and good designing.

Regardless of weave architectures, the 3D woven fabrics as composite preforms have an imperative part to play in the improvement of cutting edge material composites. 3D-weaving technology does not only support extremely low cost manufacturing, but also decreases the impact to the environment and contribute to sustainability. In the first place, 3D technology supports the use of more abundant materials like plastics in substitution of metals, as well as less energy intensive manufacturing processes and decreases logistic efforts in the supply chain.

Keynote 3

“Hot and Cold 3D Fabric Design”

Mr. Éric Perlinger: President of the world leader in the manufacture of high performance technical yarns, FilSpec ™, Canada.

Abstract: Since becoming President of FilSpec in late 2015, my direct supports and I have attended many “Smart Textile” academic conferences and we have joined various organisations, such as AFFOA , whose vocation is the development of “Smart Textiles”. After attending conferences in Boston, Ghent, Raleigh and Stuttgart, I have been disappointed and somewhat underwhelmed by most of the academic papers. Few discuss “smart textiles” per se. Most consist of presenting “battery-wire-sensor” configurations, which only use the fabric as a superstructure to hold the electronics in place. For all the media discussion of conductive yarns and acorn effects, few proposition presented fit into our conception of “Smart Textiles”. For us, “Smart Textiles” react and interact with the environment in such a way to offer the wearer various desired functions or performances. “Smart Textiles” are more than novel data
collection and electronic stimulation. FilSpec is a Canadian company based in Sherbrooke, Quebec that manufactures unique yarn solutions for various special applications. We view ourselves not as a yarn spinner, but as an engineering company that works in yarn. We believe that 80% of the performance of any fabric comes from the yarn. Our unique ability lies in the creation of specialty yarns that are converted into multi-functional fabrics.

In an industry suffocating under the weight of commodification, FilSpec has benefitted from phenomenal growth due our unwavering commitment to research, development and specialization. In the past 3 years, we have nearly doubled the size of the company and developed a multitude of different branded products.

One such product is WarmFil, a yarn that uses the near infra-red rays of the sun to convert them into heat energy, generating a positive delta of 6-10 degrees centigrade (depending on time of day and cloud coverage). WarmFil fits into our definition of a “Smart Textile” as it reacts to its environment (NIR) and uses that reaction to offer a desirable function (heat).

Our first incarnation of a “Smart Textile” inspired us to try to create a fabric that would use part of the WarnFil technology to cool, rather than to heat. One of the properties that WarmFil offer is the ability to evaporate water 5 times faster than regular polyester. As the fibers generate heat they also accelerate evaporation. Our hypothesis is that we can cool the wearer through accelerated evaporation. We call it the “heat-pump effect” and we patented the concept of creating a multi-layer fabric using hydrophobic, hydrophilic and heat generating yarns in order to cool through hypervapaporation.

In September 2018, we started a project with NC State’s Wilson College of Textiles to test our patented hypothesis. Students (Claire Rose, Ines Ortiz de Zevallos and Rachel Hall) spent their senior year working on the project and concluded that:
- A low thickness is paramount to allow fabric to have a higher heat loss;
- To be considered a cooling fabric, the fabric must have a high absolute and relative heat loss;
- A faster drying rate is indicative of a faster evaporation rate which showed high heat loss Phase 2 of our research focuses on the optimal fabric configuration to maximize the cooling effect.

Keynote 4
“Digital transformation and open innovation for Railway sector”

Mr. Emmanuel COX: Digital transformation officer, French National Railway Company (SNCF), FRANCE.

Abstract: SNCF Réseau maintains, upgrades and sells access to the French rail network, serving all passenger and freight rail companies. There are basically three fundamental values which should govern the rail system: Safety, Security, and Sustainability (on both environmental and economic terms). The future challenges for SNCF Réseau are huge:
- Respecting the fundamental values,
- Enhancing the existing capacity fulfilling user demand,
- Increasing the reliability delivering better and consistent quality service of European Rail system,
- Decreasing infrastructure’s exploitation cost
To meet the numerous challenges ahead and to limit the impact on environment, the rail sector should increasingly rely on its innovative potential for delivering smart solutions with regards to safety, security, punctuality, availability, accessibility, seamless operation, capacity, connectivity, sustainability and other
performances. A large digital transformation has started at different levels:
• informing customers and staff,
• training the staff,
• monitoring and automizing processes, deploying IoT on assets for industrial supervision

SNCF Réseau is facing many issues to scale and industrialize IoT deployment over his assets. To cope with this challenge, many initiatives were launched internally to ease its deployment. The conference presents SNCF Réseau’s challenges for the future, how the IoT and digital process contributes to transform the company, the leverage for implementation of digital processes and deployment of IoT, the expected impacts. On conclusion, a major initiative will be detailed: the DIGITAL OPEN LAB, a collaborative project that turns predictive maintenance into reality.

Keynote 5
“Lithium ion batteries in a fast-changing world"

Prof. Rachid Yazami: Inventor of graphite anode for lithium-ion batteries, Founding Director of KVI Group, Singapore.

Abstract: Lithium ion batteries (LIB) were first commercialized in Japan in 1991 and since has experience a tremendous market growth to nearly reach about $100b. The commercialization of LIB came 10 years after the discovery by John Goodenough and Rachid Yazami of the lithium cobalt oxide cathode and the graphite anode, respectively. In 1985, Akira Yoshino sat up the first working prototype of a LIB cell. LIB captured the news headlines when the 2019 Chemistry Nobel Prize was announced to honor the scientists and engineer who did the pioneer work that led to a success story. LIB owe their popularity owing to outstanding performances as compared to other autonomous power sources including batteries, fuel cells and supercapacitors. Firstly, LIB store the highest amount of energy per weight and volume, close to 270Wh/kg and 700Wh/l. This allows lighter and smaller batteries to be used in mobile electronics and in electro-mobility systems such as electric vehicles. Secondly, LIB provide high power to enable fast charging and discharging, merits that are in very high demand by the end users especially in electric vehicles (EV). Thirdly, depending on cells quality and usage conditions LIB an have a long life providing over 1000 deep charge and discharge cycles. For an EV application it is required a LIB pack to last about 10 years and provide over 200,000 km. Fifthly, LIB are generally safe although we hear here and there some unfortunate thermal incidents and accidents but they are statistically rare. The number of applications of LIB is steadily growing as society is moving toward cleaner environment to cope with the earth global warming issue. Energy storage systems associated with clean energy generation systems such as solar, wind, wave and hydrolytic energy are expected to play a major role in the climate change as we are transiting from greenhouse emitting energy sources to cleaner energy source provided by batteries. Besides well-established markets for LIB of mobile electronics, electro-mobility and energy storage systems, new applications are foreseen in battery imbedded systems such as in textiles. Thin printable and flexible batteries have been developed and tested in e-textile products. This is made possible owing to nanomaterials such as graphene together with polymers as illustrated in the figure below.
Keynote 6

“MASEN Renewable Energy program in Morocco”

Mr. Hicham Bouzekri: Director of R&D and Industrial Integration at the Moroccan Solar Energy Agency (MASEN), Morocco.

Abstract: MASEN is implementing the world leading Moroccan renewable energy strategy to bring the solar, wind and hydro installed capacity to represent 42% of electricity generation in Morocco by 2020 and 52% by 2030. The mission of MASEN in implementing this strategy is complete and covers renewable electricity production industrial integration, local development, research and development.

Keynote 7

“Toward the smart fiber & textile”

Prof. Dr. Eng. Toshihiro Hirai: Fiber Innovation Incubator, Professor at the Faculty of Textile Science and Technology, Shinshu University, Japan.

Abstract: Information technology, such as IoT and AI, is ruling the world in every field of industry. Our lifestyle is also changing from the very basic level. Textile industries are also involved in the trend, and the textile products are expected to be smart in various ways. Many textile companies, in Japan, declared themselves to be chemical companies, and trying to be adoptive to the trend using their technologies. In this presentation, I would like to introduce some of my results on the smart functions of the conventional textile polymers. The functions are electromechanical, electro-optical, and piezoelectric functions. The results suggest that even the conventional polymers can exhibit highly potential “smart” functions, and also suggested that they have good potential as fibers and textiles even in the conventional manner in the AI technology trend. The challenges by Japanese Chemical Fiber Companies will also be introduced.

Keynote 8

“Developments in the Belgian Textile Industry”

Mr. Kris Van Peteghem: Textile and Apparel Advisor at Fedustria, Belgium.

Abstract: As in most western economies, the textiles and apparel industry in Belgium was subjected to a major decline and transformation in the last decades. This presentation will give an overview of the main developments explaining this transformation. In the textiles industry we see 3 different
value chains. That is also how most West-European countries see it: first value chain is textiles for clothing, which we could call the apparel chain; second, textiles used at and in homes, which we call home textiles such as carpets and rugs, furnishing fabrics, terry toweling, household textiles, mattress textiles and so on. And third, there is the value chain of technical textiles. Technical textiles is a wide range of textiles products with functionalities to meet a technical challenge, such as medical textiles in hospitals and the operation theatre, textiles for the agriculture business, textiles used in cars such as airbags, geotextiles for the road construction, … There are thousands of products in technical textiles. Technical and technological innovation is the main driver for technical textiles. Basically, the apparel value chain became less and less important in Belgium and Western Europe to make place to the more specialized products in technical textiles. Two elements are important in explaining this transformation. First, the very high manufacturing costs in Western Europe. It pushed away the labour intensive textiles and apparel activities out of Western Europe towards North Africa and the Far East (Asia), certainly the making up of clothing. In a number of cases the weaving activities moved also, certainly to the Far East. In Belgium the clothing activities were replaced by the manufacturing of home textiles, such as carpets, in which Belgium is still one of the most important manufacturers in Europe. And the last 30 years technical textiles came up as a very strong third value chain in Europe. Now is represents almost half of the textiles business in Belgium, whereas home textiles represent 40% and clothing textiles only 10%. Second element is the growing need for new products, which require investment in R&D. New societal demands in the field of health and safety, environment, personal protection and so on creates always new opportunities for technical textiles. It’s a growing business. As mentioned before, the role of innovation and product development as a business strategy is key. The transformation of the textiles industry also implies new business models and new investment projects, focussing on f.i. flexibility to allow mass customization. The presentation will also explain the necessity of well educated students and the need for vocational training. Otherwise, innovation can not be successfully implemented.

Keynote 9

“Smart textiles: technological review and future perspectives”

Pr. Savvas G. Vassiliadis: Professor at Piraeus University of Applied Sciences, Greece.

Abstract: Smart textiles or e-textiles or electronic textiles are textiles that are characterized by advanced functionality and specifically by two major properties. Namely, their ability to obtain information from their environment and their ability to react based on that information. The main difference between mainstream, functional textiles that have already existed for many years (breathable, flame retardant etc.) and smart textiles is this ability of reaction to stimuli. The idea of textiles that react with their environment, and here textiles are meant to include both garments and a variety of other applications such for example medical applications, is not a new one. Nevertheless, one has only look at one of the first attempts at smart textiles, the MIThril vest from MIT (2003), with its boards and wires suspended on a fabric substrate to immediately understand some of the challenges that someone attempting to integrate electronics and textiles would face. It would take advances in circuit miniaturization, lowering power demands, development of next generation batteries as well as production of conductive textiles (embroidery/ sewing threads, conductive fabrics etc.) to bring us to today where hobbyist, arts/ crafts enthusiasts and fashionist as can use components like the Arduino and Lilypad to create garments with blinking LEDS and dresses that literally light up on the catwalk or at the 2016 MET Gala where actress Claire
Danes wore a Zack Poshen dress incorporating optical fibres. But marker research of current smart textiles products available to customers doesn’t come up with as many products as one would expect from the amount of research that is being carried out on the subject. In other words, there is a lot of research in University and Research centre Laboratories but few actual products. Examining those products that are available under “smart textiles”, sports applications are prominent. It should be noted that these smart textile sport products are geared towards organized sports or high-end amateurs (e.g. Athos training system, Sensoria tops). Main functions include bio-signal sensors (heartbeat and breathing rate monitors) and accelerometers for posture and movement monitoring. The data collected from the various sensors is aggregated to an electronic system that usually transmits the data to a smartphone or tablet. In these applications, the sensors can and sometimes are textile based and so are the power/data lines but the communication/data aggregation modules are electronics that are usually encased in a plastic shell and can be snapped on and off the product. Other commercial applications include health monitors such as baby socks from Owletcare that monitor a baby’s bio-signals and the @health system that monitors heart function 24/7. What all these products have in common are the fact that their target groups are very specialized and the solutions used for the integration of the electronics to the textile substrate are the “softest” possible. This means that all the electronics/power sources are segregated and detachable, the product can sometimes be cleaned with the usual care methods but only in the most gentle of settings (e.g. cold water, immersion only, no spinning/very light spinning, no dry cleaning). The smart textiles as a widely available consumer product seems still under continuous research and development. It would be worth debating the perceived benefits of investing time and money in researching fully textile electronics when bio-signal monitoring is readily available as a bracelet like device (e.g. Fitbit, Apple watch). The smart textiles must provide corresponding solutions and in the same time must be simple, reliable and competitive to the alternative technologies.
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