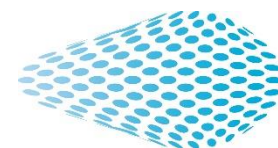




Centre for Nanotechnology
and Smart Materials

Nanotechnology and Smart Materials Enabled Textile Applications



CLUSTER TÊXTIL
tecnologia e moda

João Gomes | jgomes@centi.pt

**Innovation Day
Funding for Innovation and Smart
Textiles: best practices and
opportunities 2020-2021**

Biella, 30th September 2019

Outline

- About CENTI
- Smart Textiles – Challenges
- Fibre & Yarn Technologies
- Smart Textiles – Wearables
- Smart Textiles – Automotive
- Summary





About CENTI

High Level Shareholders



Universidade do Minho





Automotive & Aeronautics



Architecture & Construction



Health, Protection & Well-being





Approach

R&D

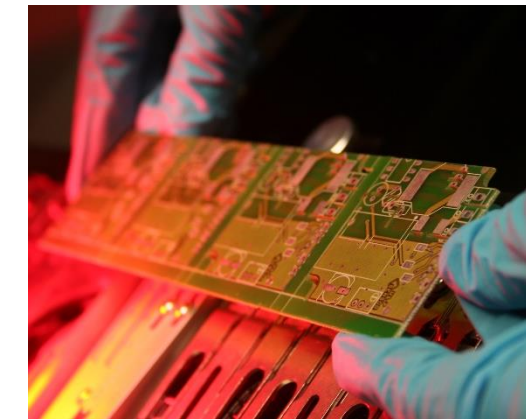
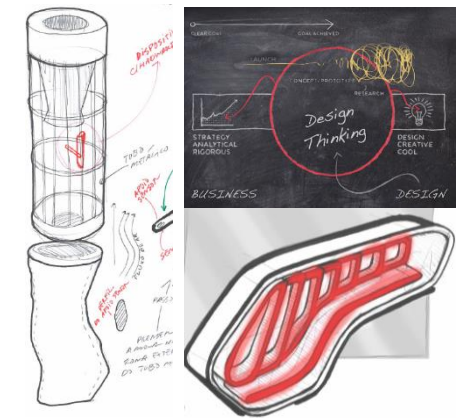
Proof-of-concept
1st Process approach
1st Cost Assessment

Prototyping

Product Design
Process Refining
Cost Assessment

**Pre-series
co-production**

Market Proof
Pre series





Substrates





Smart Textiles - Challenges

User Experience

Poor textile usability

Design restrictions

Lifetime and system maintenance;

Comfort issues and “user-friendliness”

Complex fabrication and assembly processes;

Incoherent value proposition

Complex data management services

Challenges

Designer friendly technologies

End user engagement and usability testing

Assessing suitable business models

Up scalable processing and fabrication methods

Development of new interconnection technologies

Pre-series market testing: a LabFab approach to cross the valley of death



Requirement | Need

Trend

Usability

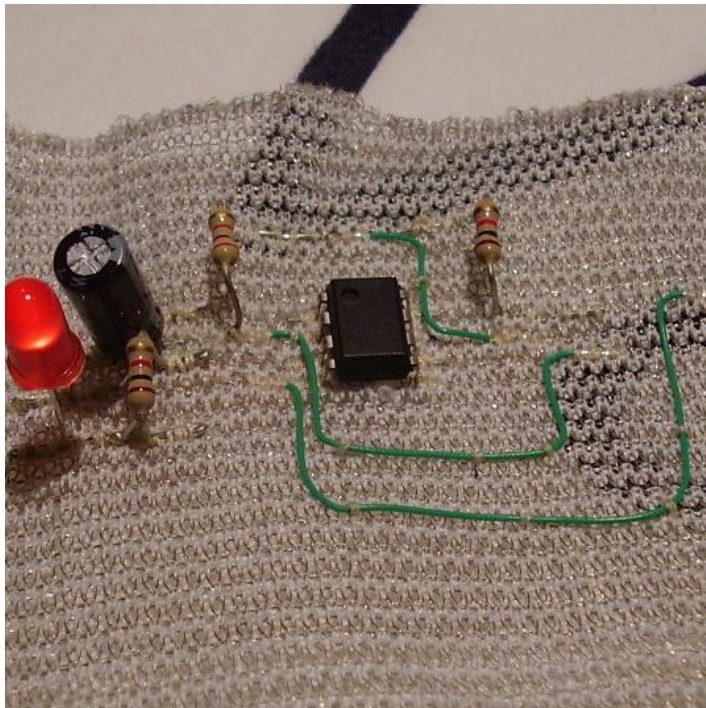
Application Design

Technology

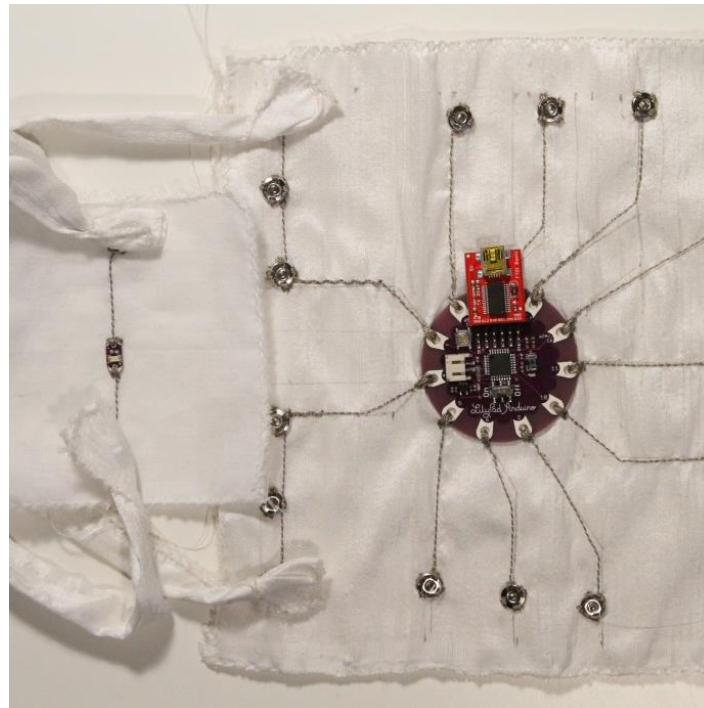
Sustainable life cycle



Too much wire



Cumbersome embedded systems



Fragile interconnections





Surface Technology



Hybrid and Embedding

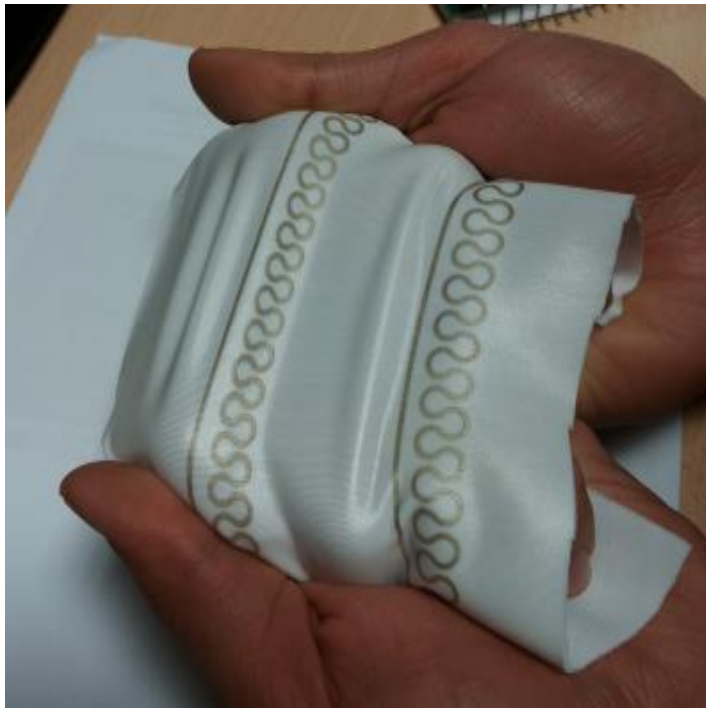


Fibre and Yarn





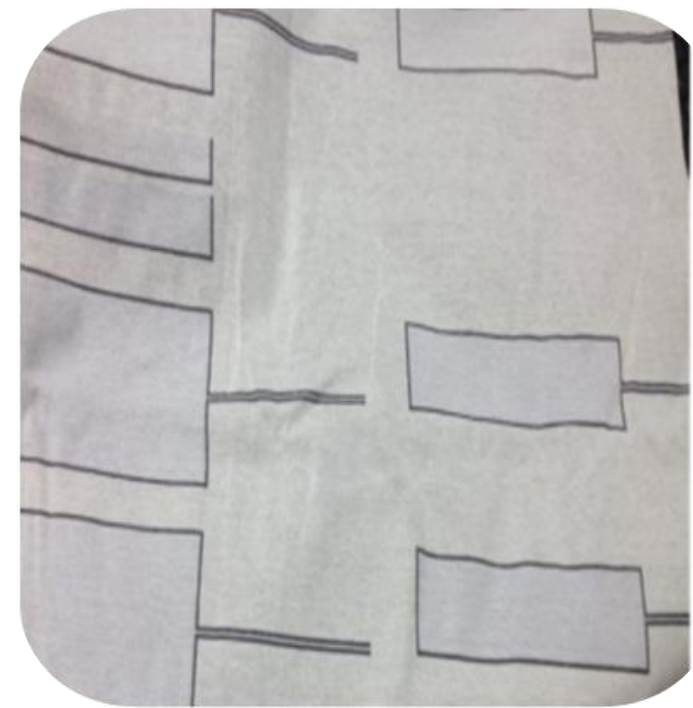
Direct Printing of Hybrid Systems



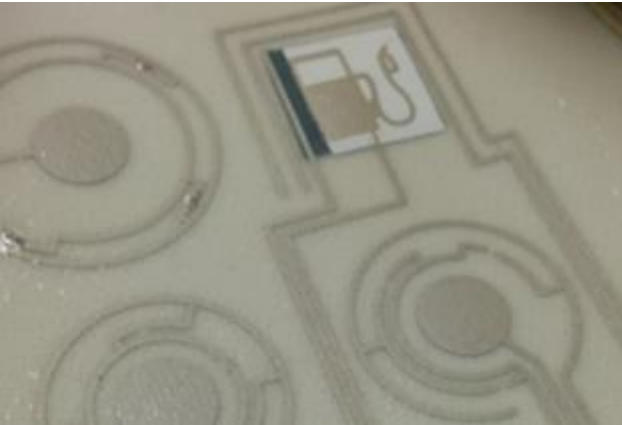
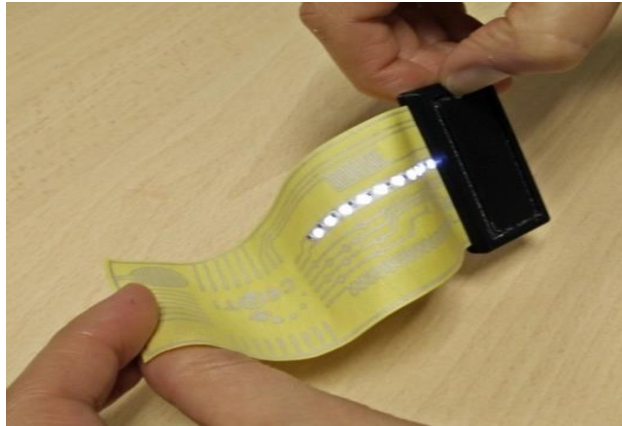
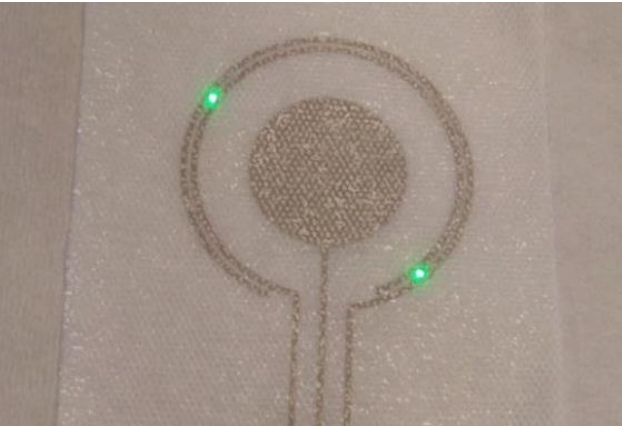
Lamination and Thermoforming



Capacitive Textile Structures



Hybrid: Printed & Integrated Flexible Devices



- **PROS: Wide variety of applications and technologies**
 - Printed actuators - push and gesture recognition;
 - Conformable flexible devices (stretchable);
 - Flexible active and passive matrixes;
 - Printed and integrated heating and cooling system (Joule & Peltier effect);
 - Printed and laminated Flexible lighting (OLED, EL);

- **CONS: Complex value proposal and lifetime**
 - Complex multi-process assembling
 - Cost-intensive
 - Design restrictions and poor usability (i.e. wash ability)
 - Lifetime issues in wearable applications

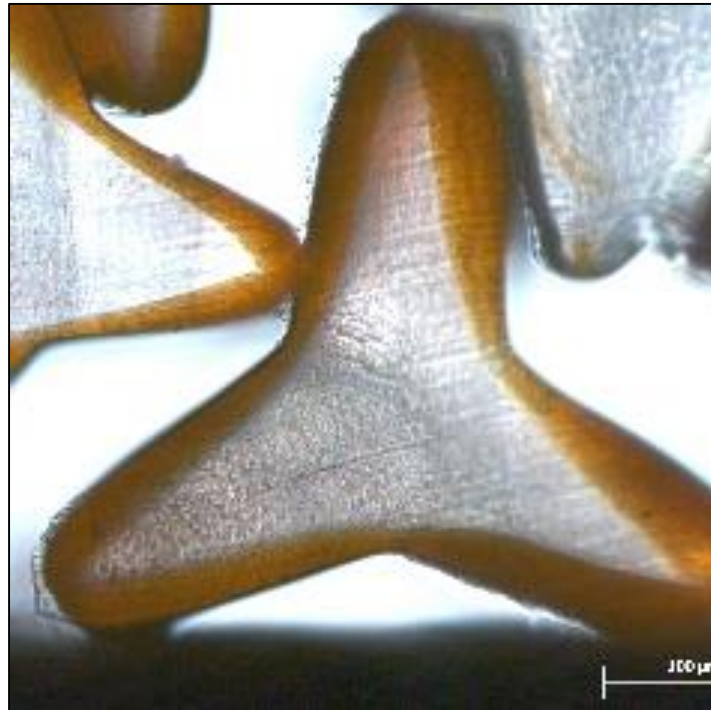




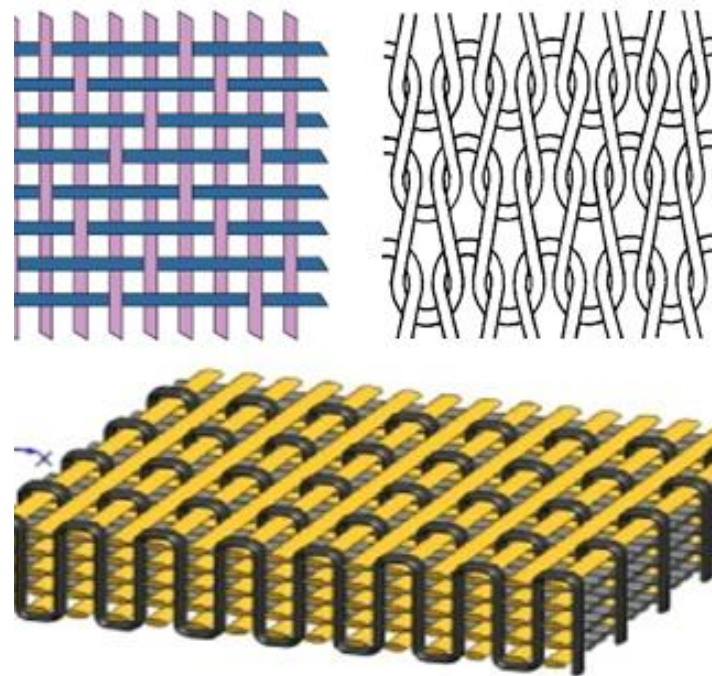
Fibre & Yarn Technologies



Smart Fibre

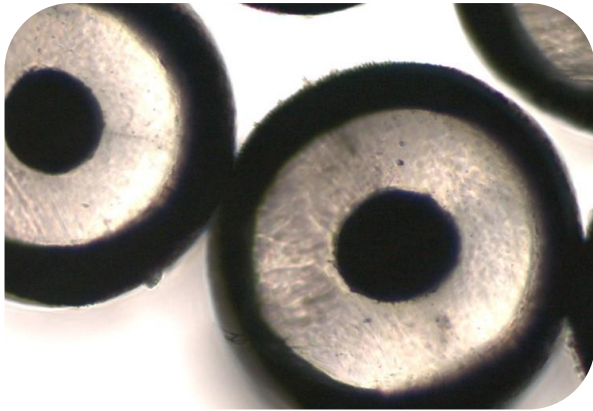


Yarn Technology



Materials Development

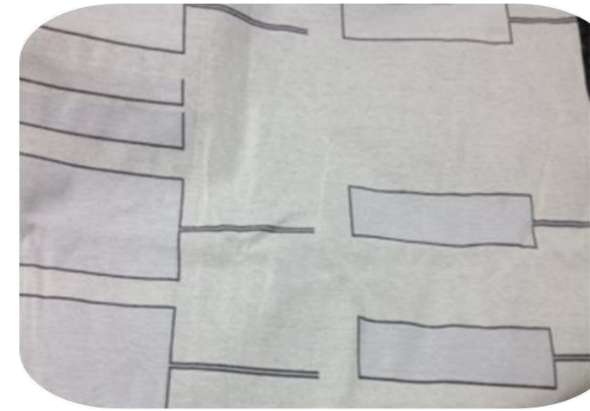




Piezoelectric fibre sensors



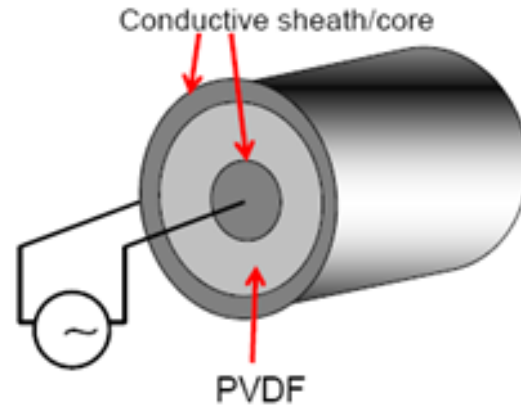
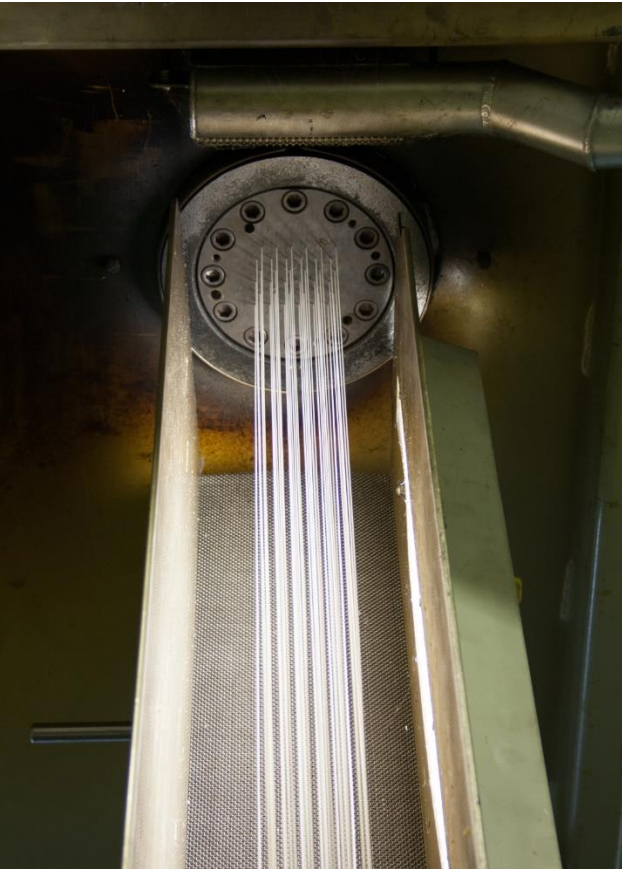
Piezoresistive fibre strain sensors



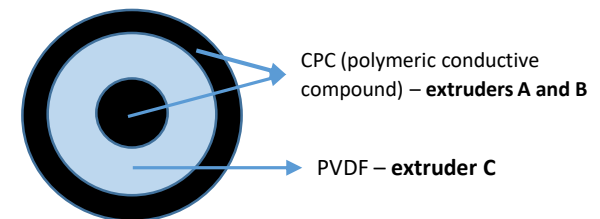
Capacitive Actuators

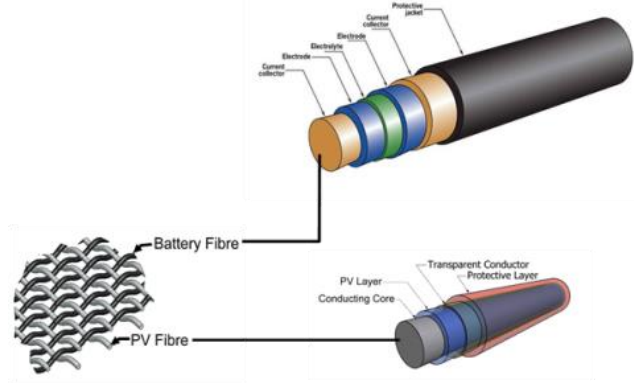


Smart Fibre Technology



- Tri-component fibre technology (pilot scale)
- Development of fibre-based and/or yarn-based electronic devices using multilayer and coaxial structures;
- Fibres compatible with textile processing (mechanical properties) and presenting electronic output:
- Sensor actuators;
- Antennas and interconnectors;
- Energy harvesting;





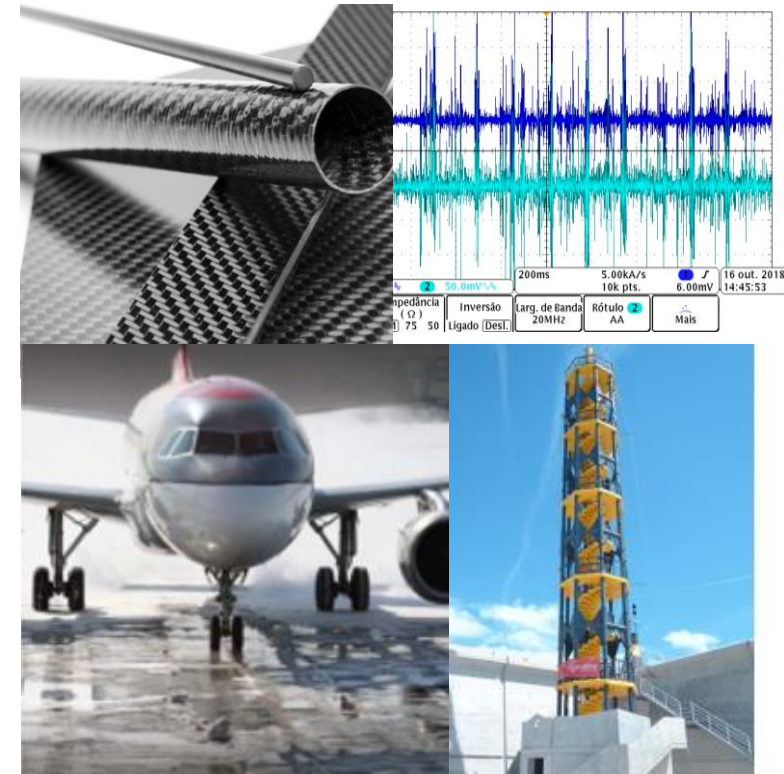
- F-SE**
 Fibre Stretchable Electrode

- F-FET**
 Fibre Transistor

- F-LED**
 Fibre Light-emitting Diode

- F-Energy**
 Fibre Energy Device

- F-Sensor**
 Fibre Sensor Device

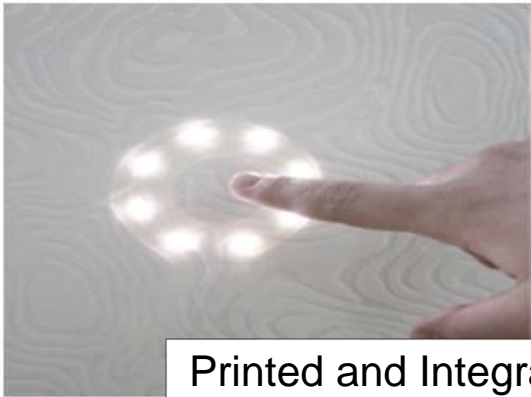





Smart Textiles - Wearables



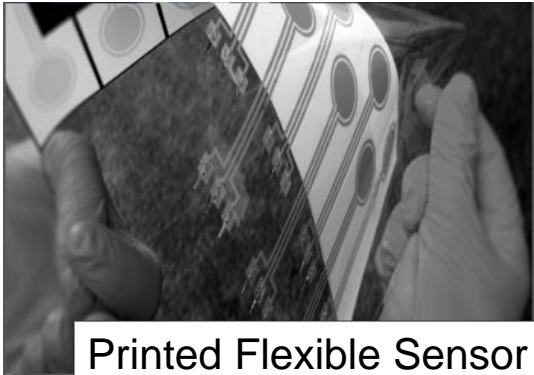
Direct Printing of Intelligence



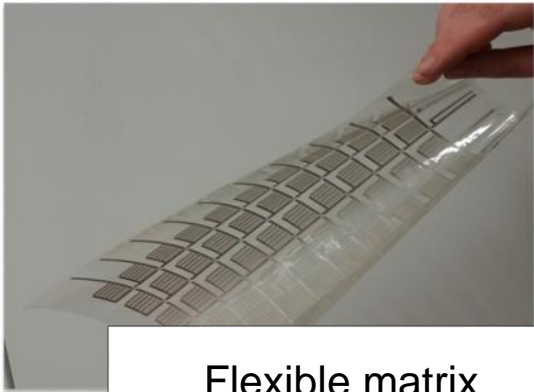
Printed and Integrated Lighting Device



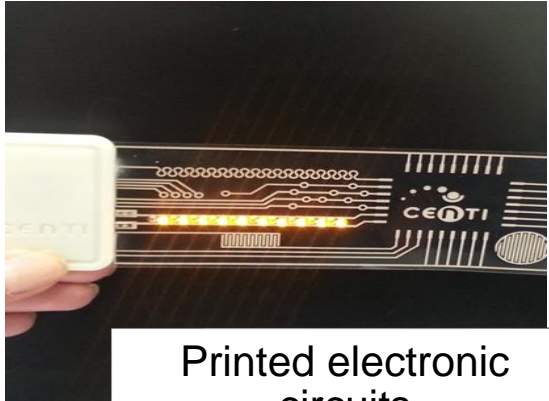
Stretchable



Printed Flexible Sensor Actuator



Flexible matrix

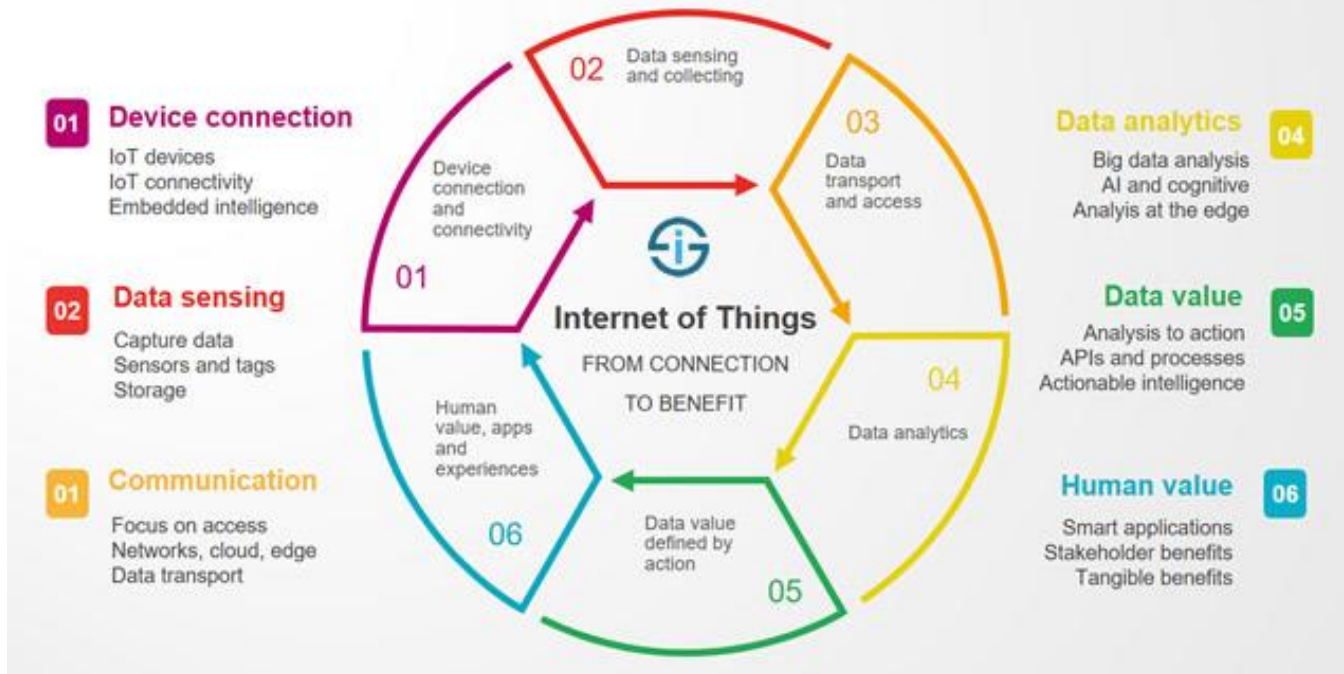


Printed electronic circuits



The Internet of Things

From connecting devices to human value

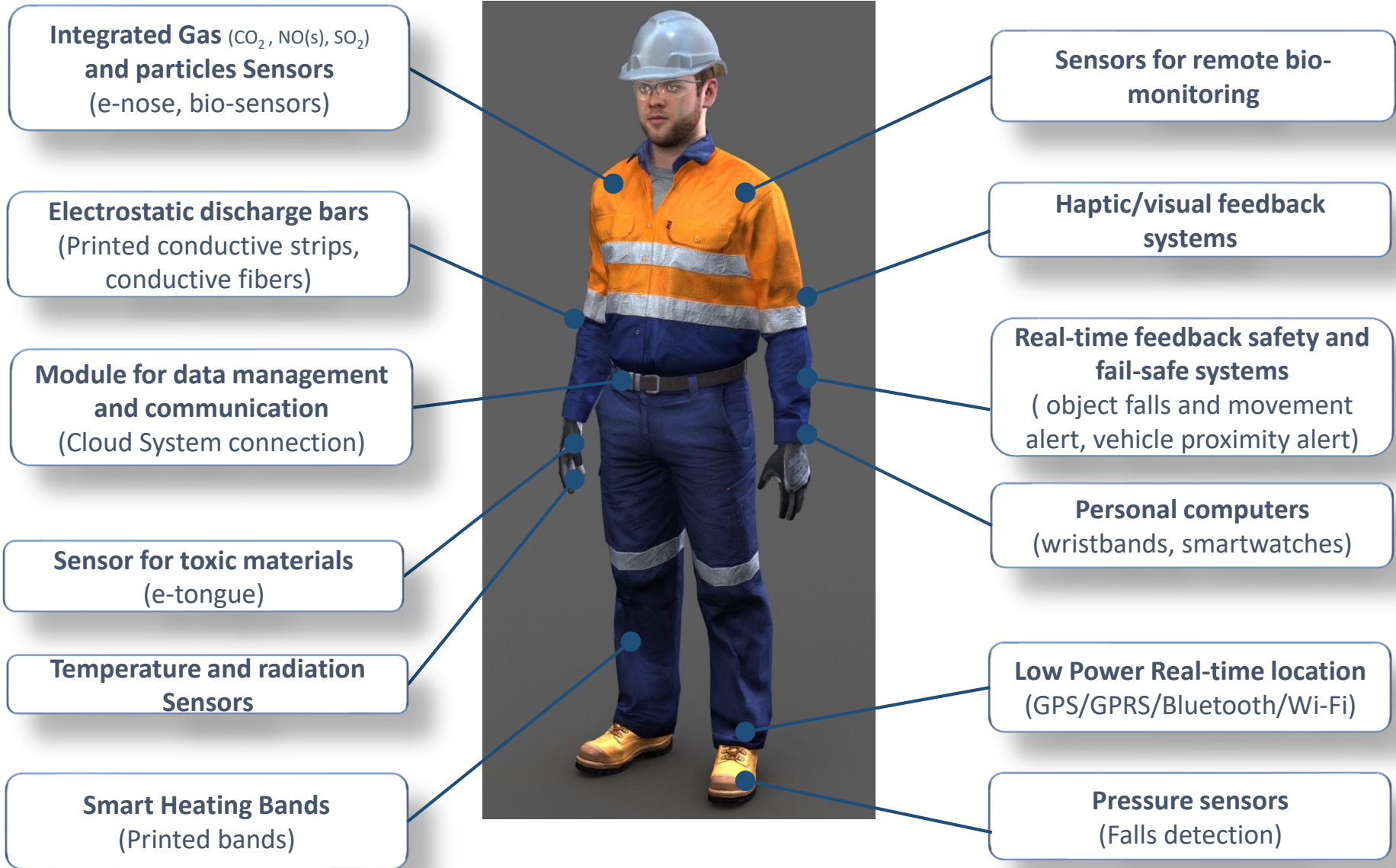


Ubiquitous interactivity – live devices:

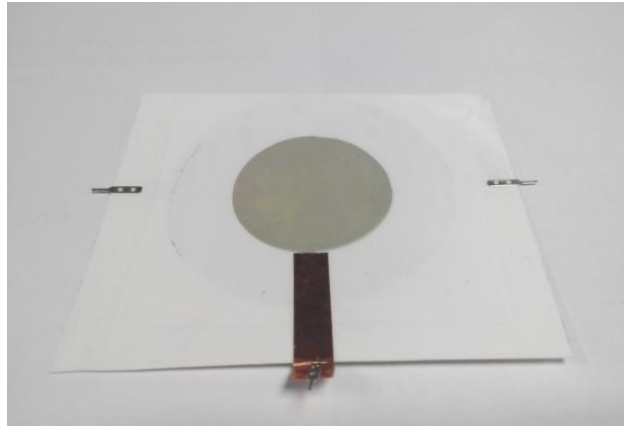
- Smart devices must generate data;
- Data must be communicated/transmitted;
- Data must be analysed;
- Specific value must be obtained from the data;
- Data must serve to aid human, or to increase value into day life
- Integration of actuation interface



ICT and IOT Integrated Technologies



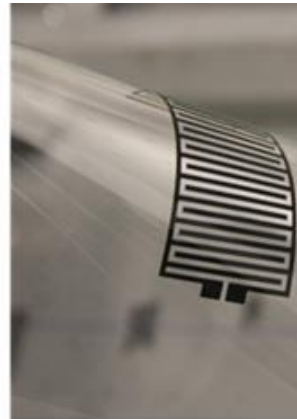
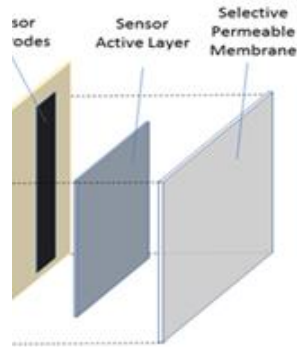
Printed and Hybrid Systems



- Integrated lighting and printed elements;
- Combination with SMD components (LED and micro processors);
- Direct printing and encapsulation of devices;
- Encapsulation enables the printed component to be washable;



WISEN

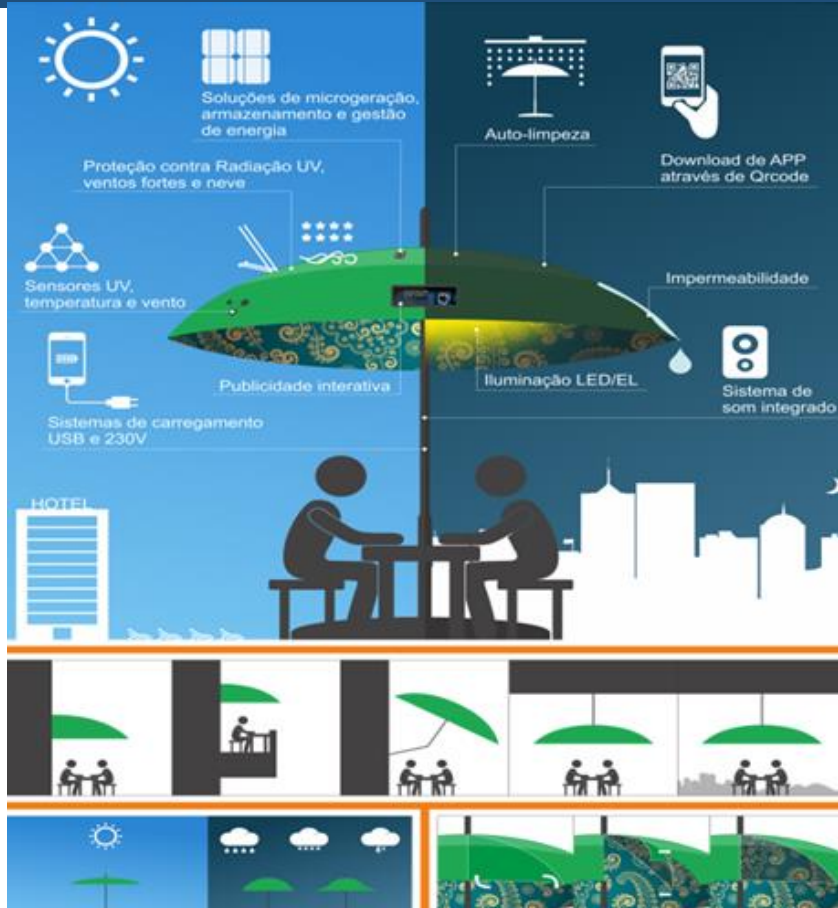


WISEN project aims to create an integrated solution of sensing and communication systems in industrial environments, namely for a waste management plant via:

- Optimization of a wireless data transmission architecture;
- Development of new sensors and respective integration solutions;



Home Textiles





- Synergies between traditional Portuguese sectors, such as the metal-mechanical and home textiles industries;
- Develop aptitudes in the area of embedded electronics in textile materials, increasing the quality of the products and strengthen the position of the companies in the growing market of smart materials and devices;
- Concepts:
 - Full Automation (solar orientation) and interconnection w/ other peripherals;
 - Energy Harvesting – Self Powered;
 - Integrated Lighting - Self-Lighting;
 - Autonomous management;
- Develop new design concepts of metal and dynamic structural modules.

① www.iparasol.pt



Smart Textiles - Automotive

Automotive Interiors Vision



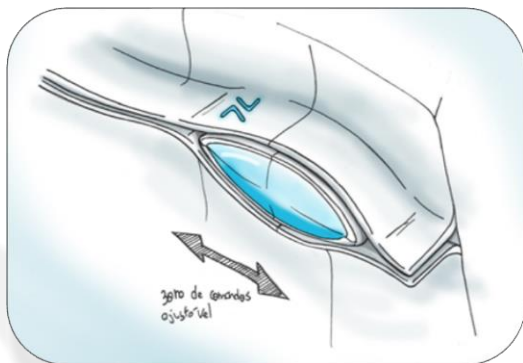
Clean Design



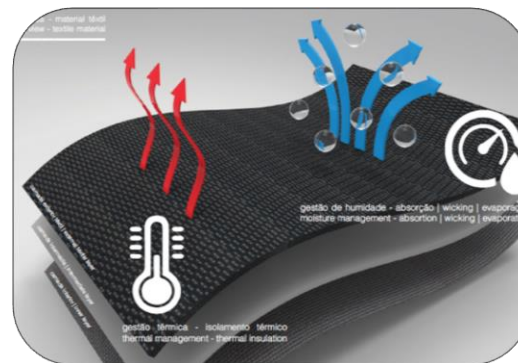
On Demand
Functions



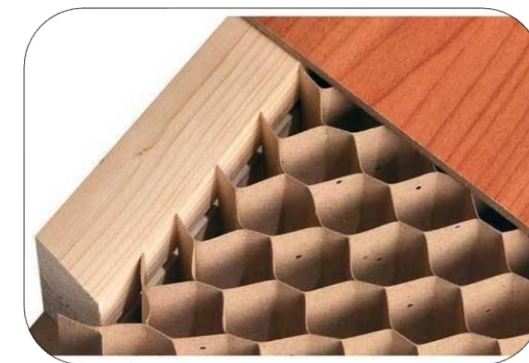
Seamless Feel



Personalize and
Adapt



Functionalized
Comfort



Sustainable
Structures

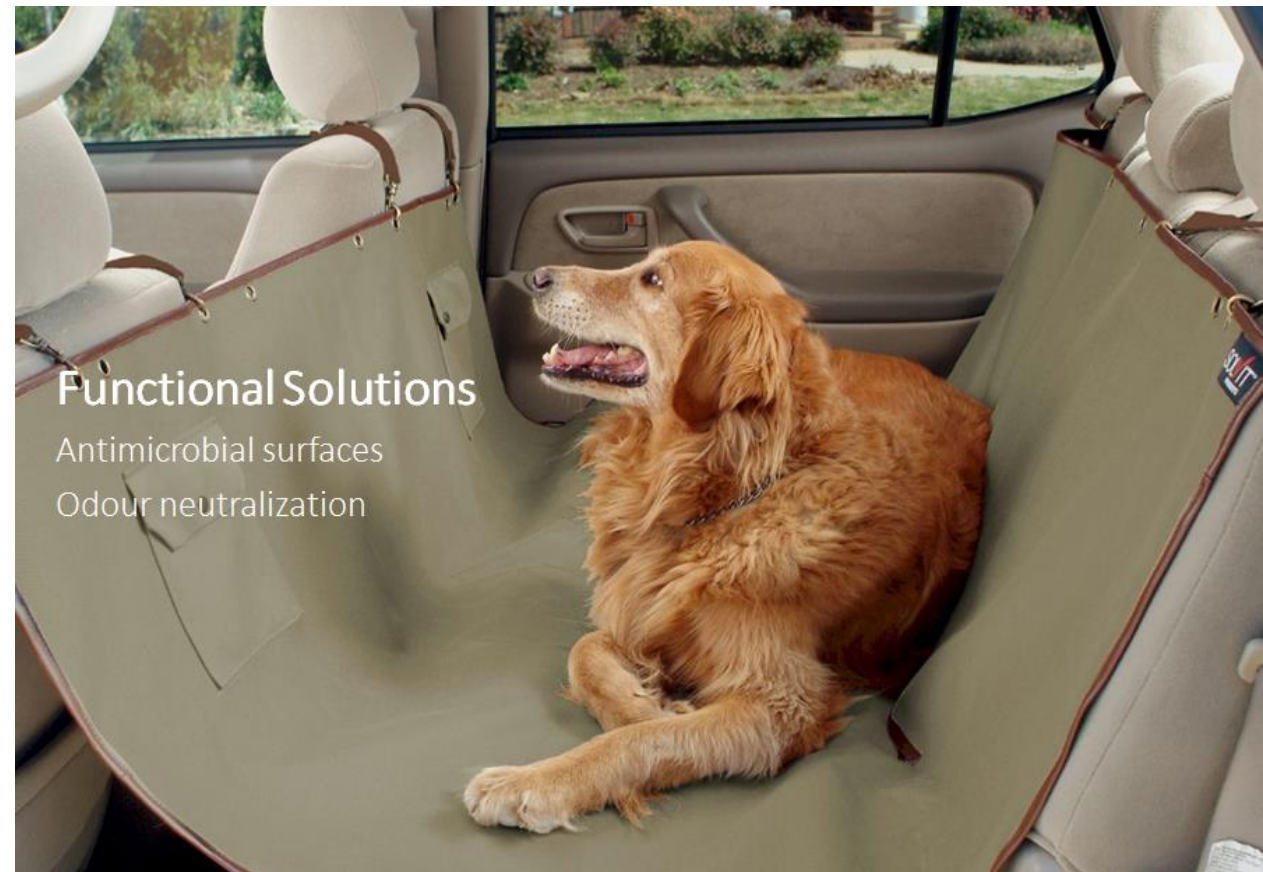


Surface Functionalization



Functional Solutions

- Water repellent
- Oil repellent



Functional Solutions

- Antimicrobial surfaces
- Odour neutralization

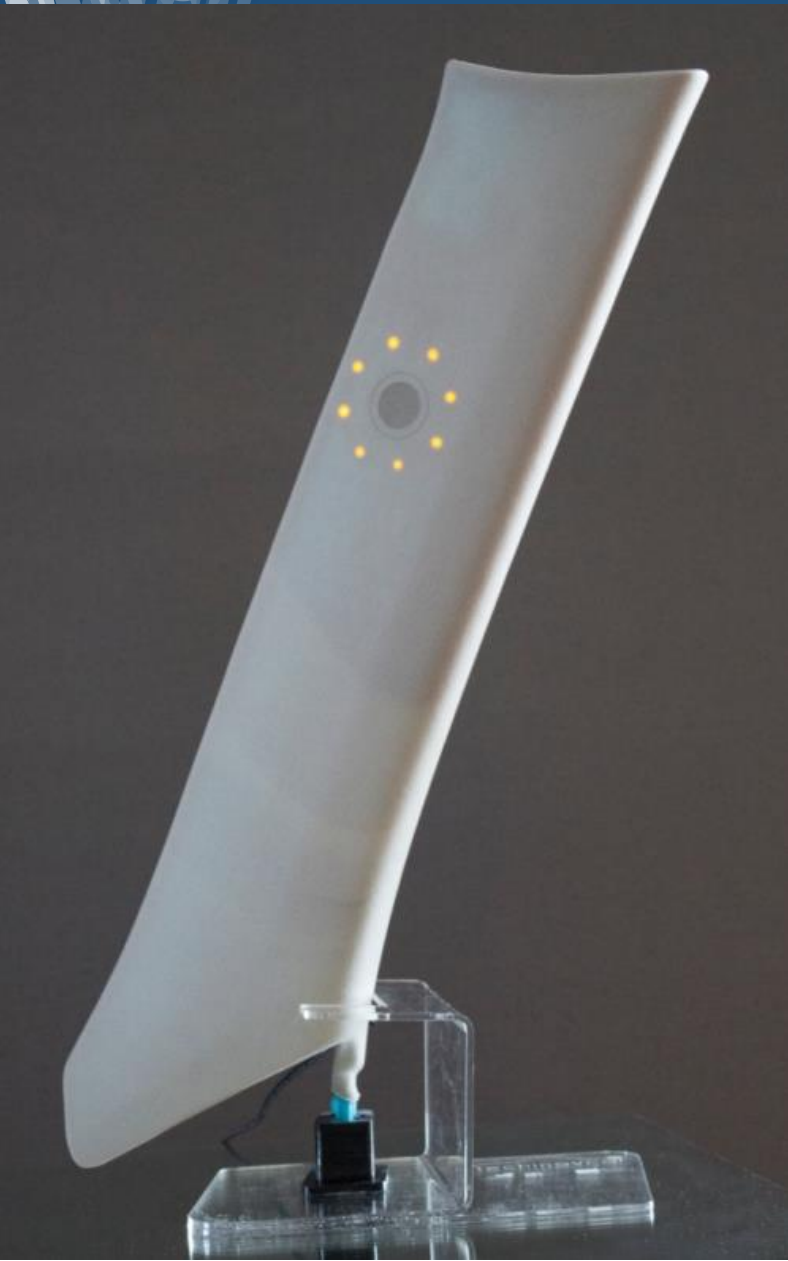


Interactive Translucid Artificial Leather Structures



- Direct printing onto woven and non woven structures;
- Stretchable membrane integration is achieved via thermoforming at 80°C and/or 120°C (for fully encapsulated devices);
- Direct printing and lamination of mechanically stable and stretchable silver inks are feasible for thermoforming and hot-press lamination;
- Integration of RGB LEDs and other SMD components feasible for hot-press processes;





No modification of industrial fabrication process;

Integrate lighting and actuators directly onto IM component;

Replace wiring and embedded systems with printed and hybrid components;

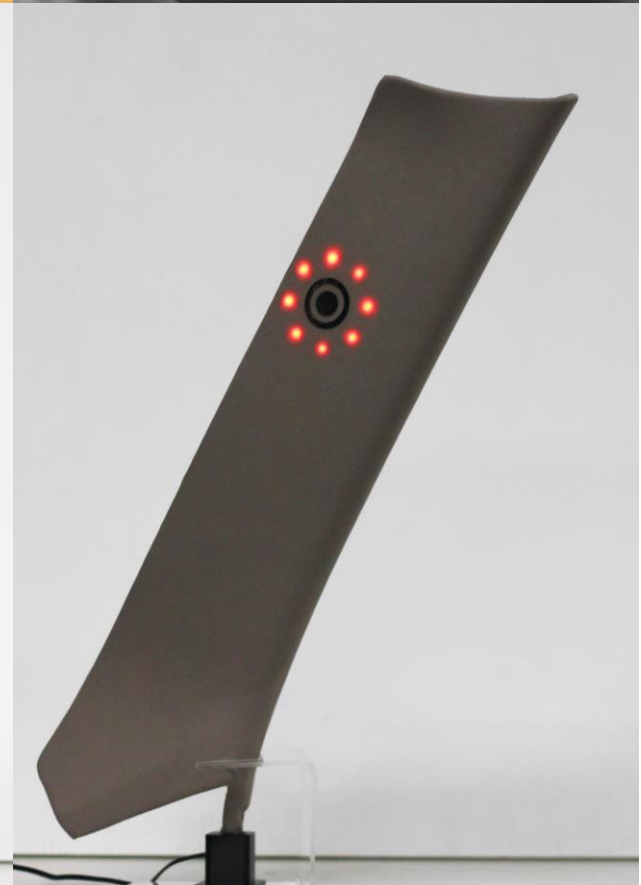
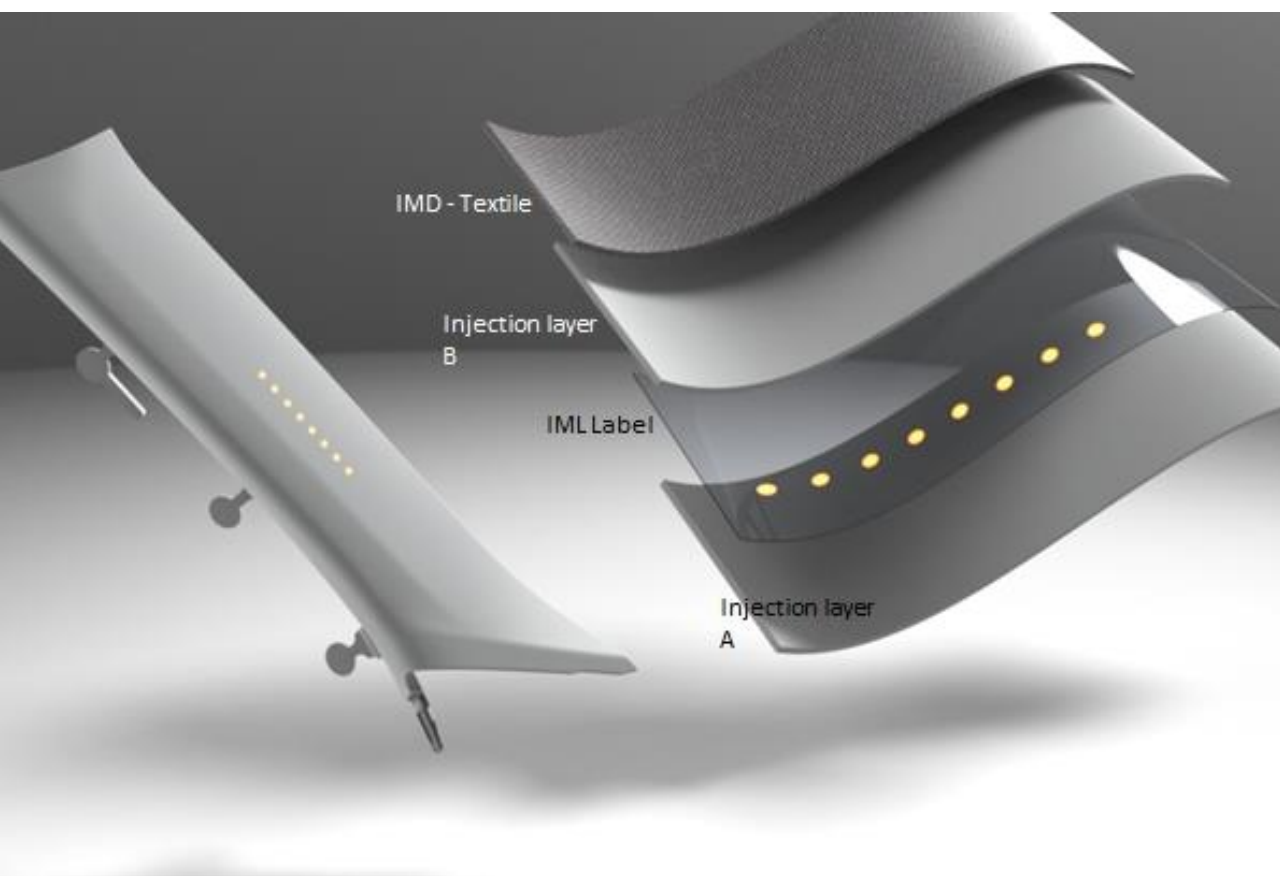
Validation in industrial production conditions (at shop floor);

Ultimate Goal – Integrated an LED display directly on the structure of IM Component via IML;



Gold Award Winner
<http://www.fespaawards.com/2016>

IML Process

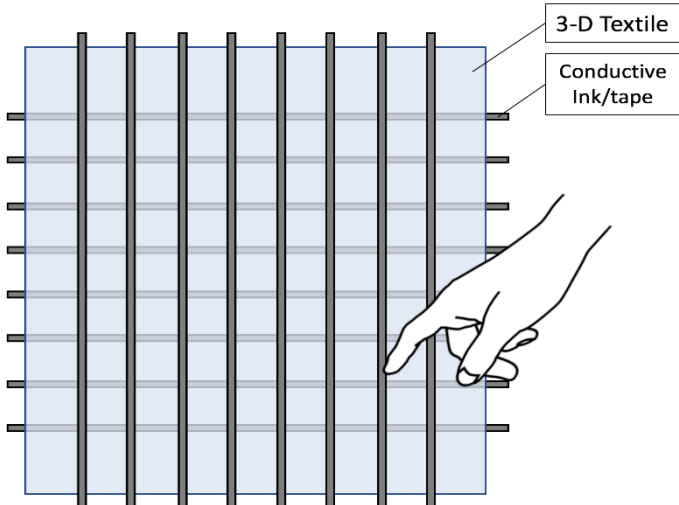
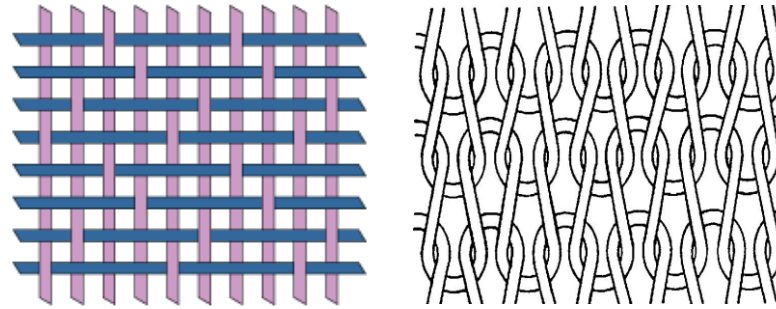




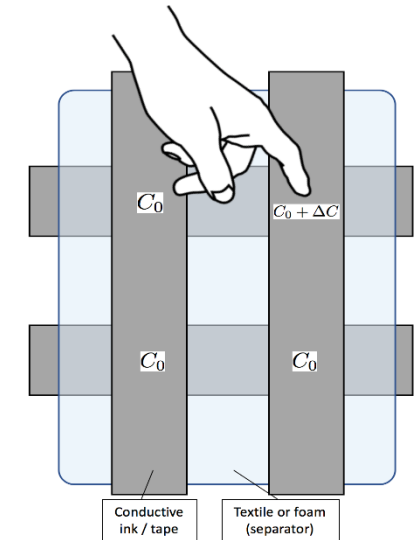
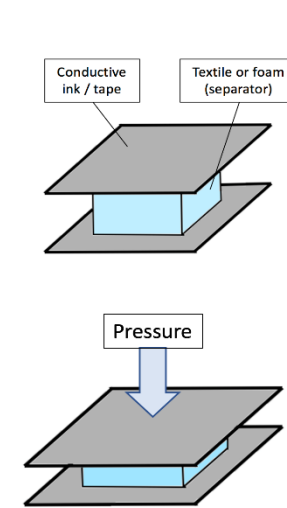
Textile Touchpad



Structure Approach

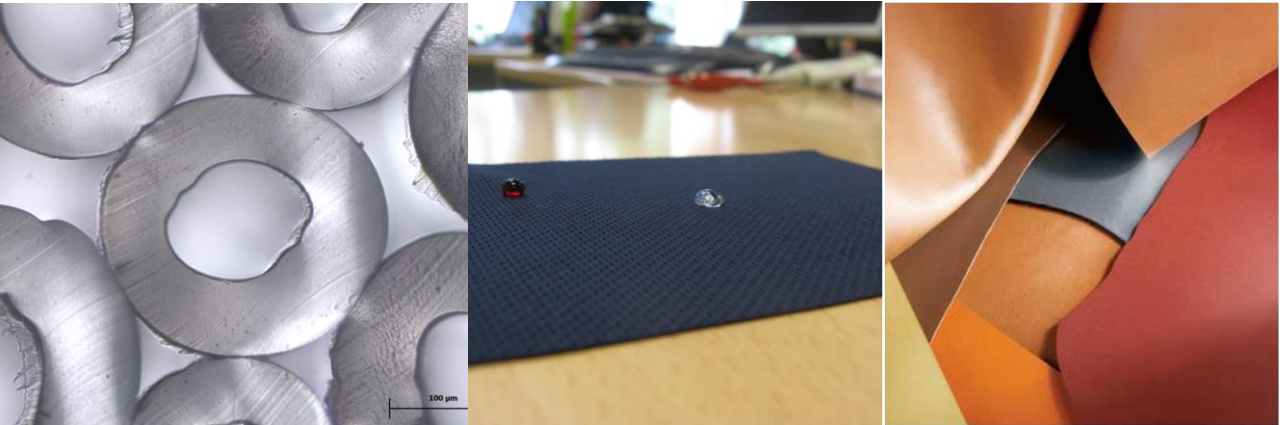
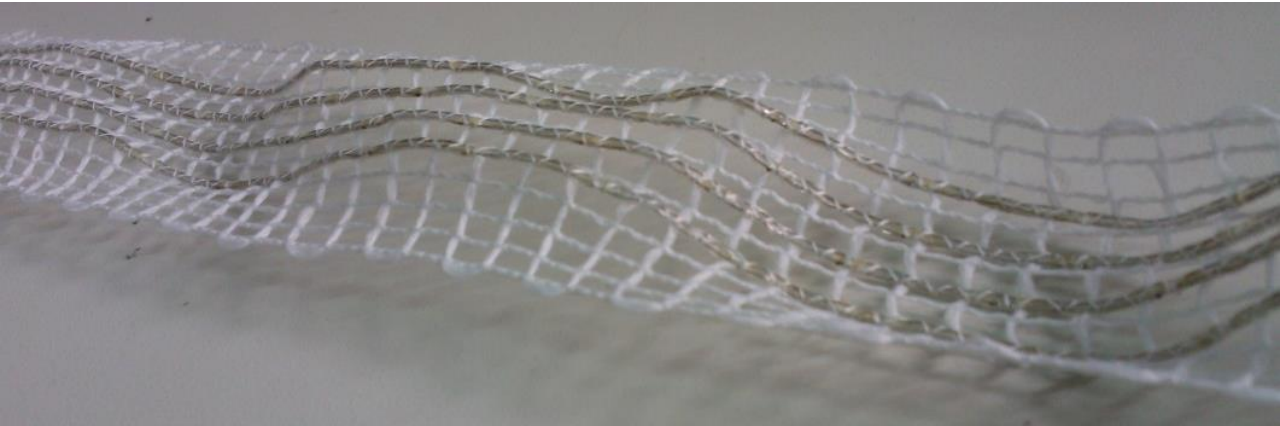


Surface Approach – Printed



- Textile Functionalization;
- Single and Multi-touch;
- Gesture/trackpad;
- Pressure sensitive;

Summary



- Integration of nanotechnologies into textile structures may be compatible and/or adapted to conventional high throughput processes;
- Adaptation or development of textile industrial processes may be achieved via pilot lines and/or pilot test beds to validate upscaling process;
- Continuous innovation in the field of materials engineering is key requirement for international competitiveness:
 - Digital process integration;
 - Digital product integration – ubiquitous continuously connected devices;
 - Digital Sustainability;
 - Materials sustainability;





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Thank you for you attention!

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