Wearable Textile System

Design layered intelligent materials

destex

Co-funded by the
Erasmus+ Programme
of the European Union

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Introduction

Wearables, initially stated as “wearable computing” can be considered as “***the study or practice of inventing, designing, building, or using miniature body borne computational and sensory devices. Wearable computers may be worn under, over, or in clothing, or may also be themselves clothes***” (Steve Mann, 2012)
Placed in between the digital and human world wearables have the potentialities to change the way we live and interact with each other’s thanks to the ***enhanced functionality of sensing, reacting, and/or adapting to stimuli in the environments*** to which they are exposed.

Wearables fall in many different categories: glasses, jewellers, headgear, belts, arm wear, wrist wear, leg wear and footwear are taking on new forms and functions but also skin patches and e-textiles.

In the Context of **DESTEX Project**, the present OER aims at giving knowledge related to wearables that falls into the category of **WEARABLE TEXTILE SYSTEMS,** the ones designed and developed using **Smart Textile**.

Keywords
Wearable, Smart textiles, Active textiles, Passive Textiles.

Goals

The OER aims at clarifying and answering questions and challenges posed by the use of smart textile in the field of wearable technologies.

The OER aims at investigating the following questions:
How can we design smart “wearable” textiles with no traditional materials but manufactured and shaped within a platform that embraces the electronics features? How can a designer shape smart textile into a clothing/wearable by considering both aesthetics and functionality? Do we need new approaches?

Structure of the OER

1. Smart Textile: definition
2. Application overview
3. Wearable Textile System
4. A working Platform
5. Approaches and Tools
6. Insight

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Learning Outcomes

With the OER the student will:

Knowledge

- *Theoretical Knowledge*: notions and concept in the context of smart textile, layered materials, and wearable technologies, fields of applications, approaches to design wearable by using smart layered textile;
- *Practical Knowledge:* design smart "wearable" textiles with using a layered system materials as platform that embraces the electronics features; shape smart textile into a clothing/wearable by considering user perspective.

Skills

- Ability to understand the user perspective VS the mere functionality of the materials
- Ability to coherently use the approaches to design new item using smart textile in wearable domain
- Ability to shape the new items (match with the correct fibres and materials)

1. Smart textiles: A definition

Smart textiles are defined as textiles (in the shape of shirts, socks, shorts, belts, etc.) that can sense and react to environmental conditions or stimuli, from mechanical, thermal, magnetic, chemical, electrical, or other sources to provide functions such as health monitoring and activity tracking. They are able to sense and respond to external conditions (stimuli) in a predetermined way.

Given, the diversified panorama of smart textiles, a clarification about the meaning of smart textiles is here needed. They can be classified as passive or active smart textiles.

Passive Smart textile are materials to which a specific function is added by means of material, composition, construction, and/or finishing (e.g., by applying additives or coatings)[1].

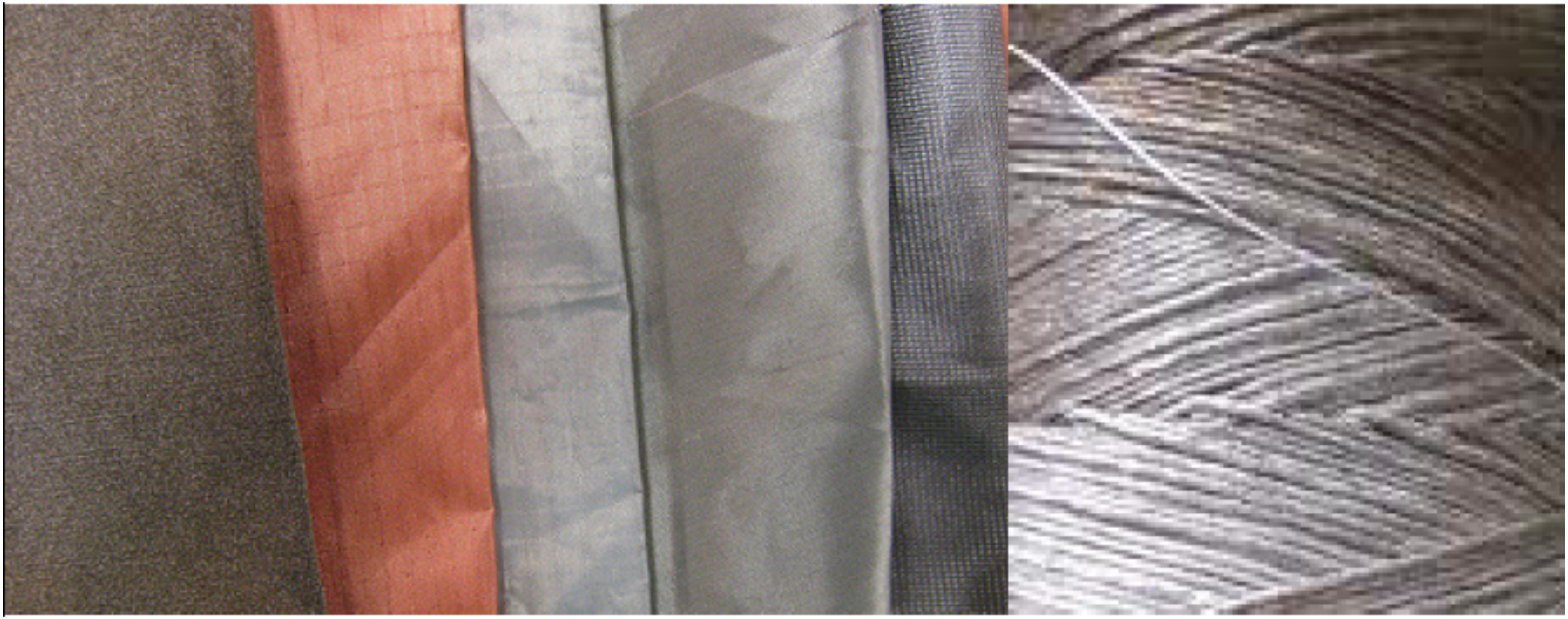
Active smart textiles, are those capable of sensing, reacting, and adapting to the environment or stimuli and integrate actuators and sensors [2].

Keywords

Smart textiles, Active textiles, Passive Textiles.

1. Cherenack, K. & van Pieterson, L. Smart textiles: challenges and opportunities. J. Appl. Phys. 112, 091301 (2012).
2. J. Vagott, R. Parachuru. An overview of recent developments in the field of wearable smart textiles. J Textile Sci Eng 2018, 8:4. DOI: 10.4172/2165-8064.1000368

2. Smart textiles: An overview

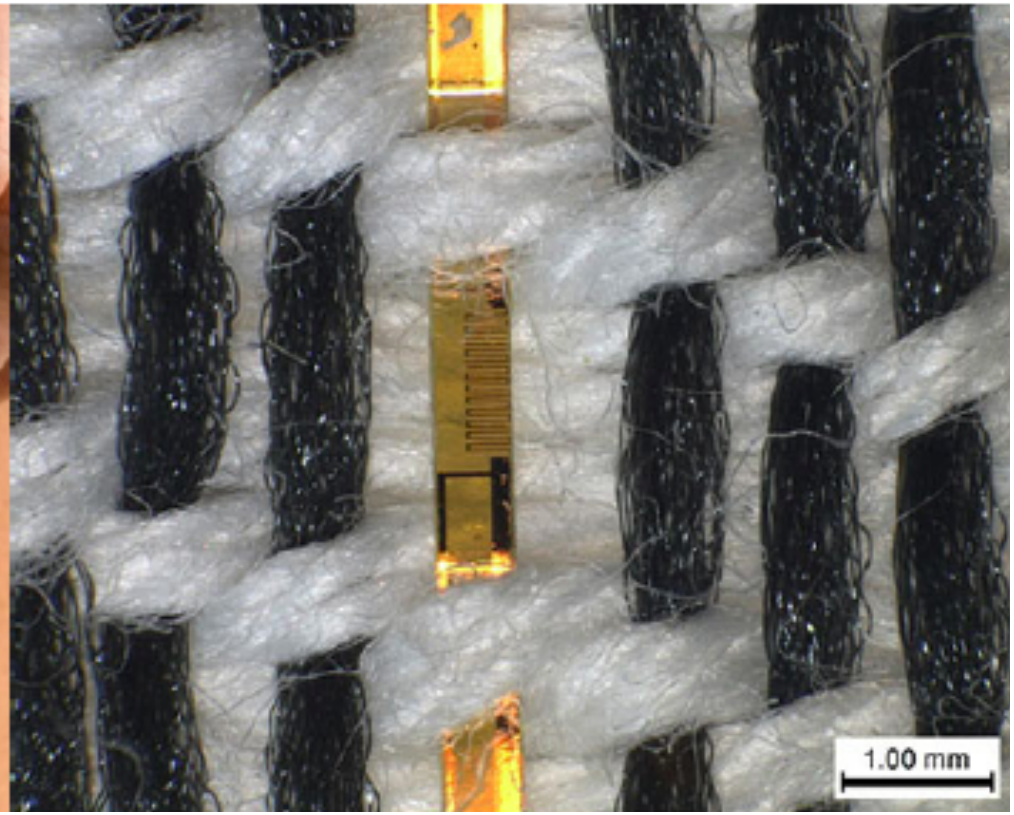


Conduct Electricity: Textile and Yarn able to conduct electricity

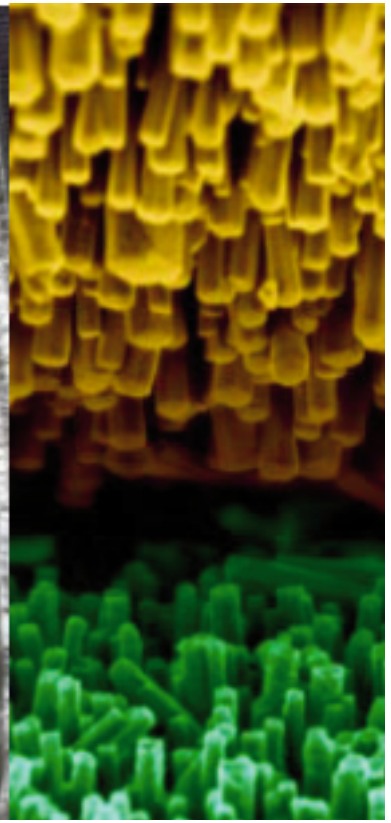
Color Changing

Lighting up

Sense Human parameters



Harvest Energy



3. Wearable textile Systems

The basic concept of a "***wearable" textile system*** consists of a ***textile structure that senses and reacts to different stimuli from its environment***. In a wide range, a smart textile system has a very simple structure thanks to which it' s possible to wear a technological apparatus with common clothes.

Wearable textile systems have been mainly designed and developed ***in health management and sports applications*** to collect data such ***as heart rate, sweat rate, breathing rate, muscle tension, posture status, location, and temperature***. For instance, they can sense the temperature outside and consequently warm up or cool down, based on the measured temperature.

Example of wearable textile systems applied into healthcare and sport.

Sportswear

In sportswear a wearable textile system promises to ***offer effective solutions for wearers who seek more detailed data about their fitness and performance***. Smart textiles can also increase the comfort level of the user and eliminate the use of bulky equipment such as chest straps. Since athletes and major league players constantly strive to improve their performance, an opportunity of storing data for analysis by lightweight devices that can be embedded in their sportswear offers a high potential for further performance enhancement.

Example of wearable textile systems applied to sportswear.

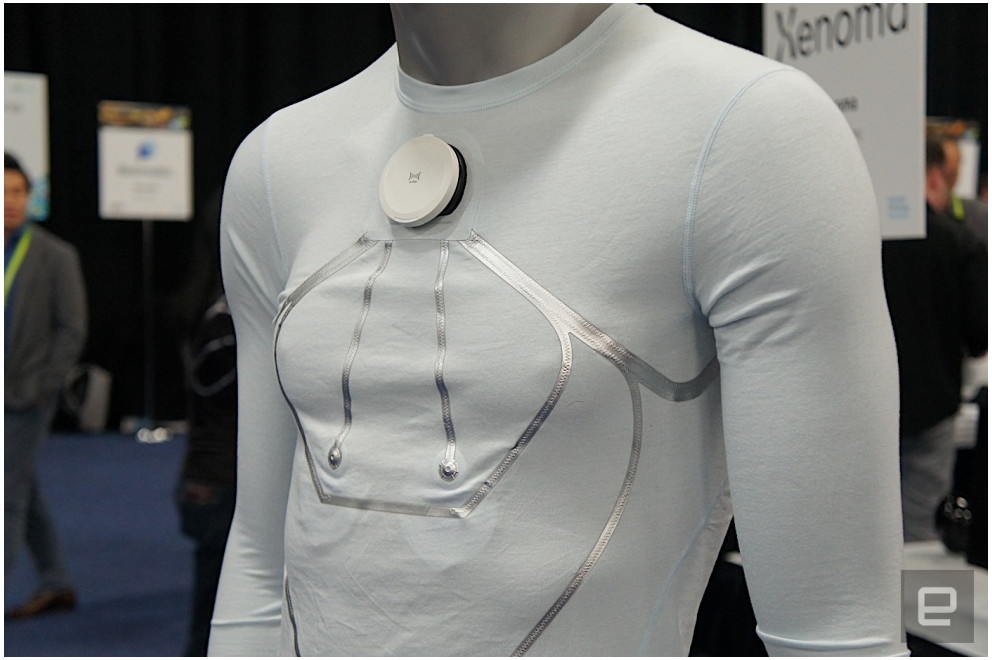
Sportswear

Specifically, technology-enhanced sportswear, including compression garments designed to and muscle recovery, can provide an appropriate medium for carrying large numbers of sensors close enough to the wearer's skin, to pick up the weak electrical signals generated by physical effort. Multiple extra data types, in addition to ***heart-rate electrocardiogram (ECG) signals***, can be collected today, including ***electromyography (EMG)*** for analysing muscle activity. Furthermore, accurate body-temperature monitoring can be useful for monitoring fitness and can also protect the wearer against the dangers of over exercising

Example of textile sensor to detect muscle activity.

Medical and Healthcare

Medical applications of wearable textile systems include the monitoring of patients' vitals such as ***temperature, hearth rate, respiration, stress and sleep levels*** and so on. In the medical field, the wearable smart textiles integrated with could monitor vitals such as body temperature and heart rate. ***Electrodes manufactured and directly integrated into the wearing surface such as Piezoresistive fabric sensors*** can be used to monitor the posture and movement of the wearer. These electrodes allow for the monitoring of medical patients over extended periods of time, as the fabric electrodes are reporting the data while the electrode-infused clothing is being worn.



Piezoresistive sensors manufactured into flexible textile

4. A working Platform

Smart textiles application in wearable domain appears to be very diversified and based on research, which has its foundation in different research disciplines: ***textile design and technology, chemistry, physics, material science and computer science and technology***.

Designing wearable that embrace smart textiles means to consider the material per se as a **designed/shaped form/object having** a ***hybrid layer*** that combine various functional fibres (with differing degrees of complexity) with attached integrated circuit components and off-the-shelf sensors.

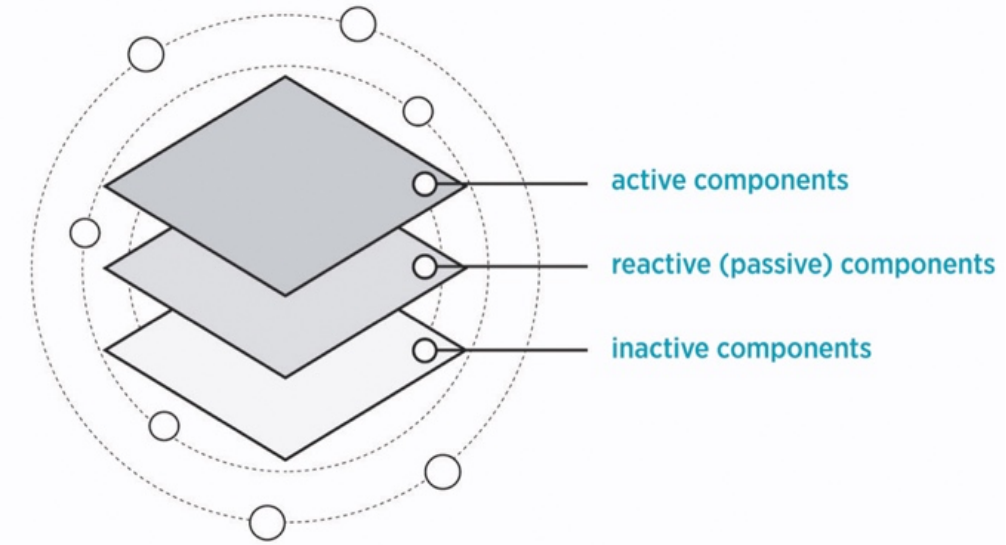
This is for sure possible thanks to ***three main technological drivers***:

1. The introduction of new type of textile fibres and structures for example conductive materials;
2. The miniaturisation of electronics, which makes possible to integrate electronics into textile structures and products;
3. Different kind of wireless technologies enabling the technology to be wearable and at the same time communicating with other devices such as computers or mobile phones.

5. Approaches and Tools

When it comes to wearable textile system a practitioner needs to design the all layered system by considering human factors and skin requirements by having: ***a moisture 'base-layer' or the so-called 'second skin',*** a ***middle insulation layer***, for breathability reason and ***a protective outer layer***.

A schematic wearable textile system can be identified through various hierarchical components through a new category of material called ICS Materials . ICS Materials are defined as systems combining inactive materials, active stimuli-responsive smart materials, and proactive materials (Parisi et all, 2018) and shaped exactly as the layered system that answers user demands and acceptance.



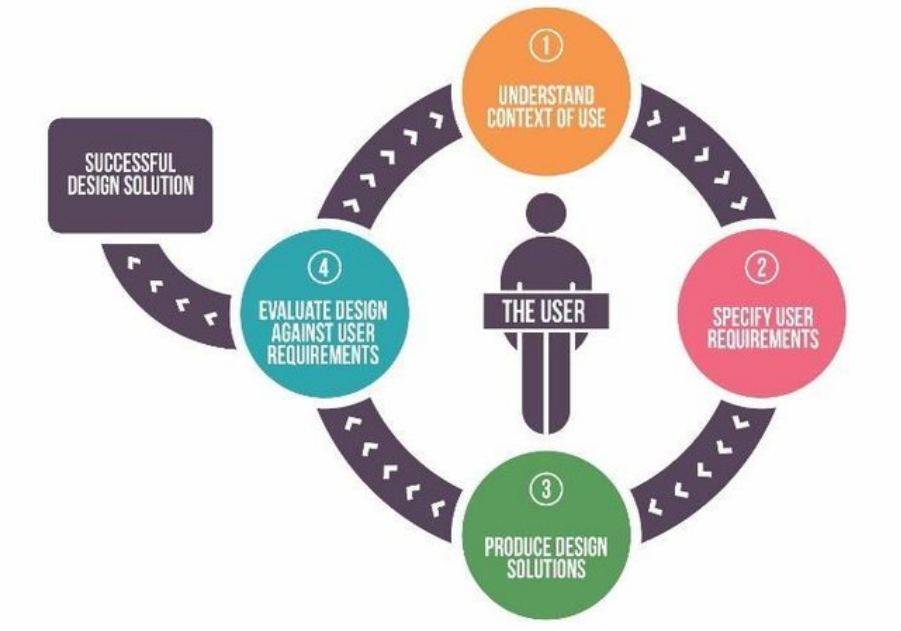
Layered System

5. UCD Approach

The hybrid layer system required for the wearable textile system needs to meet both technological and aesthetic/acceptance requirement. This class of materials as all ***the different recent technologies change the way people behave and interact defining also the behaviour of artefacts, environments and systems*** (Forlizzi et al, 2004).

It is therefore crucial to design them, as they uncover new modes of interaction as well as new ways to engage, entertain and inform people.

Based on this ground, a user centred approach (UCD) is required. I***n an UCD approach, users appear as the ultimate experts, those who can properly assess design prototypes, propose changes, and ultimately, integrate end products within their routines*** (Assis HS, 2009)



6. Insight

Design and developing wearable textile systems means to take into account functional elements (realm of engineers), but also the features needed to involve users. For instance, ***for sports, fitness and health purpose social acceptability will be*** enhanced if they enhance an individual's social status as well as providing the functionality needed.

By considering smart materials as ***a working platform that generate the end product (wearable)*** a set of requirements need to be met:

- **Responsiveness to end-user;**
- **User centric ergonomic functionality: a new term – 'wearer ware' – may be needed to fill a gap in terminology;**
- **Wearer comfort (weight, bulkiness, flexibility, skin-friendliness);**
- **Ease of care & maintenance (wash-ability, repairability)**
- **Connectivity to and from the platform;**
- **Support for a diversity of sensors.**

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Visit http://destexproject.eu/ to see the rest of the intellectual outputs of the project

Acknowledgement:
DESTEX project (INDUSTRIAL AND CREATIVE DESIGN IN ADVANCED TEXTILE MANUFACTURING; project reference number 2019-1-SE01-KA203-060379) is co-funded by the Erasmus+ programme of the European Union.

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