Smart clothes can improve occupational safety

”Smart clothes” are clothes that employ new technologies: technological developments have made it possible to integrate electronic components into conventional garments. In demanding conditions, such as working in heavy industries, very specific demands are placed on work apparel and materials, as they must protect the wearer from any hazards found in the working environment. Smart clothes design offers new material technology applications to make work apparel safer and more specifically suited to the work and environment in question. Smart clothes also make it possible for the wearer’s vital functions to be monitored, using, for example, an electromyograph (EMG).

The goal of the Academy-funded Models for Intelligent Garment Design (MeMoGa) research project is to develop methods and models for the research and design of smart clothes as well as to study matters related to their usability and social acceptability. The MeMoGa project approaches new, multidisciplinary research fields through the research of clothing design, fibre material technologies and physiology.

The material applications used in new types of work apparel include impact-protective materials, which can be divided into two categories: phase change materials (PCMs) and auxetic materials. "One example of phase change materials might be d3o, which is made of ”smart molecules”. Phase change materials move normally with the body, but when impacted, they protect the wearer by instantly hardening and then returning to their normal state once the impact load is released," explains researcher Mailis Mäkinen. Auxetic materials, on the other hand, are energy-absorbing materials, whose cross-section expands when stretched. "Auxetic materials include metals, ceramic or polymer materials or composites. These materials withstand pressure better than standard materials," says Mäkinen.

Many challenges facing the adoption of new materials

There are many challenges facing the use of new materials. The use of innovative new materials and integration of electronic and other types of components into garments requires, for example, the development of new types of testing methods and standards.

Furthermore, the development of materials, such as their mechanical properties, temporal durability or functionality in various conditions, may take a long time.

Garment-integrated electronics or other types of components in particular present problems in the washing or maintenance of the garment. In many cases the high cost of new materials discourages their adoption.

User needs and desires play a key role in the development of smart clothes

The needs and desires of work apparel users are surveyed before beginning the design of smart clothes, in order to ensure that the design will meet the user’s needs as effectively as possible. Before the design phase, it is important to identify the user as someone who is generally open to the use of technology and understand in what way a new technology, such as electronic components, change the user’s perceptions of the garment. This helps to predict how the technology should appear in the garment, i.e. how invisible or visible it can be.

A crucial part of ensuring the user-orientation of smart clothes is a usability assessment. A virtual prototype was developed for this purpose in order to allow end users evaluate a still non-existent smart garment before actually building the actual, physical prototype. "A virtual prototype involves such material as 3D

models and 3D animations, which are used to present a realistic iteration of the prototype to the user instead of just showing them conceptual drawings. Animation makes it possible to show how the prototype will be used in a working environment, which demonstrates the smart garment's possible uses in a heavy industry environment," explains researcher Riikka Matala. The goal of assessment is to make the user a part of the design process and possibly reduce the need for producing expensive (at this stage of development) and time-consuming physical prototypes.

Intelligent garments are being studied as part of the Academy's PROACT Research Programme

The University of Lapland Department of Textile and Clothing Design, Tampere University of Technology Institute of Fibre Material Science, and University of Kuopio Department of Physiology are participants in the MeMoGa research project. The project is part of the Academy of Finland's Proactive Computing (PROACT) Research Programme.

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