WORKSHOP: SMART DESIGN FOR HUMAN PERFORMANCE

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This paper introduces the brainstorm on Smart Design for Human Performance. New available technologies challenge ergonomists to use these technologies to improve working life. This can be realised by creating smart work equipment or a smart work environment by integrating sensors. The main goal of smart products is that they improve the human performance by providing adequate feedback, i.e. they prevent health problems, provide comfort and increase productivity. Examples of smart work equipment are the E-seat and the Hoverstop mouse. During this workshop, we take a step into the future by exploring new possibilities for smart solutions.

Brainstorm, Smart products, Embedded intelligence, Future applications

1 Let's get smart!

The future starts now! The challenge, ergonomists are facing today is to utilize new available technologies to achieve their common goal: to provide a healthy work place, which improves the feelings of well-being and increases the productivity of employees. New technologies give us the opportunity to design smart or intelligent workplaces and work equipment. These technologies may help the employees to change their (unhealthy) behaviour or to support their work process. The other side of the coin is that employees are exposed to just another source of information, which increases the mental work load. As ergonomists we should be aware that Smart Products are applied in a way that they support the employees and that they do not cause extra work load.

2 For instance…

The *E*-seat and the Hoverstop mouse are examples of embedded intelligence at the office, the latter being operative, and the first still in the process of development. The *E*-seat is an office chair, which recognizes the employees' posture and postural changes. When a posture is held for a too long period of time, the seat will warn the employee by vibrations in order to stimulate him or her to change posture or to go for a walk. This will avoid that people will sit too long in an awkward posture, which is associated with musculoskeletal complaints. In addition, the *E*-seat could be used to support the work process in a control room. Warning signals can be given through vibrations in the chair, instead of adding another button or flashlight in the control panel. Or think of adding sensors in the driver's seat of a truck, which warn the driver just before he falls asleep or crosses a line.

Figure 1 TNO's idea of an *E*-seat. The small dark spots are pressure sensors and the bigger light dots are vibrating parts

The Hoverstop mouse notices if the workers' hand is lying on the mouse or hovering above the mouse without performing any mouse clicks. This is an undesired behaviour as it can cause musculoskeletal complaints of the upper extremities. The mouse will start vibrating when the undesired behaviour occurs and the worker will release the mouse. A field study indicated that people who use this mouse change their behaviour and that the time their hand is hovering decreases.

Figure 2 Hand hovering above the Hoverstop mouse

An example of embedded intelligence outside the office is the electronic torque wrench. This wrench gives a visual, audible and perceptible signal when the OK band of applied torque is reached. This tool is used where quality demands specific torques, like in the automotive, aviation and support industry. Another example in the industry is the so-called Intelligent Work Assistant Device), which is a new kind of manipulator giving servo-assistance in welding operations in the automotive industry. Perception enhancement is achieved by the use of haptic devices in order to give the operators more precision and speed in the welding task and a better feeling of comfort. The tool is under development in the European project CyberManS.

3 What will make products smart?

Products can be made smart by built-in advanced sensors. For instance, the I-phone's *accelerometer* detects when you rotate your phone from portrait to landscape and then it immediately changes the content of the display. The *proximity sensor* detects when you lift up

your phone to your ear and switches off the display in order to save power and prevent inadvertent touches. The *ambient light sensor* adjusts the display's brightness to the appropriate level of the current ambient light.
The function of built-in sensors can be illustrated by posing the questions they can answer: What is this? Who are you? How are you? What are you doing? Is anyone there? What happens in there? Am I finished? The answers to these questions are intended to provide people with adequate feedback on his or her behaviour. The ultimate goal of this feedback is to increase the people's well-being and productivity

What is this?
Products can be recognized by reading the RFID-tags by using a RFID tag reader. When all products in the storage room are equipped with a RFID-tag, the boxes do not need to be opened to count the supply. Barcodes and barcode readers are used to identify products in the supermarket and to calculate the prices at the cash desk. Shapes, colours and movements of products can be recognized from videotape using the Automatic Video Compilation and Analysis System (AVCAS). This system fully automatically recognizes specific events like a car crossing a barrier.

Who are you?
People can be recognized by the same method as products, namely by using a RFID-tag. Advanced videotape analysis software can recognize peoples' faces and movement patterns. Iris scans and fingerprint scans are other methods to answer the question: who are you?

How are you?
In order to answer this question several measurements on the human body can be performed, like, hear rate, blood pressure, skin resistance, ECG, EEG, body temperature, face temperature, muscle activity (EMG), eye movements, gaze direction, oxygen consumption and breathing frequency. These parameters can tell us if somebody is doing fine, if he is tired, suffers from stress feelings etc. Not all relationships between "how we are" and these parameters are clear and well subscribed by research results.

What are you doing?
Peoples' activities and performance can be measured in several ways. Force exertion can be measured (for instance when using tools) and position, speed and acceleration of body parts can be quantified. In addition step counters count your steps when you walk. The way in which the computer keyboard and mouse are used can be registered using special software. Moreover, techniques are available to see how people are interacting during a meeting. The contribution of every person can be visualised. For instance, the amount of contributions during a time period, the amount of words that are contributed and the contents of the contribution can be analysed.

Is anyone there?
Sensors can feel or see if anyone is present. Think of all kinds of security devices: air pressure changes, movement detectors and infrared cameras. If someone sits on a chair, pressure sensors can detect this. A hand hovering above a computer mouse can be registered by a disturbance in the electrical field. Furthermore, one can see if someone is there by using video registration that automatically switches on if someone moves into the view of the camera.

What happens in there?
Measurements of light, noise, noise patterns, air temperature and air pressure give information about what happens in a room. Gas concentration and dust concentration in the air can be measured.

Am I finished?

This question deals with if the task if finished or performed according to the standard or not. For instance, the electronic torque wrench gives a signal when the applied torque reaches the OK band. Another example is the park distance control system, which indicates if the car is parked in an optimal distance regarding the other cars or obstacles.

4 How can smart products contribute to working life?

This is the main question that we will answer during this session. The main goal of the workshop is to collect ideas of ways in which embedded intelligence can be integrated in the work situation, in order to stimulate employees to work in a more healthy, efficient and comfortable way. The workshop will start with a short introduction on the goal of the brainstorm and examples of embedded intelligence will be presented. After that, the group will split up into two or three smaller subgroups (maximum 15 persons). Each group will have a brainstorm on one field of work (i.e. office work, manufacturing sector and transport) and on one of the following questions, which can be answered by embedded intelligence, namely “how are you?”, “Am I finished?” or “How well am I doing my task”? After that, we come together again and a representative of each group will present the outcomes of the brainstorm to the whole group. The results of the brainstorm will be summarized and if there is any time left, we can discuss how the impact of embedded intelligence on health, well-being and productivity can be measured.

No special skills are needed for this workshop. Just be creative, think open-minded, be active and join us with this step into the future!

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