Eco-design of a large-area wireless sensor system based on smart textiles

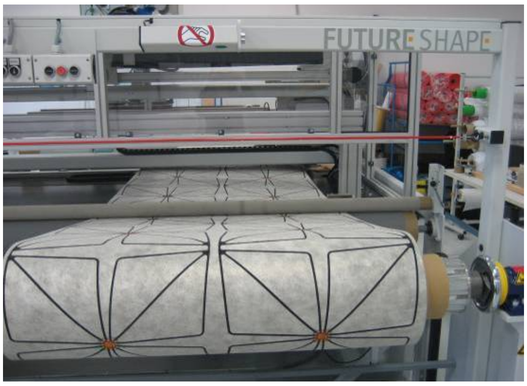
The sensing floor is a smart textile application that introduces intelligent functions unobtrusively in the user's daily living environment. A Life Cycle Assessment (LCA) was carried out to support environmentally conscious decision-making in the course of product development. The results suggest that the system's electricity consumption during its use phase is the most relevant environmental aspect and that a 2.5 mm thick polyester fleece has the highest environmental burden of the materials in the product. This leaflet presents the experiences of a small company with conducting a LCA.

Future-Shape transforms the vision of Ambient Assisted Living into useful, practicable applications. We specialize in sensor systems, which can be seamlessly integrated into large surfaces such as floors, glass panels and walls and so give these surfaces entirely new functions. We develop products that assist people in their everyday lives, which are, ideally, completely hidden from view. We add an interactive dimension to surfaces and objects, and offer a wide choice of sensor surface materials including textiles, metal, metal-coated plastic, and even glass. This technology provides a platform for new services in the field of building automation, comfort and convenience, and personal safety.

For our customers, we do not only develop large-area sensor systems but also take care of controlling the appropriate actuators, developing the application software and the connection to existing home automation systems. We also help to develop a suitable interconnect technology.

Life cycle assessment has made us aware of the environmental improvement potential of our product. Through LCA we became aware of cork as an eco-friendly base material for the SensFloor and we were directed to save energy during its lifetime through improvements of algorithms in our product firmware.

Christl Lauterbach, **Future-Shape**

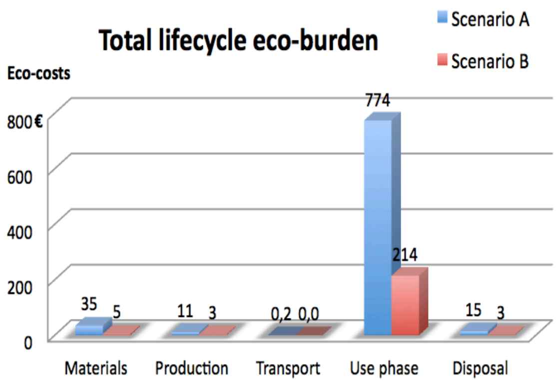


SensFloor - Principle, Applications and LCA

The sensing floor system is an example of an emerging technology that is referred to as pervasive computing. This innovation is characterized by unobtrusive integration of information and communication technology (ICT) in every day objects to make them smart. Smart objects enable the idea of Ambient Assisted Living as they provide their users with functions such as personal safety, health protection, and comfort. Textile objects can host smart functions, as they are ubiquitous in the daily living environment. Carpeting, for instance, is a common building interior material. The sensing floor is a smart textile application that is invisibly integrated the textile underlay of carpets or laminates. This system can be used to support elderly people in their daily life and extends the time they can stay independently and safely at home.

Future-Shape is interested identifying the environmental improvement potential of the SensFloor technology. This is possible by undertaking a LCA, which is a compilation and evaluation of the inputs, outputs and the environmental impacts of a product throughout its whole life cycle. However, conducting LCA prior to the product commercialisation is not easy, in particular for small enterprises (SME). The early stage of an innovation process is characterised by a high degree of uncertainty regarding technology specifications, materials and processes, product functions and product use. Information on materials and production processes, being indispensable for the compilation of a life cycle inventory, are often unavailable due to the novelty of the technology. Moreover, life cycle modelling is complicated due to lacking experiences on how future products will be used and disposed of.

Therefore, Future-Shape made use of the LCA to go tool to determine the most suitable eco-design solution for the SensFloor. In order to choose the environmentally preferable design, Future-Shape used simple input data to calculate the eco-costs of different application scenarios for the SensFloor.



Scenario A (blue)
SensFloor 30m², 20 year use: Ambient Assisted Living for elderly people + automated heating and lighting control.
Scenario B (red)
SensFloor 4m², 20 year use: Entrance area of a university lecture room + automated lighting control

One possibility to save energy is the reduction of the SensFloor's spatial resolution. A reduced resolution of 2 modules per square meter is sufficient for most applications. This saves 50% of the power consumption. A second way is to switch off the radio receiver of the microelectronic modules. It is only needed right after powering up the SensFloor. By automatically deactivating the receivers about 10 minutes after power up the consumption can be further reduced down to 170 mW/m^2. By implementing all energy saving methods simultaneously the power consumption can be reduced down to 8mW per square meter. Further technical investigations will be undertaken to select an optimal reengineering strategy for the sensing floor. The goal is reducing the power consumption as much as possible while maintaining a product quality that is sufficient for the respective application scenario.

Hardware redesign

Cork slab was tested as a substitution material for the 2.5 mm thick polyester fleece, being the component with the highest environmental relevance. The component serves as a surface levelling material and capacitive spacer, which requires specific dielectric properties. Various commercially available cork materials were compared. A 3mm thick cork insulation slab was found to be technically and economically viable. A LCA-based comparison confirmed the environmental advantage of cork slab over polyester fleece (Table 2). Cork, being a bio-based material, has lower eco-costs and a lower Product Carbon Footprint than polyester.

	Polyester fleece		Cork	
	Eco-costs €/m²	Carbon footprint kg_{CO_2eq}/m^2	Eco-costs €/m²	Carbon footprint kg_{CO_2eq}/m^2
Raw material production	0,90	3,3	0,02	0,07
Manufacturing	0,01	1,0	0,18	0,8
Use	0	0	0	0
Waste disposal (incineration with energy recovery)	0,13	0,7	-0,14	-0.8
Total	1,04	5	0,06	0,07

Eco-design of the SensFloor

LCA to go

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