INNOVATION

Innovation and Design for Sustainability

SInnDesign

Sustainable Innovation through Design

BACKGROUND MATERIAL

Innovation and Design for Sustainability

SInnDesign
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This module is part of the training materials developed in the SInnDesign project.

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Disclaimer

Lifelong Learning Programme

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Contents

1. Objectives of the module

- To explain what product innovation is and how it relates to sustainability and design;
- To present the different levels of innovation and how they relate to *factor X* thinking;
- To establish the relationship between the different innovation levels and the SInnDesign modules and tools.

Keywords: Product innovation and sustainability; Organizational innovation; Incremental innovation; Radical innovation; Factor X; Product-service systems

2. Introduction to innovation

Innovation[1] is a broad concept that can be used in many different contexts, and therefore there are many definitions of innovation. When one thinks about innovation, the immediate idea that pops into mind is "**new**": new technologies, products or services, new processes, new markets, new organizational structures and management, new businesses, etc. But "new" is not all, the concept of innovation also embraces the idea of being "**successful**", in the sense that it has some impact in the market or in society.

Innovation: something original, new, and important in whatever field that breaks in to a market or society (Frankelius, 2009)

In the context of **design for *sustainability***, the focus lies on **product and/or service innovations** that contribute to achieving a long-term balance between the economic, environmental and social pillars of *sustainable development*. SInnDesign methods and tools support design teams in developing new, more sustainable solutions, ranging from marginal improvements in existing products to completely new product-service combinations.

The most innovative solutions often require changes in consumers' behaviour and changes in companies' management. Take, for instance, a car sharing service instead of the traditional use of a private car. From the users' side, this demands for a new way of organizing one's daily travel, a new relationship with the product (sense of ownership, status), etc. For the car industry it requires a totally new business model, with new partners.

So product innovation comes together with market innovation and business innovation. See sections 4-6 to learn more.

[1] These terms or expressions are defined in the SInnDesign glossary (available at www.sinndesignproject.eu). The first time they appear in the text, they are *in italics*

3. Why is innovation important for sustainability?

Over the last few decades, a growing attention is being given to the unsustainability of current production and consumption patterns in industrialised societies, from the environmental, economic and social points of view.

But how big is the challenge?

The level of reduction in resource use and emissions per unit of consumption which is required for economic and social development to be viable over the next century can be estimated if one considers that:

- In the XXI century, the world population is expected to increase from 6 to about 9 billion inhabitants; more population means more *environmental impact*.
- Consumption per person is also drastically rising, especially in economies where a wealthy consumer class is fast developing (Brazil, Russia, India, and China). More consumption also means more environmental impact.

If the environmental impact per unit of consumption is kept the same, with more and more people, each of them consuming more and more, the impact at global level will increase by a **factor of 10**, some estimate (Tukker at al., 2008). How can we live in a planet where the global environmental impact is 10 times worse? Turning the question around to avoid such ecological and social crisis in the long run, production and consumption patterns need to be more efficient by a **factor of 10**. Intermediate targets of factor 4 and factor 5 have been proposed. This is called "factor X thinking".

Factor X is an index that compares the **increase of value** (sometimes expressed in terms of quality of life) and the **reduction of the environmental impact** of a new product with those of the product being evaluated; this index expresses the improvement in terms of a multiple (factor).

"Factor X thinking" is important to understand the magnitude of the sustainability challenge that is at hand. For the design team, this implies rethinking not only the product, but also questioning the way it is used. Is the reduction of its environmental impact outperformed by an increase in consumption? How can this be counteracted and still make business sense?

Design for sustainability is a promising strategy to tackle the sustainability challenges. But experience shows that DfS strategies that focus on improving an existing product (*incremental innovation*) typically lead to *eco-efficiency* gains of a factor of 2 to 4. To achieve long term factor of 10, DfS oriented to more *radical innovation* is necessary.

"[S]mart companies now treat sustainability as innovation's new frontier." (Nidumolu et al., 2009)

4. Product and service innovations

According to the types of changes undertaken and the eco-efficiency attained, design for sustainability efforts can be divided in four types (Rathenau Institute, 1996):

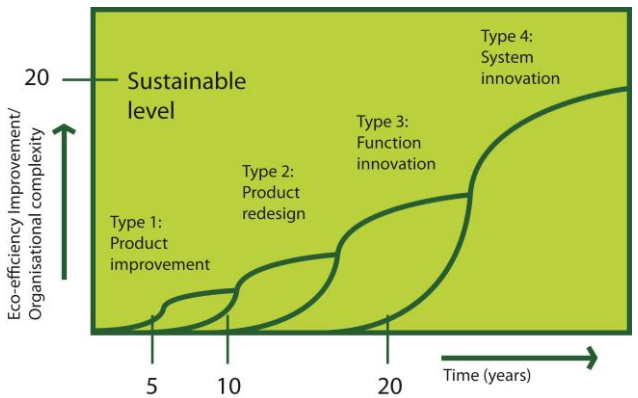


Figure 2 – Innovation types (Rathenau Institute, 1996).

Innovation type 1: Product improvement

This involves **partial changes and improvements** to products already existing in the market, the product itself and the production techniques generally stay the same. It includes strategies such as using more environmentally friendly materials, reducing material consumption, improving the energy efficiency, durability, recyclability or reparability of the product, preventing pollution during manufacture or use, etc. Therefore, a limited number of adaptations in the production process or in the supply chain are necessary to achieve this type of innovation. It is estimated that if employed on a global level, product improvement in the short term can lead to factor 2 improvements.

Next there are some examples of type 1 innovations for the SInnDesign sectors:

Example 1: Carpets manufactured with a high-end yarn composed of 100% recycled polyamide yarns

The carpets' manufacturer BALSAN thoroughly sorts its waste yarn after production and sends its supplier AQUAFIL (yarn producer) the resulting raw material, polyamide, which is then retreated and reused to produce the new Econyl yarn

Source: http://www.balsan.com/en/eco-design.asp

The carpets produced with Econyl (combined with non-recycled coloured yarns for aesthetic reasons) are more eco-friendly due the reduction of raw materials' consumption. For more information: http://www.balsan.com/en/eco-design.asp

Example 2: "Light" tiles

Ceramic tiles with reduced thickness (4 mm instead of the traditional 12 mm). The raw material consumption has been reduced and so has the energy consumption in the manufacturing process, as it takes less energy to fire a thinner tile. The tile keeps its good properties and may be applied on top of existing cladding, thus reducing the time, cost and waste related to renovations work

Source: www.revigrés.com

Example 3: Organic cotton bed products

Organic cotton bed products with Global Organic Textile Standard (GOTS) certification, meaning that they are made with certified organic cotton and that during the production process environmental and social criteria are complied with (for example free of toxic dyes and harmful chemicals in the product, accessories and packaging; less toxic chemicals is good for the environment and for the workers in factories too).

Source: http://www.coyuchi.com/the-naturalista/gots/

Example 3: Office chair RH Ambio, produced by RH Chair, one of northern Europe's leading manufacturers of ergonomic seating.

The seat and backrest of the RH Ambio are upholstered with Ventec™ – a unique product developed by RH. Ventec™ is made predominately of horsehair, a material known for its ability to transport moisture and heat, which provides the user with greater sitting comfort and, when the seat and back pads are discarded, they are biodegradable. Wool and fabric are also included in the Ventec™. The Hairlock material that forms part of the Ventec™ has been tested by recognised institutes for the possible presence of some 130 harmful substances. The product complies with national and international standards, is certified according to Öko-Tex 100 and is biodegradable.

Source: Environmental Product Declaration : RH Ambio. S-P-00182. http://environdec.com/en/Detail/epd186#.Vdb5FvlPUqN. Accessed 2015-08-21.

Innovation type 2: Product *redesign*

Product redesign focuses on **incremental** or step-by-step environmental improvements on **all technical aspects and parts of a product**. Although the existing product concept stays the same, the components of the product are improved or replaced, aiming at the use of non-toxic materials, *recycling* and disassembling, improved distribution, reuse of parts and energy use reduction with respect to all components over their life cycle. This level of innovation requires substantial changes in the production, supply and distribution activities. Experience has shown that when applying extensive product redesign a reduction of environmental pressure by a factor of 5 could be reached, though on a longer time base.

Nevertheless it remains limited to the possibilities offered by the existing product concept.

Example 1: Natural mattresses handmade in Czech Republic

- Manufactured exclusively from natural materials: cotton,
- Handmade in the Czech Republic using traditional techniques
- Accurate handcraft manufacture with an emphasis on design and detail
- Additional services: mattress adjustment and repair service

Source: http://www.prirodni-matrace.cz/novinky/natural-mattress

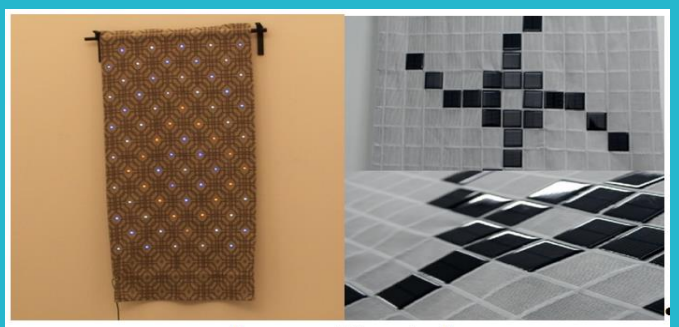
Innovation type 3: Functions innovation

This type of change is no longer confined to the existing product concept; in this case, the way the function is fulfilled is changed. Here the focus of a new design is in the service that the consumer receives from a product and on the way the customer uses a product's function. According to an innovative environmental concept, a new product-service is developed together with a new way of marketing. Becoming multi-functional, products achieve higher added value, and industry competitiveness is increased.

Instruments that can be used to dematerialize and to shift towards producing and delivering a system of products and services that fulfils client demands (see next chapter) are: integration of functions, shared used of products, leasing, etc. To pursue this level of innovation, extensive revisions of the company management strategies have to accompany changes in the design and production processes, as well as in the supply chain. Cooperation and development of synergies between industrial companies and research institutions must also be enhanced. In the medium term it should be possible to achieve improvement in the overall environmental performance by a factor of 10.

Example 1: Functions integration

Textile structures, such as curtains, that promote different functions such as LED integration and photovoltaic panels that allows the reduction of energy consumption and energy harvesting.



Source: Newlight Project

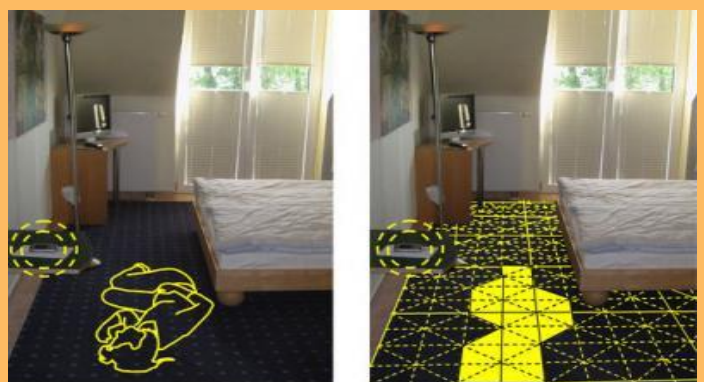
Innovation type 4: System innovation

In this case, the entire technological system (the product, the production chain, associated infrastructure and institution) is replaced by a new system. In this case we are talking of radical innovations. Besides the technological aspects, social and cultural aspects are also intensely considered, especially when rather different approaches are required, such as substantial changes at the production and organizational level, extensions of relationships and implementation of new forms of partnerships among all *stakeholder*s of the value chain and/or other (such as public bodies, *NGO*s and consumers). This results in an integrated solution for the customer and final consumer, supported by a solid infrastructure and new validated business models.

If globally adopted, system innovation would lead, in the long term, to the sustainable level factor 20 of environmental improvement.

Example 1: SensFloor® – large-area sensor system

SensFloor is based on a textile underlay with a thickness of 3 mm that can be installed beneath PVC, carpet, and laminate. The sensor system has four integrated radio modules and 32 proximity sensors per square meter. Whenever a person walks across the floor, sensor signals are sent to a control unit and various different types of events are identified: The sensor system differentiates between a person standing or lying on the floor and determines the direction and velocity of movements. Static signal detection and self-test capability are important features for security applications. SensFloor switches lights, controls automatic doors and detects unauthorised intrusion. In health care, SensFloor detects patients leaving their beds or their rooms and transmits alarm signals through indoor call systems or radio components. For high-security applications, like access control in combination with radio-frequency identification, SensFloor can count individual people. The SensFloor system is suitable for public buildings and has already been used in care homes for Alzheimer patients



Source: http://future-shape.com/se/technologies/127/sensfloor-large-area-sensor-system

There is no data regarding the sustainability profile of this solution. Of course, there is a specific consumption of materials and energy related to the incorporation of the above mentioned devices, on the other hand it shows important social benefits in health care and security explained above. When evaluating the sustainability benefits and drawbacks, with what should this system be compared?

5. Product-service systems overview

In the previous chapter, the questioning of how a certain function or need is fulfilled and whether or not there is the possibility of finding innovative solutions other that the traditional products to fulfil them was presented, in relation to type 3 innovations. A particular business model that is very promising in this debate is that of product-service systems (PSS), which is explained in this chapter. The best way to introduce it is to start with a practical example:

Some years ago, the answering machine became virtually obsolete oncethe telephone operators started providing voice mail services. One is able to track who called, to hear the recorded message, save it for a certain period of time and call back automatically. For the user this is a far better choice from a practicality point of view and in economic terms as it is not necessary anymore to buy the equipment. As a matter of fact, what does the consumer really need – to own an answering machine or to be able to use the function of receiving phone messages?

This is a classic example of the replacement of a tangible product (the answering machine) by a service (voice mail) and it is often used to illustrate the potential sustainability benefits of servicing. Instead of thousands of answering machines being manufactured, distributed, used and disposed of at the end of life, the already existing phone is enough. Moreover, consumer satisfaction is higher.

As previously explained, a demanded "Factor 4" or greater reduction on environmental impact is hard to achieve by modifications to existing products only. Product-service systems (PSS), which have a high potential for sustainability, are based on business models that combine the delivery of products and services in order to add value to and meet the needs of users in a more sustainable way. PSS may be categorized as in table 1, which shows PSS ranging from those that are close to the traditional product to those where the business model is focused on the result, and there is no predetermined product to fulfil it.

Table 1 – Categories of PSS
Sources: SusProNet project[2]; Tukker and Tischner, 2006 and Tukker, 2004 (modified)

Categories	Ownership of the product	Examples
Category A: Product oriented Services	The product is owned by the user/consumer	*Product extension service*, the value of a product is increased through additional services, e.g. upgrading, repair, guarantees, financing schemes, supply of consumables, etc. *Advice and consultancy* concerning the most efficient use of the product. *Vertical Integration*, meaning modified delivering strategies to supply products to customers, retailers and/ or customers who get directly involved in the process of production, e.g. production on demand.

[2] Thematic Network on Product Service Development: www.suspronet.org.

Categories	Ownership of the product	Examples
Category B: User oriented Services	Product is owned by the service provider who sells functions instead of products, by means of modified distribution and payment systems	*Leasing*. The provider retains ownership and is often responsible for maintenance, repair and control. The leaser pays a regular fee for the use of the product and normally has an individual and unlimited access to the leased product. *Renting or Sharing*, similar to leasing but the user does not have unlimited and individual access to the product. The same product is sequentially used by different users. *Pooling*, which is similar to sharing but there is a simultaneous use of the product.

Categories	Ownership of the product	Examples
Category C: Result oriented Services	There is not a pre-determined product involved in this category	*Activity Management*, the supplier gives incentives for the customer to consume more efficiently and optimises a system e.g. by using modified payment systems, e.g. contracting. *Functional result*, products are substituted by new solutions; the delivery is a result which is not related to a specific technology system anymore. Examples are pest control service instead of pesticides, delivery of a "pleasant climate" instead of selling heating or cooling equipment, etc.

Are PSS more sustainable?

The PSS concept has been a matter of great attention for sustainability experts due to its potential to decouple *revenues* from material flows and to increase *resource productivity*. In other words, whereas in the traditional product-oriented business model, the company revenues depend on the number of units sold (the more the better and this is unsustainable!), in a PSS business model the company sells a result and owns the products: the less products they need, or the longer the products last with good quality, to provide the service, the better for the company. The incentive for profit changes – and this is why one talks about *decoupling*.

Generally speaking the sustainability potential of PSS increases from category A to category C. According to Tukker (2004) product-oriented services have probably only marginal environmental benefits, due to better maintenance and extended lifetime of the product and the same applies to activity management. Radical changes cannot be expected since the technology system remains the same; it is simply managed in a more efficient way. Renting, sharing and pooling can lead to higher environmental gains, especially if the burden is related to the production of the product, since less units are necessary when the product is used more intensively. In the case of pooling, the potential benefit is even higher, as consumables in the use phase serve more persons at the same time. The most promising PSS in environmental terms is the function oriented PSS, which gives the service provider higher degrees of freedom to design a low environmental impact system, while maximizing the customer satisfaction.

Coming back to the link between PSS and innovation levels, it is clear now that not all PSS correspond to type 3 innovations: product-oriented PSS would fall into type 1 or type 2 innovations; only user-oriented or result-oriented PSS are aligned with what is described as type 3. But one should keep in mind that these categories and definitions are helpful to systemize the ideas and understand the basics. What really matters is the challenge of looking for more sustainable solutions, disregard of the "box" they will be classified into!

Example 1: PSS for carpets (user-oriented service)

Under the traditional model a company would sell carpet to a customer and then wait for the carpet to wear out. At that point they would compete for business with the same customer who might allow them to rip all of the old carpet out and replace it with completely new carpet. The customer now owns the carpet and is responsible for keeping it clean and making the decision for when to replace the carpet. Under the PSS system a company would contract to provide floor covering. In one common scenario they would cover the floor with carpet squares. As portions of the carpet deteriorate due to use the company would replace the portions of the carpet which need replacement and leave the rest of the carpet. The carpet company now owns the carpet and replaces portions periodically as necessary in order to ensure that the client is provided with adequate floor covering.

This is more sustainable in several ways. First less carpet is being replaced. Second, the carpet company is now incentivized to design carpet which can be refurbished or recycled. Under the scenario where the customer owned the carpet any such measures would be subject to the actions of individual companies. Under a PSS, the carpet company would be in a position to do all of this without needing to convince each client of the sustainable benefits of recycling. Interface is a company that adopted this business model.

http://www.quora.com/What-are-the-best-examples-of-Product-service-systems-function-oriented-business-model-in-terms-of-improved-sustainability

Image: http://www.interfaceglobal.com/

6. Organizational innovation levels

In order to deal with such challenges companies will have to drastically change the way they address their business strategy, *product development* and co-operation with stakeholders. Figure 3 presents, in a schematic way, three levels of business strategies, from those that focus on short term decisions to those that consider the long term and forge strong relationships with their employees, partners in the value chain and members of the community.

Figure 3 – Three stages of innovating
Source: Network for Business Sustainability, 2012.

Organizations in **stage 1 add environmental and social criteria to existing quality or profit criteria in their product development processes**. This results in reducing the harm by **doing the same** things. The business strategy here presented relates to type 1 product innovation in the previous section.

Organizations in **stage 2 see the business opportunity in developing new products and services** that fulfil human needs and also benefit the environment. This business strategy relates to types 2 and 3 innovations in the previous section.

Organizations in **stage 3 also engage in totally new product and service developments** with an improved sustainability profile, but do not do this alone, but rather **as part of an interconnected ecosystem** – existing to benefit and change society. This stage of business strategy is required to type 4 innovations in the previous section.

7. SInnDesign and innovation types

SInnDesign methods and tools help designers and product developers to make sustainability-driven improvements of existing products in the habitat sector. SInnDesign also includes tools targeting more radical innovations, such as those related to product-service systems. In a given DfS process, the level of ambition in terms of innovation and sustainability outcomes will depend on the company's strategy, the market, the technological options available, the possibility of establishing partnerships, etc. So the same tools can be used in the context of very different development process and provide quite different results in terms of innovation level and sustainability improvements.

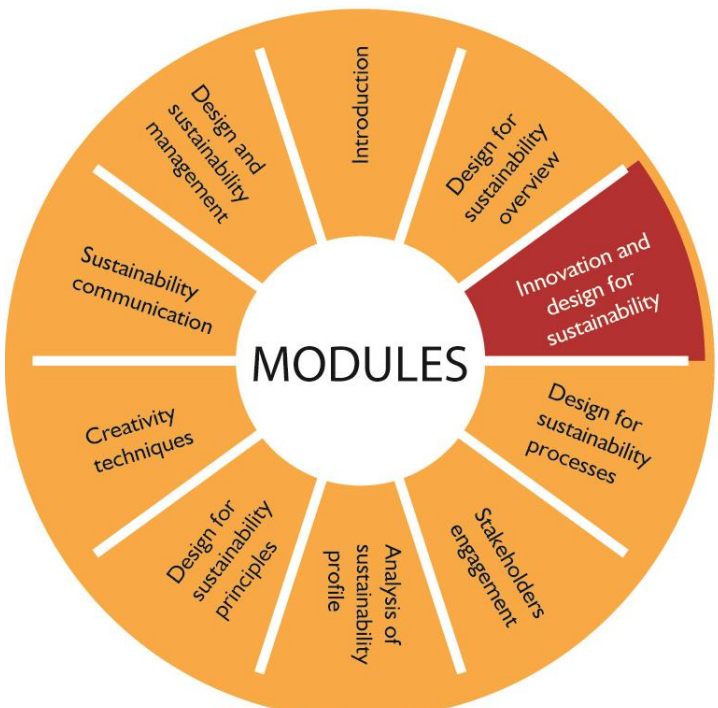
Nevertheless, some methods and tools are more aligned with incremental innovations, whereas others are more aligned with the needs of more radical innovation processes. This is presented in table 2. Type 4 innovation is not supported by SInnDesign because this type of innovation involves companies, policy makers and other stakeholders, i.e., occurs at macro level, not at micro-level. But if a company is engaged in such process, it may use SInnDesign methods and tools for specific projects that would contribute to the whole.

Table 2 – SInnDesign process types and tools, and innovation types

	Product-service innovations				Organizational innovation		
Innovation types SInnDesign processes + tools	**Type 1**	**Type 2**	**Type 3**	**Type 4**	**1 "Operational optimization"**	**2 "Organizational transformation"**	**3 "Systems building"**
Product improvement / redesign process	Yes	Yes	No	No	Yes	No	No
Product-service systems development process	Yes	Yes	Yes	No	Yes	Yes	Yes
Motivating factors	Yes	Yes	Yes	No	Yes	Yes	Yes
Design brief	Yes	Yes	Yes	No	Yes	Yes	Yes
DfS checklists	Yes	Yes	Yes	No	Yes	Yes	No
Ecodesign Pilot	Yes	Yes	Yes	No	Yes	Yes	No
QFD	Yes	Yes	Yes	No	Yes	Yes	Yes
Matrix for evaluation of DfS ideas	Yes	Yes	Yes	No	Yes	Yes	Yes

SInnDesign
Sustainable Innovation through Design

SInnDesign Modules and Tools



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