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# DO USER DRIVEN INNOVATION AND ECODESIGN ENRICH OR FIGHT ONE ANOTHER, AND DOES SUFFICIENT METHODOLOGIES FOR COMBINING THE TWO EXIST?

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## ABSTRACT
This paper is a theoretical investigation and case study of the presently highly debated and much referenced terms 'ecodesign' and 'user driven innovation', with the aim of illuminating the juxtaposition of the two terms. The terms are briefly described, addressed further through a number of cases and discussed with regards to how they correlate to each other. In order to illustrate the area assumptions of the underlying design methodologies have been made. A possible connection between the two is established and the areas in which they collide are illuminated. It is shown how scripting can be utilized to help establish the intended product usage. Both by providing information to the users for them to act in a reasoned fashion and by behavioural steering that guides the users to act in a sustainable desirable manner without necessarily having to make a conscious decision regarding the matter. Finally it is proposed that the current set of methodologies of combining the two are insufficient, and that new methodologies would be beneficial for future product development

*Keywords: sustainability, eco design, human behaviour in design, scripting, user driven innovation*

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# 1 INTRODUCTION

The increase in world population and wealth is causing increasing consumption, the impact of which does not give cause for much optimism: resource depletion, greenhouse effects, etc, and all indicates this progression is permanent. Needless to say, sustainable innovation is required in order to make for a environmentally more sound development. An approach to develop more sustainable products is called 'ecodesign' and this approach has become increasingly popular in the process of product development and innovation.

When innovation is discussed, lots of parameters other than sustainability enter the equation. It is recognized as beneficial to product development to include the end-user in this process. This has caused a broad philosophy of product development, described by many under a number of terms such as 'user driven innovation', 'user centered design' and more.

These two considerations, 'ecodesign' and 'user driven innovation', are both important factors to product development. But if sustainability is the driver for innovation, will the user then accept it? If a product is based on 'user driven innovation' can it still maintain sustainability? Is it possible to combine both aspects successfully so they can enrich one another? Or will one consideration fight the other?

This paper seeks to investigate important aspects to these questions, through literature analysis and hypothetical post-analysis of a number of cases. Hopefully this can aid future investigations into how the two approaches can be more intertwined in sustainable product development.

# 2 USER DRIVEN INNOVATION

Product development including the end user can be done in many different ways. A number of theories and investigations into this approach have been conducted through the past many decades. Thus there is a distinction between 'user driven innovation', 'user centered design', 'inclusive design' and so on. Examples of important work on these terms can be observed in 'Designing Inclusive Futures' (Clarkson et al., 2008), 'Democratizing Innovation' (Von Hippel, 2005), 'Handbook of Usability Testing: How to Plan, Design and Conduct Effective Tests' (Rubin et al., 2008), to mention a few. While the above authors represent slightly different approaches and views on user involvement in product development, these will not be investigated further in this paper, as they are all regarded as being in the same general field, i.e. product development with the user taken into account. In this paper we will, for simplicity, refer to this as User Driven Innovation (UDI), even though this traditionally does not cover every aspect of the field. As a somewhat gross simplification, the aim of UDI is to design products or services that better correlate with the way the end-user utilize, experience and feel about the products, hereby making the product more appealing to potential buyers. As part of the research for this paper, an interview with a product designer and expert on UDI and Man-Machine-Interface at a large Danish medical company, that also incorporates ecodesign, was conducted.

# 3 ECODESIGN

Ecodesign or Design for Environment (DfE) is an approach to design, in which the environmental impact of the product is the main focus. Ecodesign addresses the entire life cycle of the product, from handling raw materials (extraction, manufacturing e.g.) over manufacture, distribution and usage to disposal (including reuse/recycling). Life Cycle Assessment (LCA) as described in ISO 14040-2006, is a method to assess the environmental impact of each of the phases of the product, giving an overview of where the effort would give the biggest gains. To illustrate the basics of how to think in terms of ecodesign, the *ecodesign principles* from (McAloone and Bey, 2009) is listed:

Ecodesign principles

- Reduce the material intensity of the product or service
- Reduce the energy intensity of the product or service
- Reduce the dispersion of harmful substances through the product
- Increase the amount of recycled and recyclable materials in the product
- Optimize the products durability
- Incorporate environmental features into the product
- Signal the product's environmental features through the physical design

- Maximize the use of sustainable resources and supply chains
- Optimize the product's performance
- Design the life cycle first and then the product

A well-known symbiosis within larger corporations is 'triple bottom line', where in order to gain success, it is necessary to consider the three P's: People, Planet and Profit (Elkington, 1997). Ecodesign is one approach to improve sustainability within the planet part of the 'triple bottom line'. It is, however, thought to be somewhat complicated for companies to interpret and practice these eco-design principles, why a different set of models to facilitate these principles has been proposed. For instance, a model that aims to support the application of ecodesign practices in Product Life Management was proposed by Pigosso et al. (2011).

# 4 COINCIDENCES

Based on the above definitions of the two approaches to product development, some interesting and pertinent cases of products will be discussed.

## 4.1 TV

As an example, we can look at the development of the television during the last decades. Twenty years ago the TV-set was a heavy and very power consuming device. Through the years though, the progressive technology is responsible for making the TV practically into an entirely different device. The voluminous picture tubes were replaced with flat LCD / PLASMA / LED screen panels. These new technologies made the TV both lighter and much less power consuming. From an environmental/ecodesign point of view this should be considered a success, given that a device that exists in almost every household, has become less power consuming. But this technology-driven development carried with it another factor, we need to count into the equation. The new technologies lowered the production cost, consequently lowering the entire consumer price. The combination of this and the increase in general wealth resulted in abundant sales. Not only has the quantity increased, but in addition it became attractive for the user to have an increased screen size.
What was thought to be a promising and more eco-friendly development produces a non-favorable outcome, when seen it from an environmental point of view. On the other hand, from the user's point of view, they experience an inexpensive device, that in itself can be described as energy-efficient. A divergence between how ecodesign affects the sustainable development and how the user interprets and uses a product is hereby indicated, which exemplifies the complexity of the symbiosis between user interaction and ecodesign.

## 4.2 Axis kettle

Another interesting case used to illuminate the relation between user driven innovation and ecodesign is the redesign of the Axis Kettle. Mec-Kambrook, Australia, a manufacturer of electrical appliances, conducted the redesign with a goal of making the kettle much more environmentally attractive. They named the process EcoReDesign. By means of an LCA of the existing product and the ecodesign principles mentioned earlier, they successfully developed a kettle with improved environmental specifications (Coakley et al., 2007):

- Up to 25% less electricity used during heating
- Approximately 50% reduction in the number of materials
- One single material now constitutes 66% of the weight of the kettle

- 40% reduction in the number of components
- Total weight has been reduced by 16%

During the redesign, the designers involved the user in the process (Baker, 2010) taking into account the user's desire for improvements. A few results based on these user-based requirements, included that the kettle was able to keep the water warm for a longer period of time, making it unnecessary to reheat the water when forgotten, and a temperature indicator, letting the user know if reheating is necessary.
On paper this product development seems to incorporate both 'ecodesign' and 'user driven innovation'. However, when evaluated in a broader sense, these improvements had very little environmental effect, which can be explained in two ways. Firstly the analysis of user inputs may not have been done comprehensively. A typical "slip-up", when working with UDI is that requirements from the user may be incorporated into the redesign, but a deeper understanding of the issue in question is not revealed / discussed. "Keep the water warm longer" is an obvious requirement, with an apparently "easy" fix. The problem lies within the typical user interaction with this device. When forgotten, the user is accustomed to reheat the water; therefore the user will keep doing this, regardless of the new feature consisting of a temperature indicator. Hence product-user interaction is more complex, than just "doing what the user wants", and this issue needs to be addressed properly when working with UDI.
Secondly the EcoReDesign of the Axis Kettle was limited to making improvements to an existing device. This carries with it limitations to the environmental change of the redesign. This issue of limitation will be discussed further in the next section.

### 4.3 Kindle

The last example regarding this matter is the development of the E-reader. Jeff Bezos, the inventor of what is said to be the first successful E-reader, the 'Amazon Kindle', noticed a need for a digitalized book-system. Not only is the digital book (in most cases) more portable than a regular book, especially with the option to carry multiple books, but the Amazon Kindle made it possible to easily purchase books practically anywhere. The Ebook-innovation can be classified as mostly user driven, though the availability of new technologies also affected the development. Environmentally though, is Amazon Kindle worth saluting? It is power and resource consuming compared to a traditional book. The plastic, metal and electronic components are not at all eco-friendly, compared with the $CO_2$-neutral tree that the traditional paper is made from. On top of that manufacturing an electronic device like this is much more demanding and power consuming compared to the production of traditional books. Based on these considerations one could argue that environmentalists would not appreciate the Amazon Kindle.

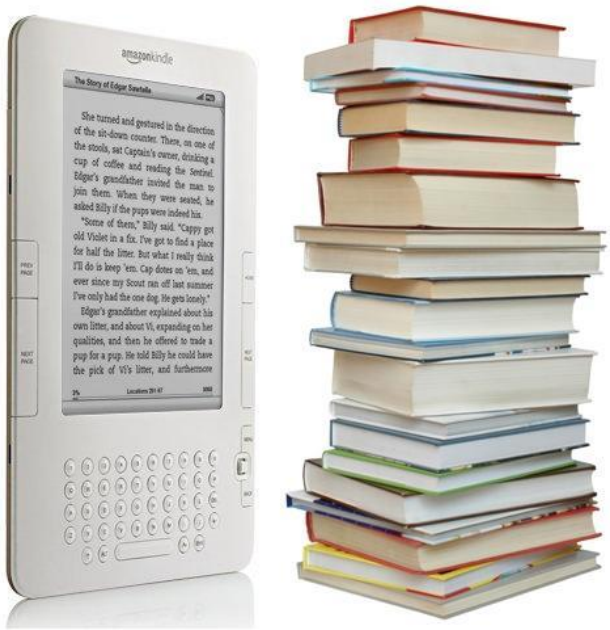


*Figure 1. The Amazon Kindle has an environmental impact equal to that of 22.5 traditional books (Ritch, 2009) (Website1, 2012).*

However one must consider, not only the E-reader, but also the entire system that lies beneath, before conclusions can be made. In spite of high environmental cost of an E-reader like the Amazon Kindle compared to a traditional book, arguments can be made in favour of the E-reader; The Kindle is capable of storing, through it's entire life span, an unlimited amount of books. Calculations have been made (Ritch, 2009) showing that if 22.5 books are stored and read on the Amazon Kindle through its entire life span; the carbon footprint will be equal to that of 22.5 traditional books. For every additional digital book the balance will tip in favour of the E-reader. We need to keep in mind that conventional books may end up being read multiple times by different readers, resulting in small margin of error. Not only will the amount of "unproduced" books affect the environment in a positive manner, but the resulting absence of distribution also causes a positive effect on the environment. In a broader perspective, this technology made way for the digitizing of other publications, such as magazines and newspapers, which in turns expand the possibilities of decreasing undesirable environmental effects even further.
This user driven technology, when evaluated in isolation, seems to be environmentally undesirable, but when the innovative and more comprehensive system is evaluated a more sustainable technology is exposed.

# 5 MAINTAINING BOTH APPROACHES

While UDI provides a broad approach to product development, it holds most of its potential in the use stage of a product's life phases. The comprehension of the user's interactions and understandings of the products is what makes UDI effectual. Ecodesign provides a more systematic approach to examine and improve each of a products life phases, including the use stage. This leads us to the connection of UDI and ecodesign through the use stage.
As described in the previous cases, efforts to make eco-friendly products can be difficult, especially when considering the entire lifespan of the product. Even though the user is held in mind, the environmental features are not necessarily successfully implemented, as seen with the Kettle example. This is an example of both ecodesign and UDI, but it does not seem to produce a radically better performing product. It does though also reveal where a potential combination of the two might be beneficial. The idea and vision of the Kettle design is in tune with the ecodesign principles discussed earlier (McAloone and Bey, 2009). Especially "*Incorporate environmental features into the product*" has been considered, though the features themselves are seldom sufficient. If the environmental features are not being used properly, the ecodesign effort fails. This is made up for by the next principle "*Signal the product's environmental features through the physical design*". But this principle also suggests, that one can predict the acting and mindset of the user, which is in great contrast to the principles of UDI, where the users must be "asked" through a series of developed methods. The same goes for "*optimize the products performance*", at least in regards to the performance in relation to the user/usage. The three mentioned principles all deal primarily with the use stage and are therefore where UDI should be incorporated. The involvement of the user is a crucial step to ensure that the features, designed at this stage of product development, will be used as intended. Consequently an effort should therefore be made, in order to gain knowledge of the users interactions, needs, feelings, etc. towards the new product or new features of the product.
On the other hand UDI traditionally does not provide a method for improving a product's environmental impact in itself. Even though being environmentally conscious is gaining ground, the need for environmentally better solutions are seldom illustrated by the users interaction with a given product. Propositions to include sustainability into UDI have been made. For example the Human-scale Development methodology (HsD) is argued to be extended to include non-human actors by Max-Neef (2011), such as animal-subjects, to make way for sustainable development.

> *By integrating otters into the matrix of needs in a way that enables us to compare the needs and satisfiers of people and otters, we can rebuild the articulations between people, nature and technology.* (Max-Neef et al., 2011).

While this provides some framework for including sustainability into UDI, it does not prompt inclusion of the standardized ecodesign principles.

Generally the user's needs tend to go towards better performance, which can cause solutions that are directly bad for the environment. As described by Verganti (2010) in "User-Centered Innovation Is Not Sustainable":

> *User-centered innovation has helped conduct us into an unsustainable world. The reason is sustainability is not embedded in the anthropology of our existing culture, society, and economy. Yes, people are starting to be concerned about the environment. But their concerns about many other things — their budgets, health, safety, well-being, and emotional fulfillment — are increasing, too.* (Verganti, 2010)

While UDI might not provide means to design better performing products in regards to the environment, the insight it provides in the user's product-interaction can prove valuable in an ecodesign process.
A thing to keep in mind, and another possible reason as to why the Axis Kettle was not as successful in reality as on paper, is one of the very important points in ecodesign. It states that "*approximately 80% of a product's environmental profile is fixed under concept creation*" as illustrated in Figure 1 (McAloone and Bey, 2009):

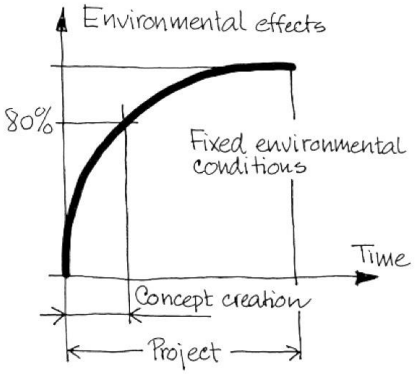


*Figure 2. Approx. 80% of a product's environmental profile is fixed under concept creation in product development (McAloone and Bey, 2009)*

So while it sounds impressive that the kettle consists of less parts, is less power consuming etc. this is mostly due to change in component and subsystem levels, which do not alter the general concept of how the kettle boils water. So by definition this redesign is only able to ameliorate the products environmental profile by around 20%. Two points are drawn from this example:

- Firstly an eco-focused (re)design should embrace the underlying basic concept if a radically better product should be made. But to ensure and verify that the proposed concept does indeed provide the intended improvements UDI should be incorporated.
- Secondly involving the user just to add environmental features is not enough. For the features to work as intended, it is necessary to investigate how the user will interact with it, which leads us to the term "scripting".

The term scripting is usually accredited to Akrich: *"Thus, like a film script, technical objects define a framework of action together with the actors and the space in which they are supposed to act"* (Akrich, 1992). This can be described as behavioural conditioning, making way for the product developer to make the intended acting of the user most plausible, by means of design, features, materials etc. By utilizing this well-established approach and involving the user to verify, development of environmental features can be more accurate.
The term 'scripting' is by definition closely related to the behaviour of the user. To control, or more accurately put, to steer the users behaviour with a given object through scripting can be done in various ways. However to modify the users behaviour is generally done in one of two ways. Either the user's interaction is altered without the user's perception of the change in behaviour or with information given to the user that (may) lead to a change in behaviour. To illustrate the first form of

scripting, we look at the paper towel dispensers often found in public bathrooms. To avoid excessive use of paper automatic electronic dispensers have been implemented. When the user needs paper a gesture in front of the dispenser, causes a controlled amount of paper to be dispensed. It even incorporates a delay before dispensing can be repeated, hereby avoiding excessive usage. There is no need for the user to know why a controlled amount of paper is dispensed; the goal is reached nonetheless.
The other way to steer user behaviour is to inform the user about the consequences of a certain (inter-) action. With regards to ecodesign, this could be the indication of the environmental impact of an action. This type of scripting relies on the user to make a conscious decision, and hopefully the user will, based on the newly acquired knowledge, choose to make the environmentally sustainable decision. This is exemplified through another type of paper dispenser, in which information is given to the user, indicating excessive paper usage results in a loss of the South American rainforest. The user becomes responsible for the environmental change. Two examples are illustrated in Figure 3:


*Figure 3. Behavioural steering with or without feedback to the user. (Websites 2 & 3, 2012)*

But how can a decision be made on whether to steer user behaviour with no information to the user or to indicate environmental consequences for the user? In the case regarding the Axis Kettle, information was given to the user, but this unfortunately did not result in a change in the user's interaction with the product, as intended. As mentioned earlier, this issue could be attended with longer intensive application of the UDI approach. Had the kettle-user interaction been observed (a method of UDI) the design team would most likely make iterations, making up for the fact that the user reheats the water regardless of the new feature. A different UDI-method that potentially can determine if eco-feedback should be incorporated into the product is "prioritizing". By incorporating the user's opinion on what is important, and just as essential, what is not considered important, unnecessary features can be left out of the design. Conclusively the choice on whether to apply eco-feedback into a product or not is determined by how the users interact with the product. This interaction can be revealed through iterative and thorough methods of UDI.
This way to modify user behaviour is described as 'nudging', and in the paper '"Designing-in" sustainable behavior: A nudge in the right direction (2008)' the explained terms are discussed with regards to an environmentally justified point of view. Two notable cases are explained in the paper, and these will be briefly discussed in the following sections.

## 5.1 Wattson

An intelligent device that is connected to the electricity meter or fuse box of the users home. The main feature of the Wattson is a display, taking the current energy-consumption of the household, scaling it up over a year and displaying the result to the user, either in watt or the desired monetary currency. For instance, if a vacuum cleaner is powered on, the projected yearly cost increases, letting the user know this is a power- and money-consuming device.

The purpose of this product is to reduce power consumption, but the remarkable part of this product, is that it by itself doesn't contribute to a greener environment. On the contrary, the product consumes power, and is like many other electronic products demanding in production and manufacturing. The product has the potential to endorse a better environment, though it relies on the user to make a change in behaviour, based on the projected information. If a high yearly cost is displayed, this could encourage the user to turn off power consuming devices. It is notable that the form of feedback is not directly showing the environmental impacts, but tells the user the financial cost of power consumption. If Wattson underwent UDI-methods in the development, it could have revealed that users prioritize saving money, leading to the design. This would be an example of how UDI might be able to steer user behaviour in an environmentally viable direction, even though this might not have been the initial intention. If Wattson was based on ecodesign, which could be befitting its potential, a more complex work would have been necessary, to assess the environmental impact of all the product's life phases, including the positive returns that usage may or may not provide. It is hard to imagine this being done in a comprehensive way, without utilizing UDI methods for verification of the end users behaviour.

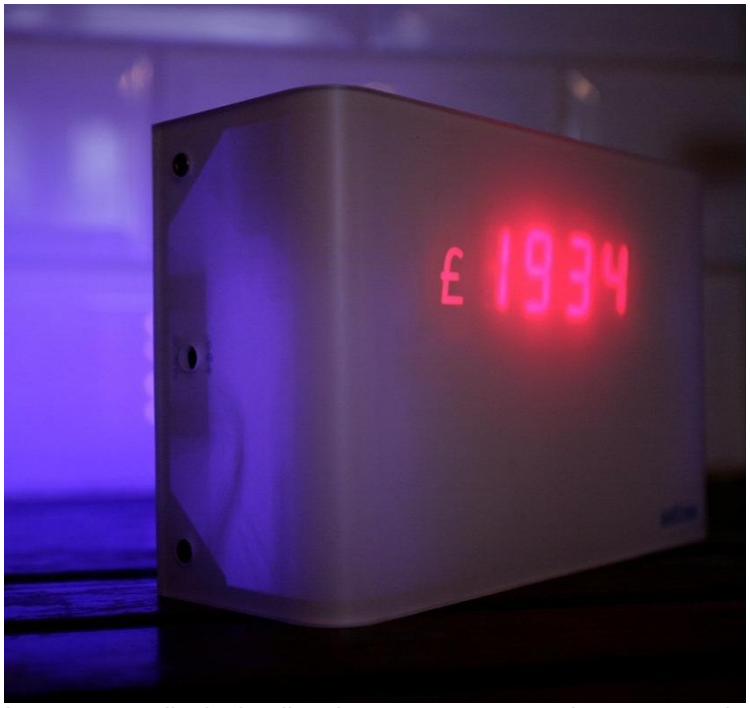


*Figure 4. The Wattson, displaying live the power-consumption converted to currency. (Website4, 2012)*

## 5.2 Nissan ECO pedal

In 2008 Nissan developed the ECO pedal. To help users drive more fuel efficient, a system detects if the gas pedal is pressed more than necessary for the given conditions and tries to correct this accordingly. This is done both physically by a counter push-back mechanism and visually by a display in the control panel, informing the driver that more fuel is used than required. According to Nissan's own data this can lead to 5-10% more fuel efficient driving (Nissan, 2008). This example shows how both simple feedback in terms of a display and behavioural steering in terms of the pedal pushing back, is incorporated as environmental features. Once again, if this feature was a result of ecodesign, UDI should definitely be incorporated to enhance, refine and verify the effect. Especially if actual figures on the savings are to be used in advertising context.

It has been established that both UDI and ecodesign are of great relevance to both present and future product development. The discussed cases, the TV, Axis Kettle and Kindle indicate that issues in between the two takes on product development may/will arise. Either term may contradict the others potential of success. With the two terms significant importance to product development, a new combined methodology is of great relevance.
Methodologies have been proposed to include environment into UDI (Max-Neef, 2011), however a more practical guideline would be beneficial. One such methodology has been proposed to practice ecodesign taking into account input from the user (Telenko et al, 2010). However this methodology includes the user, primarily in the early stages of concept redesign, and does not propose how to verify the product-usage relation in the final stages of concept creation.
We therefore argue/encourage that further investigation on the subject is required, to make way for successful product development, with regards to both ecodesign and UDI.

# 6 CONCLUSION AND OUTLOOK

Through this paper the terms user driven innovation and ecodesign have been discussed and examples of both the terms and the complexity of the relation between them have also been discussed. While both UDI and ecodesign can contribute to the creation of interesting and innovative concepts separately, a combination of the two can be beneficial and even necessary for development of sustainable products and services. When product development is based exclusively on UDI, sustainability is rarely a top priority, why this approach will profit environmentally from the ecodesign approach and principles.
If a development process is carried out purely in reference to the ecodesign approach, the end product is likely to be mis-used, as we saw in the case of the Axis Kettle. The ecodesign approach to design can on this basis gain effectiveness by the implementation of UDI-methods, making sure the interaction with the product is as intended. This is applicable for both environmental features, but also for development of the basic concept/system, where the opportunity for highest environmental gain is predisposed. This was illustrated by the Amazon Kindle case, where the concept of reading a book was revolutionized.
Finally two ways to influence the user behaviour have been illuminated, in the paper dispenser case. Additional examples of user behaviour steering were mentioned (The Wattson and The Nissan Pedal). When to utilize ecofeedback, which ultimately puts the responsibility of sustainable behaviour on the user, and when to incorporate direct features of behavioural steering can not be strictly concluded. These considerations can be illuminated through UDI methods to assess, which form of scripting gives the best results, thereby producing environmentally favourable concepts.
So do ecodesign and UDI enrich or fight one another? It is proposed that UDI and ecodesign can in fact enrich each other for successful sustainable product development. While some efforts has been made to provide means for this (Max-Neef et al. 2011, Telenko et al. 2010), it is suggested, that there is room and need for a new more practical methodology that combines the more complex and thorough method of standardized ecodesign with the dynamic and numerous methods and approaches of UDI, UCD, HsD and so forth.

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