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## Postprint

This is the accepted version of a paper presented at *EnviroInfo 2016, 14-16 September 2016, Berlin, Germany*.

Citation for the original published paper:

Mustaquim, M., Nyström, T. (2016)

Some Aspects of Using Universal Design as a Redesign Strategy for Sustainability.

In: Wohlgemuth, V., Fuchs-Kittowski, F., Wittmann, J. (ed.), *Advances and New Trends in Environmental Informatics* (pp. 49-60). Cham: Springer International Publishing

Progress in IS

[https://doi.org/10.1007/978-3-319-44711-7\\_5](https://doi.org/10.1007/978-3-319-44711-7_5)

N.B. When citing this work, cite the original published paper.

Permanent link to this version:

<http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-296284>

# Some Aspects of Using Universal Design as a Redesign Strategy for Sustainability

Moyen Mustaquim and Tobias Nyström

**Abstract** Sustainability is something that unites humankind and the important 2015 UN Climate Change Conference manifested this and was described by many as our last chance. A shifting towards sustainability through design is a challenge for managers and policymakers of organizations since the existing system or product could be complex and may have difficulty to adopt such a shift. This paper explores how organizations and their designers and developers could benefit from having a predictable process to follow for conducting such a shift, since numerous challenges are associated with costs and revenues. While universal design (UD) is a design philosophy closely associated with the sustainable design, an advanced perspective of UD could be implied as a redesign strategy for existing design and may be used as a radical design and innovation strategy for sustainability. In this paper, some of the aspects of UD as a redesign strategy for sustainability are addressed. Based on the previous theoretical frameworks, a UD approach for redesigning towards sustainability was formulated and discussed.

**Keywords** Sustainability, Information System Design, Universal Design, Universal Design for Redesign

## 1 Introduction

Organizations face continual challenges and are in fierce competition to keep up to date with constantly changing market needs, due to rapid technological developments. Following or being ahead of any current trends is also seen as a major reason for investment to make a company unique and differentiate them from others through innovation. Sustainability is well known for its power to differentiate products and their design since it add values that can be appreciated by the customers. Moreover, society as a whole naturally feels different social and environ-

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mental pressure and responsibilities [13] and organizations running business are no exceptions. With different strategies of adopting current trends, redesign could be seen as central for organizations' strategy while dealing with sustainability. This is because redesign could be an ideal incremental innovation strategy for organizations that take into consideration complex parameters of the business process, which are important for an organization's commercial and economic success. Although, at one time design could be sufficient for an easy situation, Weick [20] emphasized the importance of redesign in a turbulent environment by referring to Kilmann et al. [8]. When designing a product with sustainability in mind, redesign strategy is equally important since in a redesign process different factors like customer satisfaction and user experience could be easily accessible, which are important for the success in terms of sustainability. The risks associated with redesign are also lower compared to a completely new design in a radical innovation process. While design could have a lot of potential in relation to sustainability, the present lack of different designer engagement is seen as a missed opportunity for business from the sustainability perspective. Therefore, new radical thinking and solutions are required for the sustainability achievement through design, by demanding more engagement of the designers in the design for sustainability issues [13]. In this respect, UD has been well known to be interrelated with the notion of sustainability and in recent times it has been often strictly argued that sustainable design cannot be achieved without being universally designed, and vice versa. UD as a design strategy has notably shown its potential in design for sustainability issues. For instance, Mustaqim and Nyström [9] revealed how UD principles as a base could generate sustainable IT system design principles by thinking outside associated accessibility issues. Although UD is being used as a design philosophy, it has failed to show any evidence of being used as a redesign strategy with respect to sustainability. This absence of using UD as a redesign approach initiated the underlying research question of this paper—What could be the aspects of UD as a redesign strategy for sustainability?

A brief background presented in Sect. 2 analyzes the status and relationships of UD with sustainability to explore the scope of UD as a redesign strategy. These analyses lead towards exploration of UD as a redesign process for sustainability, presented in Sect. 3 in which previous theoretical frameworks are used. Some design principles are then derived (Sect. 4) that could be useful for designers to practice redesign for sustainability. Finally, discussions with future work aspects and conclusions are drawn in Sect. 5.

## **2 Background**

### ***2.1 Sustainability and Universal Design***

Redesigning strategy and UD has not been found to be discussed in the previous literature (searching 05-20-2016 Scopus and Web of Science with keywords: 'UD,

universal design, design for all, and inclusive design' combined with 'redesign and re-design') and therefore should be considered as a very new and interesting concept to explore. However, considering UD previously proved to be useful in research conducted by Mustaqim and Nyström [9, 10] when UD was viewed as a useful resource for sustainability achievement. Historically, UD as a concept was introduced as a solution to accessibility problems detected in the environment and products and it resulted in seven design principles [15] that should permeate the design process. The accessibility problems became noticeable when the demography changed and more people got older or had other disabilities.

There is ambiguity surrounding the definition of sustainability and the expression is dependent on the research field, context, and personal cognition [3]. We recognize that the current processes of design, consumption, and production could be unsustainable and may thus have a negative impact on the multidimensionality attribute of sustainability. It should therefore be of highest priority for all levels of analysis (global, regional, closest society, and individuals) to try to strive towards equilibrium or to reverse human impact. The impact is sometimes measured as our global footprint; the footprint measures the human demand on biological productivity by assessing how much biologically productive sea and land area is necessary to maintain the given consumption of the human population at a specific point in time [19]. The calculation of the aggregated global footprint is very complex and yields only a rough estimation, [17] but it is clear that our present consumption is far from sustainable. The number of planets demanded by all humans has an increasing trend line, which showed 1.47 planets in 2012 [4]. In previous research, Nyström and Mustaqim [12] thus perceived and stressed the importance of not neglecting the complexity, dynamics, and multidimensionality that demands a holistic view on sustainability issues. This is especially important when setting goals and strategy for design or redesign. In the previous research, UD showed the possibility of analyzing sustainability, but was not considered as a redesigning concept since usually UD is practiced in a way to be a quick solution when addressing accessibility problems in the environment or products. The value of UD could be larger if it is applied as something with the possibility of changing the context of a design and thus having a larger impact on the outcome of the sustainability issues. The latter use of UD towards a radical design outcome is thus the focus of this paper.

## ***2.2 Universal Design as a Redesign Strategy***

UD as a redesign strategy for a focused scope of interest like sustainability is the attention of this paper and therefore will be discussed here. Although the term "design for sustainability" is well known, it often aims to redesign existing products or services towards any sustainability-focused view. This, however, still triggers incremental innovation and is quite useful for many underdeveloped or developing economics because the associated risk would be less for this kind of redesign. But for a long-term commercial success, radical innovation is important and as soon as

we bring the knowledge from design science into this process, the needs of user-centered design, etc. come into consideration. Using UD from a design science perspective is a novel idea for sustainability with which the associated risk could still be low since a total new radical shift for designing towards sustainability would not be initiated. Thus, the large-scale radical innovation could be achieved by the conjunction of several smaller incremental innovation outcomes achieved previously through UD, and that is one way to view the redesign using UD.

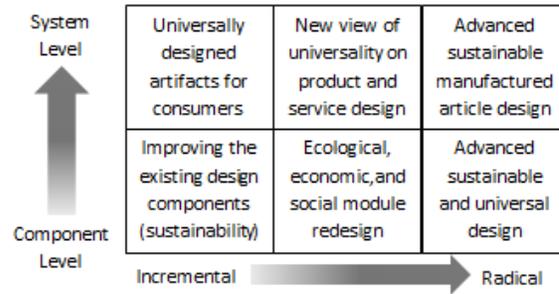
It is also important to realize that redesign for sustainability could again mean going back to the roots of a specific problem in design and then finding an improved solution, i.e. practicing radical design strategy. In addition, redesign was recommended to be started by practicing radical design [7]. The UD philosophy is not a revolutionary process and therefore it is not possible to come up with a result suddenly reflecting UD in a design phase. Instead it should be incorporated from the beginning of a design. Hence, UD could be seen as a radical design process, which should be ideal for redesign.

Norman and Verganti [11] addressed the hill-climbing paradigm to describe how incremental and radical innovation can take place and also explained that there is a need to change the frames of different solutions for a radical design movement. Both UD and sustainability are well known for creating several solution frames within their respective domains. What is needed now is to do something with both UD and sustainability that has not been done before and thereby triggering and unfolding the radical design movement. Norman and Verganti [11] also claimed that most radical innovations were done without the help of design research and therefore are a weakness of any radical design thought. Understanding and incorporating an advanced concept of UD as a design philosophy in the form of redesign strategies could therefore work as a trigger in a radical design movement for sustainability. By UD as a redesign strategy, it would be possible to generate a long-term breakthrough radical design map for bringing changes in the sustainability research. That is to say, while several incremental designs and innovations through human-centered design and design-driven research have contributed different solutions by traditionally looking into UD, it is now time to take a radical look into this concept as a redesign strategy and by doing this some novel interpretation could be initiated within the interest of sustainability and its research domain.

### **3 Universal Design as a Redesign Process for Sustainability**

Previous discussions clarified that in discussing the potential of UD as a redesign strategy for sustainability it would be justifiable to discourse how UD could be used as a design philosophy for radical design and innovation for sustainability. In this section, the arguments for this will be presented and discussed. Tidd and Bessant [16] illustrated in their framework, based on the Henderson-Clark model, [5] the dimensions of innovation when they showed how different ranges of choices could occur at diverse levels(component level and system level) and the degree of inno-

**Fig. 1** Dimensions of UD as innovation strategy of sustainability (adapted from Tidd and Bessant [16])



vation (incremental and radical). Utterback and Abernathy [18] presented in their dynamic model an innovation life cycle that described the innovation process from the appearance to the disappearance, compared to Tidd and Bessant who presented a static model of innovation theory. In this section, UD as a radical design and innovation strategy for sustainability will be discussed within the context of this framework and life cycle. Figure 1 shows the different dimensions of innovation (adapted from Tidd and Bessant [16]) discussed in Sect. 3.1, while Fig. 2 shows the revised life cycle of innovation (adapted from Utterback and Abernathy [18]) discussed in Sect. 3.2.

### ***3.1 Dimensions of universal design as a radical innovation strategy***

Figure 1 illustrates how UD could be used as a component to system level. The kinds of changes in terms of innovation for sustainability or sustainable actions that an organization could experience are also highlighted. The figure could be seen as a matrix displaying six dimensions of UD, dependent on the radicalness versus incremental degrees of innovation and from the component to system abstraction level.

An existing design of a product or service could be improved using UD as a design philosophy with which the new design could be more sustainable than the previous one. In the component level of a system this could be seen as an incremental innovation since the output action after using UD would actually be improving (sustaining) what an organization was previously doing. On the other hand, at the system level this incremental innovation could result in sustainable artifact designs for the consumers. If UD was used, this artifact could be called ‘universally designed’ where the boundary of the universality could be predefined within the context of sustainability. For example, during the improvement of a home for the elderly in which UD was already practiced, the design could be more sustainable if UD was used for further addition of different functions instead of a total redesign of the home. This way it would be used as a redesign tool at the component level.

A step from the incremental innovation stage towards radical innovation would be possible when UD could be thought to be used in a more complex way, introduc-

ing a new concept to the organizations. At component level, the addition of different parameters from the classical sustainability could be seen as a new way of using UD for the organizations. Thus, the concept of universality could be extended from the boundary of limited understanding of sustainability from the system-level view. The end product design could be benefited from an attempt to build an advanced notion of universality supporting a broader concept of sustainability. For example, a complex business model could be an example when the addition of a component for making the whole model's outcome sustainable is a challenging task. However, with UD as a redesign strategy in this case, the organizations could obtain new knowledge about how the business model would behave. Adding or removing elements at the component or system levels for sustainability could therefore be easier, as new knowledge about their business model could be realized by the organization in this example case.

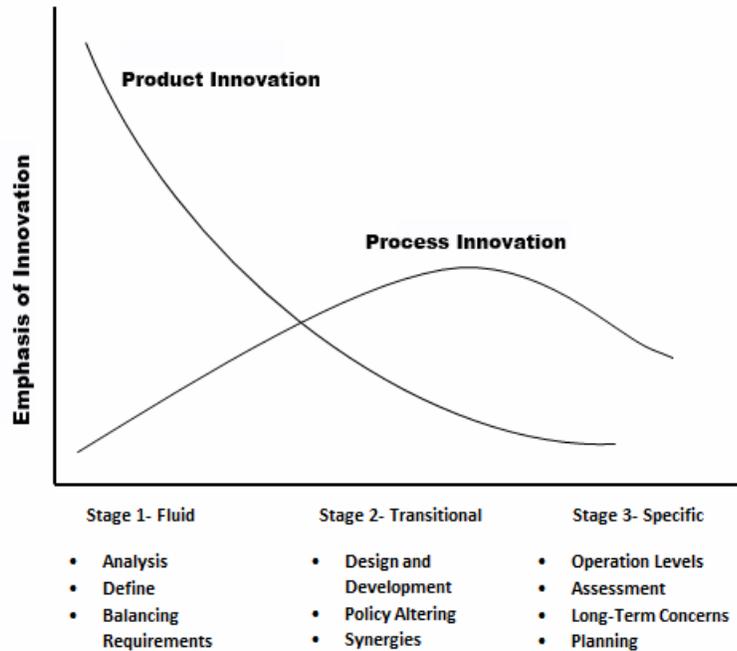
Finally, radical innovation could be achieved when organizations would consider an advanced concept of UD in their design at a component level. Of course knowledge of these concepts should be built by doing things in an improved way that the organizations are aware of, that is to say, by successive performances of incremental innovation. Since radical innovation aims for unique knowledge, the component level could be represented by the new way of looking at sustainability. Similarly, at the system level the sustainable artifacts designed by organizations for the end users could be seen as the radical innovation. For example, a complex integrated business system could be thought of as an example in which the presentation of a complete new knowledge of the world could be attempted by the organization. In this case, the different component levels of the complex system could be redesigned by using UD as a redesign strategy. By doing this, a resulting system could reflect a radical innovation result, while achieving and maintaining the goals of sustainability too.

It is important to realize here that the matrix explained above should not be confused with the use of a design philosophy, like UD as a new addition to different ranges of services. Instead, the existing component or system levels of the system could be augmented by using UD as a redesign concept, thereby triggering radical innovation towards the objective of sustainability.

### ***3.2 Innovation Life Cycle for Universal Design as Redesign Strategy***

Innovation often occurs from unknown circumstances and it is thus important to realize different innovation opportunities over time. Figure 2 was adapted from Utterback and Abernathy, [18] showing three phases of the innovation cycle with the corresponding stages associated with them, while UD could be considered as a redesign strategy and is described in this section.

The fluid state reflects the initial uncertainty stage in which UD could be seen as a redesign strategy to realize the new configuration and required features of the system to be designed. In this phase, it is also important to understand how any



**Fig. 2** Innovation life cycle for UD as a redesign strategy for sustainability (adapted from Utterback and Abernathy [18])

technical knowledge will be used to design a configuration to be delivered in the form of an artifact to users. In the context of UD for sustainability, analyzing the existing product, design, and users and thereby defining the required configuration by keeping the requirement balanced within the technological ability dimensions are some of the stages that could be associated in the fluid phase. Realizing the proper configuration is tricky in this case and therefore the fluid phase would require a trial and error strategy for finding the right setup for an organization. A sustainable product innovation using UD would be highly benefited from the fluid phase of the innovation life cycle. An example of this could be realizing the setting up of the proper sustainable actions needed to be designed by an organization using UD. Thus, understanding the correct parameter of sustainability that needs to be focused on or achieved using redesign should be accomplished in the fluid phase.

Once the fluid phase is initiated properly, the next step will be a transitional phase called 'the dominant design' phase in which design and development, alternation of policy, and handling different synergies happen. The rules for defining sustainability for a process or product design using UD should be considered in this phase, and therefore it is very important for an organization since escaping from this boundary defined in this phase would be very difficult once the process in this phase had been started. The dominant design phase could be ideal for focusing process innovation for sustainability using UD. An example could be the setting up and designing of

**Table 1** Characteristic matrix for design principles and stages of innovation life cycle

<b>Design Principles Properties</b>	<b>Fluid State</b>	<b>Transitional State</b>	<b>Specific State</b>
Component-level definition	<b>Requirement analysis</b>	Redesign module	Module cost reduction
Systems level balance	<b>Balance user needs</b>	Artifact design	System productivity
Redesign in component level	Define sustainability	<b>Custom design</b>	Cost analysis
Transitional redesign of artifact	Product assessment	<b>Idea maturation</b>	Alter business strategy
Specific component level	Redefine requirements	Define boundary	<b>Cost reduction</b>
Low-cost sustainable artifact	Reanalysis of needs	Alter policy	<b>Advance productivity</b>

different selected sustainability actions through UD and thus focusing the specific scope of an organization.

Finally, the specific state of the innovation cycle would focus on fine-tuning the end artifacts. Operation-level analysis, assessment of the designed product or service, long-term benefits or problems, and thereby planning for new product design are some of the associated stages here. Both product and process could be considered here to be designed. Using UD could be beneficial as a redesign strategy for sustainability in this phase, since it would reduce cost, which is one of the primary focuses of this phase. Cost reduction of the designed product or service and analyzing for further redesign could be examples of this specific phase, e.g. products could be efficiently built by using more sustainable products and using less raw materials and other resources. Here the complexity of sustainability is exposed, namely to balance between cost and sustainability and finding a good solution (Pareto optimality) since multi-objective optimization has no single optimal solution [6], and thus the decision-maker picks the trade-offs and chooses one solution [1]. Thus redesigning using UD for a sustainable outcome of a product or process could be seen as a scope of narrowing down possibilities in a successive way, whereby different possibilities and scopes of innovation should be emerged for an improved sustainable outcome through design.

## 4 Design Principles

The different UD dimensions and associated innovation phases presented in Sect. 3.1 and 3.2 were used as a base to structure six design principles that are presented in this section. The addressed design principles could be used to redesign an existing product or services for sustainability by triggering radical innovation and design in the long run. These design principles and their corresponding actions with the three phases of the innovation life cycle were shown in Table 1 in the form of a characteristic matrix described below. For each of the three stages (states) two design

principles and their properties in bold text are allocated and are exclusively dedicated for each stage. None of the bold text are design principle properties belonging to the respective stage.

**Principle One: Analyze and define sustainability problems with component level.** Sustainability achievement is often a complex problem and analyzing the requirement from the root level is therefore important. Breaking a system into smaller components might bring novel solutions by new thinking patterns. Realizing and defining the key sustainability problem that an organization would like to see through redesign should therefore be the first stage of a redesign process for sustainability.

**Principle Two: Balance sustainability requirements in system level.** Analysis from the component level would move more towards system-level analysis, and a balance between the sustainability requirements for different components of the system is needed to avoid any unachievable needs at the system level. This will manifest the comprehensive sustainability goal and wrongful optimization caused by myopia at the component level will thus be avoided.

**Principle Three: Redesign and develop sustainability modules at component level.** Component-level redesign based on the boundary of sustainability is the next thing organizations should follow. This is a transitional phase and is often ambitious, and a dominant design strategy would be necessary to facilitate the right innovation. Here different earlier initiated design concepts associated with sustainability could grow with the help of UD in the form of running incremental innovation.

**Principle Four: Alter policy and handle synergies for transitional redesign of the artifacts.** In the next step, the focus should be on the artifacts, since redesigning different components or modules of a system would eventually lead to the end design. Organizations need to alter their policy and accept or reject different synergies as this comes from the proper understanding of sustainable artifacts by using the contextual meaning of UD. Here the alignment between business strategy and artifact is expressed and might need adjustments if mismatched. This could then give incentives to modify the strategy and gain or strengthen the competitive advantages of the organization.

**Principle Five: Operation-level assessment of specific component redesign.** Operation-level assessment and analysis of the design from the component level could help to reduce costs for future design and development. Organizations should therefore use redesign strategy at a specific level of the design for a specific component or set of components of the system. Vision for future design and requirements for the new or reanalysis can be realized here and thus the perceived and real meaning of sustainability could be realized in an improved way for the organizations by the use of UD.

**Principle Six: Specific advanced low-cost, sustainable artifact design.** More mature incremental innovation trying to take a radical shift in design should consider complex concepts like cost or improved productivity in the specific phase. Component-level analysis, although specific, with focused parameters of sustainability would then lead towards the artifact level. How to keep the artifacts' cost lower for their users and still provide sustainable results through the use of UD will therefore be the ultimate challenge.

## 5 Conclusions

It is often more cost effective to redesign something existing compared to initiate and construct something new. Also the associated risks and uncertainty is higher, and calculating return on investment is more difficult. The novelty in this research is reached by the use of UD as a redesign process towards a set sustainability goal, i.e. combining UD and sustainability. In their research, Norman and Verganti [11] concluded that it is very much possible to reach a meaningful radical innovation result

through design-driven research, and for doing this, research directions should be changed towards new meaningful interpretation for users. Following this, we state that the traditional way of interpreting UD seems to be in a loophole and by looking into UD as a redesign strategy for promoting sustainability through design is a novel concept and can produce meaningful results for the end users by triggering radical innovation, which was argued in this paper. Furthermore, the addressed aspects of UD in this paper could be interesting and important for business when identifying critical targets and accomplishing them with limited resources. Organizations can improve different associated items in their business model with the help of UD as a redesign tool for sustainability.

Improved understanding of sustainability could be achieved by not looking at only the environmental aspects of sustainability. Geels [2] therefore identified from Stirling [14] that sustainability is “a deliberate social learning process” and not merely a “technocratic challenge.” Now this deliberate process cannot be designed at once, but searching outside technology in radical design and redesign could be supported by the idea of UD. The concept of sustainable human-computer interaction (HCI) can therefore extend beyond the persuasive and use traditional HCI design concepts to contribute to sustainability.

One weakness that should be further studied is the problem to implement a strategy for radical innovation, since most of them are unplanned. Many regard a strategy that includes radical change as futile, but the use of sustainability could bring novel ideas and thus enable radical innovations in the form of novel business models. Another problem is measuring the radicalness of an innovation, and at what stage the incremental innovation becomes radical. Future research based on findings from this paper could be in the form of investigating the factors found in the three stages of the innovation life cycle for UD and distinguishing if they are equally important for success in the pursuit of a redesigning strategy towards sustainability.

In this paper, we explored the possibility to using UD as a redesigning instrument for sustainability for the task of redesigning exiting artifacts, socio-technical systems, products, and services. Sustainability is presently a major business driver, and organizations are trying to keep it up. Proper tools for achieving sustainability are still in the form of an expanding growth, and technological development enables social, environmental, and economic improvement. A change is needed since limitless economic growth is not possible, as our planet’s capacity is limited following our present global economic footprint status. To compete in this challenging market redesign towards sustainability can be a critical movement that the organizations should embrace for adding value to their brands for achieving customer satisfaction. If an organization does not embrace sustainability, there is a risk of losing competitive advantages to competitors and missing the opportunity of increasing present human capital value and gain ahead of others. UD and its expanded approach as a redesign philosophy as presented in this paper could improve the chance of reducing the risk associated with redesigning and thereby may reduce investment costs with improved user experience. Further analysis with empirical data of redesign for sustainability would therefore give new insights about the presented process and design principles in this paper.

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