Design as an instrument to bring about behavioral change

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Abstract

In their daily lives, people engage in all kinds of activities during which they interact with products and use energy. Designers, through their design decisions, have influence on user behavior, and thus on resource consumption. However, products are often not used as the designer intended, which in turn influences the effects on resource consumption. Therefore, in order to anticipate on the effects of products, users need to be involved in the design process. This notion is essential for sustainable design, where unintended use can nullify or even 'rebound' the products' desired effects. Furthermore, researchers in the field of Design for Sustainability (DfS) now argue that in order to reach sustainability, designers need to look beyond single products and their use, towards a more systemic approach of daily life. Meanwhile, researchers in sociology have been calling for similar ways of approaching DfS, exemplifying that effective change can be achieved when designers step away from products and take daily activities as the basic level of analysis. Taking these developments into account, a design method is proposed that involves users in the context of their own home in developing innovations on the level of daily activities. This method was developed and tested within the context of the Living Lab design study. The pilot study on the activity of bathing indicated that this approach is capable of generating insights for innovations that yield strong reductions in resource consumption while fitting into daily life.

Keywords: Bathing, Co-Design, Sustainable Innovation, Household Resource Consumption, Practice Theory

Introduction

Society is currently consuming resources at a rate that is likely to compromise the ability of future generations to meet their own needs, i.e. society is not sustainable according to the Brundtland definition (Brundtland Commission 1987). In Europe, households account for around 25 percent of the total direct resource consumption of society (European Commission 2007). Products play an important role in household resource consumption. Many products, when used, have a direct impact on the environment; they require energy or water to function (e.g washing machine) or they are (partly) discarded in the form of waste (e.g packaging). The notion that designers, through these products, can influence resource consumption is permeating the design world, which increasingly wants to take responsibility for reaching sustainability through design (Hekkert et al.2009; Manzini 2008; Ehrenfeld 2008).

In the design field it has long ago been acknowledged that if and how products will be used is for designers very difficult to understand, let alone predict it (Branscomb 1983; Gould and Lewis 1985). Experience has learned that when aiming for a specific effect of products during the use phase, like reduced resource consumption, involving a use perspective in the design process is essential (Wever 2008; Verbeek and Slob 2004; Roy and Caird 2006; Elias et al. 2007). Developing sustainable technologies alone, a so-called technology push strategy, has proven not to be sufficient to reach effects in the household arena. In spite of increased efficiency of energy consuming products, overall energy consumption of the household sector has not decreased. On the contrary, electricity consumption of Dutch households for example, has increased by 24 percent in the past twenty years (MilieuCentraal 2009). Partly because sustainable technologies are primarily serving a societal need rather than a personal one, they do not tend to sell themselves. Furthermore, research has shown that when in use, the desired and anticipated effects of the technologies on household resource consumption are often not met because they are not used as intended (Hertwich 2005). When aiming to achieve sustainable innovation, it is therefore particularly important to integrate a use perspective in the design process.

Living Lab research infrastructure

The Living Lab project[1] is an EU funded design study for a new European research infrastructure. The current project runs from January 2008 to December 2009. Goal of the research infrastructure will be to foster societal needs such as environmental sustainability and quality of life and stimulate the competitiveness of European industry that brings such innovations to the market by researching human interaction with innovations around the home.

The unique aspect that makes this Living Lab infrastructure different from existing initiatives is that it contains a physical infrastructure of Living Lab houses that allow test persons to reside in a realistic home environment for longer periods of time. Existing initiatives such as

[1] Partners in the Living Lab project are: Delft University of Technology (coordinator), Wuppertal Institute, ETH Zurich, Universidad Politecnica de Madrid, BASF, ACCIONA and Procter & Gamble.

home labs in companies and universities only allow for short stays and don't create a realistic living situation, for example because inhabitants don' have their own front door.

Roughly, the Living Lab approach consists of three related steps of 1) generating insights at existing homes, based on the insights 2) develop sustainable solutions and test prototypes in the Living Lab house with temporary inhabitants, after satisfactory completion of this stage 3) evaluate fully functional prototypes over a longer period of time in the field (Figure I).

Figure I: three step research model Living Lab research infrastructure

Unique about the infrastructure are its long term, in context user testing of innovations and its labs in different countries in Europe that will facilitate cross-cultural research. To foster valorization of knowledge, the research infrastructure will serve as a meeting place of science and industry. Researchers can use it to develop new knowledge on people's behavior in relation to energy consumption in the home and new innovation methods.

Part of the design study is the development of novel methods for sustainable product development with the goal to reduce household resource consumption. One important ingredient for successful sustainable innovation has been mentioned already, and that is close user involvement. Another notion that is gaining increased attention is the need for taking a system level approach. Both will be addressed in more detail in the following.

User involvement in design

In his thesis on Human Centered Design (HCD), Marc Steen gives an overview of different forms of HCD, which he has defined as researchers and designers talking to the people the designer is developing a product for (Steen 2008: 19). In this sense HCD is clearly distinct from technology push that is separate from people's needs and preferences. He places six distinct HCD approaches on two axes. The vertical axis represents the difference between studying and understanding users on the one end and (help users) envision and create innovations on the other. Or in other words: 'designer-centered design (imagined users in imagined situations)' vs. 'user-centered design (real users in real situations). The vertical axis represents the different orientations within the methods with regard to their descriptive or generative orientation. The six methods thus categorized are further explained below.

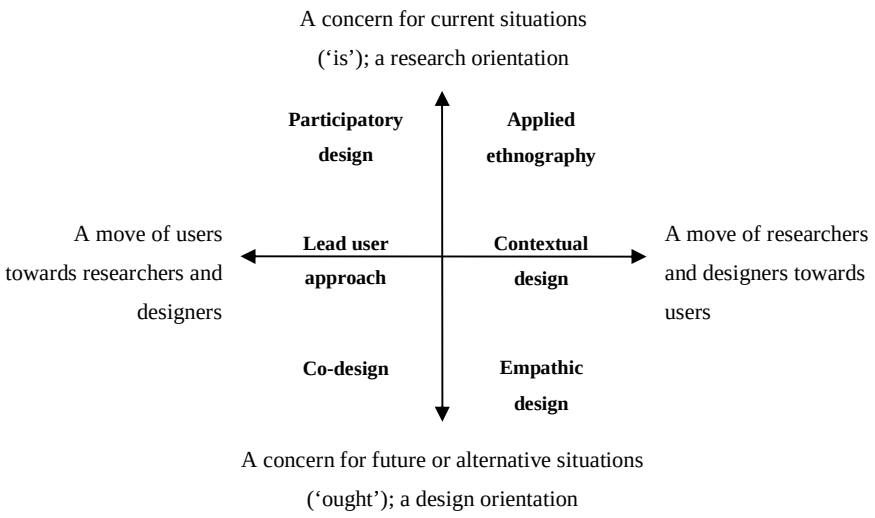

Figure II: Different human-centered design approaches (based on Steen 2008: 31)

Participatory design is a design approach with its roots in Scandinavia where it emerged in the 1970s in computer systems design. The method is based on the notion that the end users of the product, first mainly professional users, are experts of their own work situation and should thus be given the opportunity to bring their knowledge and skills into the design process (Bødker et al. 2004). *Applied ethnography* studies how people use (current and future) products in the field. It was first used for design purposes by Lucy Suchman, who convinced Xerox management of the importance of in context user research by presenting the results of her study on how people use copiers in their offices, which was quite different from what the management had expected (Steen 2008: 37-38). The *lead user approach* is based on the observation that many ideas originate in the hands and minds of innovative users, a phenomenon first documented by Von Hippel (1986). The lead user approach is different from participatory design mainly in its commercial rather than democratic character. In *contextual design*, researchers and designers observe people in their natural context to gain insights for design. The findings are immediately discussed and translated into recommendations and design requirements. *Co-design* is a form of co-creation. In co-creation all stakeholders of a certain system, product or service collaborate in its development (Prahalad and Remaswamy 2000). Co-design lets users, researchers and designers cooperate creatively so that they can jointly explore ideas and concepts, make and evaluate sketches and tinker with mock-ups or prototypes (Sanders and Stappers 2008). It can be seen as a form of participatory design, but more generative, including creative tools from art and design traditions. Key points of co-design are the recognition that everyday people can become co-creators rather than just customers and users and can contribute as experts of their own experience (Sleeswijk-Visser et al. 2005). Co-design focuses on what people make rather than what they say and do to obtain tacit knowledge about peoples dreams and ambitions. Finally *empathic design* is an approach where designers try to empathize with users in their daily experiences and emotions using combinations of observations, role playing and playing with prototypes (Buchenau and Fulton Suri 2000).

Co-design, which is the most user oriented and generative approach of the six, seems most compatible with the objectives of the Living Lab research infrastructure. It takes a user perspective, involves users and focuses on gaining insight into future (use) situations rather than what is currently there. Within co-design, creative tools are used to streamline communication between designers, researchers and users. An example of such a creative tool is cultural probes. Probes are defined by Mattelmaki (2008) as 'specifically designed material packages given to the potential users to document their private lives, contexts and experiences'. Practically this means that people from the target audience of the product are approached to participate in a study by executing prescribed tasks in a use context.

Practice theory

In the field of Design for Sustainability (DfS), different strategies have been developed to address the issue of high and increasing household resource consumption. Experiences from the past, however, show that reaching sustainability through design is not a straightforward task. Traditionally, design has taken a product oriented approach, focusing on the energy efficiency of the product and the way it is used. Often, however, this is not realistic. For example, the efficiency of light bulbs sold today is such that they use only half of the energy they used fifty years ago. However, this increased efficiency was counterbalanced by a corresponding fourfold increase in per capita 'consumption' of light (Herring and Roy 2007). This effect of increased consumption in response to increased energy efficiency of technologies, the so-called rebound effect, has been thoroughly described by others (e.g. Hertwich, 2005; Frondel, 2004; Herring, 2004).

In response to recommendations made on the basis of rebound effect studies and in line with developments in the field of design, recently a user centered approach to design for sustainable use has emerged. This approach aims to influence the use of energy consuming products through the way the product is designed. An often used example is that of an electric water cooker. An energy related problem with this type of products is that people tend to heat more water than they actually need, thus wasting energy (Elias et al. 2007). Design for sustainable use aims to identify these 'wasting' aspects of product use and design the interaction between the product and the user in a way that this waste is prevented, for example by making a water cooker that is filled in portions of one cup at a time to make users more aware of the amount of water they heat.

Although valuable for steering product use toward better energy efficiency, this design approach aiming for sustainable use behavior is less suitable when aiming for radical sustainable innovation. Researchers in DfS and related fields are now arguing that to reach a sustainable society, more radical innovation is required that looks beyond single products and their use. Already in the 90s, Brezet and Hemel (1997) describe the type of innovation needed to reach sustainability as 'system level innovation', complementing but going beyond product improvements, redesigns and functional innovations. A more recent call for a different approach to sustainable design comes from Ezio Manzini. Manzini is an influential thinker in the field of Design for Sustainability and initiator of the Changing the Change conference, an international

conference on the role and potential of design research in the transition towards sustainability. In his opening speech of the conference he says:

> "Research on eco-efficiency has been successful, but has not improved the overall picture. Current products and services, taken one by one, use far less energy and materials than those of some decades ago. However, no indicator of aggregate consumption (residence, mobility, tourism, etc.) indicates a decrease: even in countries where research on eco-efficiency has been most successful, overall consumption of environmental resources continues to increase. This tells us clearly that increasing improvements in the existent are not enough: the transition towards sustainability requires a systemic change. It is not a question of doing what we already do better, but of doing different things in completely different ways." (Manzini 2008)

Manzini calls for visions of sustainability on different scales and with reference to various aspects of people's lives. Energy efficiency on this lifestyle level is primarily about the choice of means to reach a certain result, e.g. mobility, clean clothes or food delivery and not about single products and their use. However, designers are not used to thinking beyond product-user interaction. To design for system level innovation, a level of analysis is required that encompasses people's lifestyles, but of which products and product use is still part. This larger entity can be found in practice theory.

Practice theory, a concept developed within the social sciences, takes daily practices, such as bathing, cooking and doing laundry as the basic unit of analysis (Reckwitz 1994). Central to practices are not products, but 'doings'; actions taken to accomplish the practice (Ingram et al. 2007). These actions are shaped by the interconnected elements of practice that can be summarized as conventions, competences and material artifacts (Shove et al 2007:9). Conventions are collective ideas that exist in society of what is normal practice. Competences are skills and knowledge that can be embedded both in products and in people. Material artifacts represent the orchestra of things deployed in the 'doing' of the practice. In cooking for example these include pots, pans, stove, tap, counter, food products, microwave, knives, cutting board, and so on. These three elements can be abbreviated into the terms image, skill and stuff to make a graphical representation of the practice (Figure III).

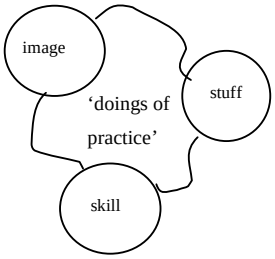

Figure III: the elements of a practice

From a design point of view this means that products play a role in shaping practices, in which resources are consumed. Engaging in a practice, or the execution of practices, results in a certain amount of resource consumption that can be expressed in different units. For example,

doing laundry requires a certain amount of electricity and water per month. Through product interventions the activities within the practice can change and therefore the resulting resource consumption. Starting point in this approach are thus not products but coherent sets of activities.

A practice oriented approach is different from a use behavior oriented approach because a practice can include more than one product and the resource consumption of the practice as a whole is targeted instead of the resources consumed through the use of one product in the practice. This broader view on resource consumption in the household does not only open a new approach that can offer different kinds of insights for sustainable innovation, it also offers a platform for more radical forms of innovation. An innovation is a successful change from one situation to another. In this case the goal of the change is to reach a situation with lower resource consumption than the current one. To illustrate the position of practice oriented design, different levels of innovation can be distinguished: changes on a practice level, i.e. practice level innovations and product level innovations (Kuijer and De Jong 2009). Product level innovations can be both use behavior innovations and technological innovations. To illustrate these three levels of innovation, an example of making transportation by car more energy efficient is shown in Table I.

Table I: three levels of innovation

Technological innovation	Improving efficiency of car motor to drive further on one liter of fuel.
Use behavior innovation	Giving feedback to car user on when best to change gears to save fuel
Practice innovation	Sharing a car with more people, offering alternative means of transportation

The notion of applying practice theory to DfS problems has been advocated by a particular research group in sociology led by Elizabeth Shove (Shove 2003; Shove 2006). Shove argues that 'designers have an indirect but potentially decisive hand in the constitution of what people do' (Shove et al. 2007: 137). The question remains how designers can purposefully use this influence to steer practices towards lower resource consumption. This is where the connection between practice theory and design is made. Practice theory is useful for understanding the dynamics of practice as it is. Design is specialized in thinking about potential future scenarios and ways to achieve these through products.

Two main ingredients

Summarizing the above, two main ingredients should be integrated into a successful method to bring about change in household resource consumption. The first is close user involvement and taking into account the actual context of use in line with the principles of co-design. The second is taking the coherent sets of activities that form daily practices as a basic unit of analysis.

The design method

In the Living Lab design study, the product development process has been divided into three steps, which are insight generation, developing and testing and evaluating in the field (see Figure I). The two ingredients were applied in a method for insight generation. The proposed method is based on earlier work by Kakee Scott. In her master thesis, Scott proposed a practice oriented co-design approach to generate insights for practice level changes in the lives of ordinary people (Scott et al. 2009). Core concept in the method proposed by Scott was 'innovation in practice'; participants are challenged to come up with new, less resource intensive ways of doing and experiment with those in their own homes. The method was tested in a pilot study on the practice of bathing. Bathing is defined as a collective understanding for all kinds of washing activities at home, such as showering, washing at the sink and so on. It was proven to be useful for coming up with ideas for new ways of bathing, that were less resource intensive than the currently dominant daily shower, for example 'taking a sponge bath' (Scott 2008). Although Scott did not focus on the role of products in bringing about or facilitating the change, the outcomes did show opportunities for design. For example, when sitting down for a sponge bath, the shower tap is difficult to reach because it was designed for use while standing.

In general it was observed that in changing towards less resource intensive ways of bathing and maintaining these, participants were limited by the possibilities of their existing material surroundings. To take the approach one step further into the direction of product development, adjustments were made to the proposed method to extend its scope to product ideas. When approaching practice oriented design from a product design perspective, two different kinds of ideas can be distinguished: ideas for different ways of doing and product ideas.

The second version of the method still contains the elements of letting users experiment with their practice at home. In addition a final group session is held that focuses on generating product ideas. Figure IV depicts the set-up of the generative method. The figure includes the elements of the pilot study used to test the method, which will be explained later.

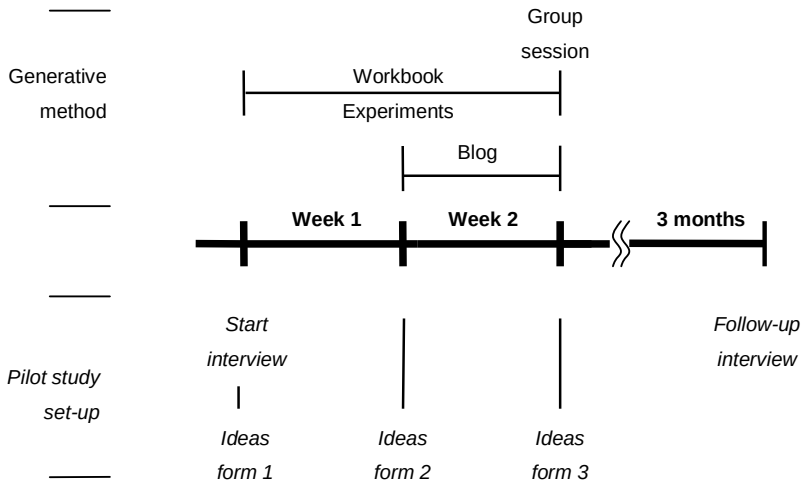

Figure IV: Set-up the generative method and pilot study

The proposed method consists of two main parts. Part one is a two-week homework assignment where participants are asked to describe their current practice and come up with and execute experiments; to think of different ways of doing that would reduce resource consumption and still be acceptable or even preferred as daily routines. Individual workbooks (cultural probes) with assignments and reflective questions guide participants in the process. An important function of the workbook is to stimulate participants to think about the practice and its resource consumption on a practice level. To explain the elements steering the practice and their relations, the simplified terms image, skill and stuff are used and represented graphically including an example (see Figure V). Participants are asked to describe their current practice and changes therein according to these elements. To stimulate exchange of ideas, participants are facilitated to interact on an online blog during the second week of experiments.

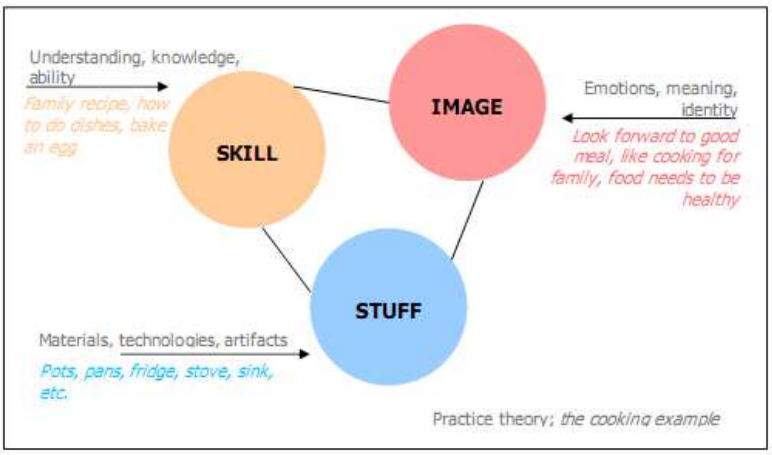

Figure V: Explanation of interrelated elements of practice

The second main part of the method is a group session at the end of the two weeks, in which the participants, together with the researchers exchange experiences of the previous weeks and develop product ideas.

Pilot study

The proposed method was tested in a case study, again on the topic of bathing, to be able to build on experiences from the study by Scott. The set-up of the case study is depicted in Figure IV, next to the generative method itself. The goal of the pilot study was to test whether and how the practice based co-design method could lead to design opportunities for reaching practice level innovation in the direction of (strongly) lower resource consumption. Sixteen participants from different countries in Europe were recruited, including representatives of the bathing industry. To track the development of the types of ideas, participants were probed for their ideas at three different points in time: once at the start of the study, once after the first week and again at the end of the two weeks. This probing was done with ideas forms: digital forms on which the participants were asked to individually describe ideas they had for new products, technologies and services to enable less resource intensive bathing routines. The ideas of Ideas Form 1, 2 and 3 and

the final group session were compared to determine what level of innovation an idea was and to what extent this changed during the experiment (technology oriented, user behavior oriented or alternative practice oriented). Participants were interviewed prior to the study to find out if and to what extent they had already been experimenting with their bathing practice. Three months after completion of the study, participants were contacted again to assess the long term effects of the study on their bathing routines.

Results

The pilot study was executed in November 2008. It resulted in thirteen filled out workbooks, with sixteen described experiments, fourteen ideas forms 1, ten ideas forms 2 and six ideas forms 3, notes from the start-up and follow-up interviews, thirteen posts on the blog and written and video materials of the final group session. The open innovation session was a one-day session at the university in Holland. The total number of product ideas was about one hundred.

The main research question was whether and how the practice based co-design method could lead to design opportunities for reaching practice level innovation in the direction of radically lower resource consumption.

A benchmark used to determine the level of reduced resource consumption was obtained by asking participants to report water use for bathing. Because this was a small sample with rough estimations, an alternative benchmark was included based on a comprehensive study of water use in the Netherlands (Foekema et al. 2008). Showering was in both studies the dominant form of bathing. Showering and its supporting products is therefore considered a benchmark to determine the levels of innovation inherent in the ideas generated during the study. Average water consumption for showering per week was 616 liters for the pilot sample and 358 liters for the Dutch population.

Practice level innovation

All experiments contained ideas for different ways of doing. Within the experiments however, two levels of innovativeness could be distinguished in the strategies participants took to reduce their (warm) water consumption. One was to reduce shower duration, the other to reduce shower frequency. Reducing shower duration sticks to showering as a way of bathing. It can therefore be considered an innovation on the user behavior level. Experiments to reduce shower frequency on the contrary, all sought to replace showering by some other form of washing the body. These types of experiments can therefore be considered practice level innovations. Experiments in this category were: replace part of showers with washing at the sink and; replace all showers with washing from a reservoir (bucket).

When comparing the water saving potential of these two forms of bathing with the benchmark and the short-shower strategy, it becomes clear that particularly these practice level innovations have highest potential for achieving radical reductions in water and energy consumption of bathing. An overview of the estimated water consumption of the three types of bathing compared to the benchmark is given in Table II.

Table II: Water use per week for different types of bathing

Bathing type	**Estimated water use**
Current shower	616 liters/week
Short shower	224 liters /week
Shower (weekend) & sink (weekdays)	196 liters/week
Bucket wash	55 liters/week

Looking at the development of the types of product ideas participants had, a clear shift can be observed from technology level innovations towards ideas based on practice level innovations. In Ideas Form 1, collected before the start of the experiments, most ideas were directed at either technological or user behavior level innovations. Examples are immediate hot water flow, making only a slight change to the current shower and time feedback in the shower, stimulating a change in the duration people shower. Interestingly, a remarkable number of ideas referred to the bathtub, while none of the participants reported to take baths regularly. This may be caused by the fact that participants relate a bath to large water and energy uptake. While in reality, due to its low use frequency, it only accounts for a small portion of water consumption in households.

During the experiments and especially in the final group session, the connection of ideas to the participants' experiments, whether their own or reported by fellow participants, became more and more apparent. In the second ideas form, one quarter of the ideas could be considered practice level innovations. In the group session the majority (seven out of nine) of the final idea each participant was asked to work out, abandoned the current practice of showering by adopting a different way of bathing (e.g. the ideas depicted in Figure VI).

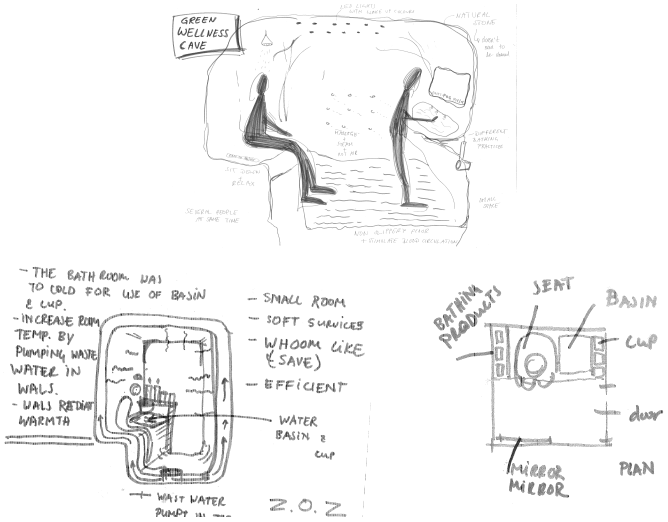

Figure VI: two of the ideas developed during the group session

These seven final ideas can be grouped into two categories based on the bathing processes they support being either ‘washing at the sink’ or ‘washing from a basin’. These categories show strong links to the ‘sink wash’ and ‘bucket wash’ experiments. From this it can be concluded that the experiments, and especially the more innovative ones, seem to have inspired participants in the development of their ultimate ideas fort he sustainable bathroom of the future. The resulting product ideas strongly differ from existing shower configurations and the different ways of bathing they support require much less water than the current practice of showering.

The use perspective

An idea, however, can only become a successful innovation and achieve reductions in household resource consumption when it is adopted and used as intended. Without making and testing the product ideas that have come out of the study, little can be said about user adoption. However, the study does generate insights into the desired future situation and barriers and possible enablers for reaching it.

The experiments, representing different ways of bathing, are not only thought of by the participants, they are tried out over a longer period of time in the home context. Participants did not just generate ideas for novel possibilities to bathe, but also gained insights on how these were experienced. For example, when taking shorter showers, participants felt stressed by the time pressure they imposed on themselves. This feeling of time pressure was not felt by the participants who washed at the sink or from a bucket. They experienced other barriers, such as getting cold or not feeling really clean. The duration of the study also resulted in an active adjustment process of the new routine. For example, one of the participants that washed from a bucket found a solution for the problem of getting cold by putting a hot towel around her neck.

Finally, because participants were consciously evaluating and manipulating their bathing routines, which is normally done rather subconsciously, it can be said that they have become experts on the doings and experience of bathing. In this light, the fact that seven out of nine of these ‘bathing experts’ picked up the sink wash and bucket wash concepts for their final ideas, indicates that they were at least considered seriously by this group of users.

Discussion

In the pilot study it turned out that innovations on a practice level, i.e. those abandoning the concept of continuously flowing water, were most promising in reaching reductions in resource consumption. However, they also require rather radical changes in the way people bathe. The great challenge therefore lies in the uptake of such an innovation. One of the basic assumptions of the study is that if people come up with new ways of bathing themselves in their own home environment, these are options that people are willing and able to engage in and thus form feasible alternatives for the current practice. What we can really say at this stage is that the *participants of this study* were willing and able to engage in those experiments *during the two weeks of the study*. This short term experience was not reflecting a long term change of routine. The fact that none of

the participants had completely continued their experiments until three months after the study, the time of the follow-up interviews confirms that.

Furthermore, the proposed method places great emphasis on ideas developed by users. Critics of human-centered design, however, argue that users are not capable of generating useful product ideas because they are not aware of technological possibilities and don't have the trained creative mind of the designer to anticipate on their future needs (Hekkert & Van Dijk 2001). This study showed that users who are actually simulating these future situations compensate this lack of anticipation.

Further research

The present pilot study resulted in two spin-off projects. One project investigates the possibilities of deriving practice level insights from different cultures (Matsuhashi et al. 2009) and the other project elaborated on the insights developed in the study to develop new products. To verify the assumption that the products designed with these insights have a potential to bring about large gains for sustainability in households, the next step will be to test these prototypes, for example in a Living Lab house, for a longer period of time to see what their effect will be on the bathing practices of the household members and ultimately on their water consumption.

Acknowledgements

We want to especially thank the sixteen participants of the study and the European Union for funding the Living Lab design study within which this research was executed.

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