Cumulus Mumbai 2015:
In a planet of our own - a vision of sustainability with focus on water
http://www.cumulusmumbai2015.org/

Engaging users through dynamic products for promoting water saving in a domestic environment.

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Abstract: Water is fundamental for life and is at the base of human progress. Although water has such an important value, every day a large amount of it is wasted due to users' negligence. We assume that designers can help users to be aware of their water consumption by designing products that provide them with more information about it, i.e. that give feedback about their behavior. In previous studies, it emerged the importance of designing such information according to three characteristic: metrics, frequency and representation.

This paper describes a research-through-design activity within a doctoral research. During the design process, the above mentioned three features of the information were taken into consideration in designing objects (i.e. a dynamic products) able to make users aware of the importance of saving water in their domestic life.

The results show advantages and disadvantages of designing dynamic products as media to encourage users save water in domestic environments.

Key words: water conservation, dynamic products, product experience, product communication

1. Introduction

It is estimated that 8% of worldwide water is used for household purposes (WBCSD, 2009). The amount of water needed for basic household activities (i.e. cooking and cleaning, excluding gardening) has been estimated at around 50 liters per person per day (Gleick, 1996). However, the real amount of water used in residential areas differs greatly region by region. The World Water Council declares that the highest use of water in residential areas is in North America and Japan (daily per capita water consumption is around 350 liters); then there is Europe, with 200 liters of water per person every day. At the other

extreme, in the residential areas of Sub-Saharan Africa, people use no more than 20 liters of water per day (Worldwatercouncil, 2015).

The households' excessive water consumption in developed countries strongly depends on the users' behavior. Indeed, a careless or improper behavior is the main cause of the waste of such a precious resource. As designers, we should reflect on the following question: How can design help users decrease their water consumption in their daily life? Studies (most of which carried out in the field of energy conservation) showed the importance of informing users about their consumptions to increase their awareness and motivation about saving resources (Darby, 2006). This information can be conveyed by different means. Among the others, like interfaces and smart devices, industrial designers can provide such information by designing communicative tangible products. In our view, such products should belong to the category of dynamic products, i.e. artifacts showing sensory features - e.g. colour, shape, sound, smell, etc., that change proactively and in a reversible manner over time, activating one or more user's sensory modality (Colombo, 2014). These products, not relying on the alphanumeric language, communicate with users through different senses. For instance, "My Shower is a Green Warrior," (Fig. 1) becomes spiky after four minutes of showering. Changing its shape, it discourages users to have long showers, promoting saving water. As this example shows, dynamic products can convey information to users in a more sensorial, and thus more engaging manner, as previous studies have demonstrated (Colombo and Rampino, 2015).

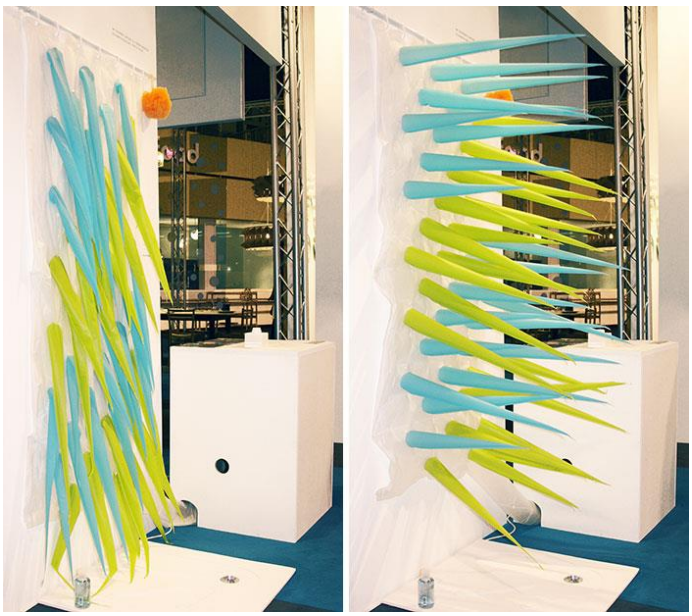

Figure.1 "My Shower is a Green Warrior," by Elisabeth Buecher

Dynamic products exploit the recent availability of new materials and technologies that lend new possibilities for designers to convey information through the materiality of products, at the same time creating pleasurable and engaging product experiences. Interesting results in the energy field have been already achieved in studies carried out in the area of critical design (Backlund, 2006). As a limitation, these studies refer mostly to electrical energy conservation.

2. Previous studies: exploring dynamic products as media for making users aware of their consumption

In a previous study (Bergamaschi, 2015) based on research carried out in the field of digital interfaces aimed to save energy, it was observed that three features of the information are important to make users aware of their resource consumption in a domestic context. They have been defined as: metrics (related to the unit of measure), frequency (related to the timing of the data: when and how many times is necessary to give information to users) and representation (related to the shape of the data). It was also argued that such dimensions might be integrated into dynamic products, to make them effective media for conveying information about user's consumption.

2.1 Metrics

A literature review on the topic pointed out different insights about the choice of the unit of measure to represent data about user's consumption. Different studies, most of which carried out in the field of energy conservation, tested the effectiveness of giving numerical data to users, such as the amount of CO2 emitted, the cost over energy and the amount of energy used (Darby, 2006; Jacucci et al., 2009; Fitzpatrick and Smith, 2009). In these studies, it was observed that giving information about financial savings is not effective over time (Darby, 2006; Jacucci et al., 2009). Fitzpatrick and Smith (2009) observed that numerical data could lead ordinary people to misinterpretations or to an incomplete understanding of the information. Indeed, pure quantitative information related to specific dimensions (e.g. the consumed energy in kW/h), which are used in the scientific field, are often difficult to understand for ordinary people. Knowing the amount of CO2 emitted is not sufficient per se to understand if one's behavior is environmentally friendly or not. Often qualitative data can give users less precise but more understandable feedback about their behavior.

Dynamic products are able to communicate with users in an intuitive way, using sensory stimuli instead of the alphanumerical language. Therefore, transmitting qualitative data is one of the peculiarity of these products. Designers can take advantage of changeable features for conveying qualitative information instead of quantitative ones.

Figure.2 Tio ghost concept by Tim Holley. It makes children aware of the amount of energy consumed by changing color from green to red and by changing the facial expression.

2.2 Frequency

Regarding frequency, it was observed that the feedback is more effective when it is given frequently and over long time, instead of inform users only when something is changing (in a good or in a bad way) during the usage of resources (Fitzpatrick and Smith, 2009; Fischer, 2008). That means the importance of the information to be continuously accessible to users.

Moreover, it was observed that users' appreciate to have historical details about consumption, because this allow them compare their usage in a given period of time, such as day by day or week by week.

On a dynamic products point of view, changeable features can be designed for giving frequent and immediate feedback about the resources' usage, since the changes can be fast.

Figure.3 Water pebble gives real-time feedback about the water consumed during a shower. It changes its color from green to red to communicate to the user that the consumption is getting unsustainable.

As a disadvantage, dynamic products are not able to convey complex information, such as comparative feedback over a period or several information organized in a hierarchical order. More accurate reflections have to be made regarding this matter. Previous studies had shown that the information that can be conveyed through dynamic products has to be simple (such as "now, your consumption of water is sustainable" or "you are being sustainable!"); comparison feedback could add complexity to dynamic products; thus, it is more appropriate to convey frequent feedback (Colombo, 2014).

2.3 Representation

Several studies (Jaccucci et al., 2009; Petkov et al., 2012; Kim et al., 2009) investigated the role of shaping information as an instrument for leading people to decrease their consumptions in a more conscious way.

Analyzing the motivations behind the resource-saving behavior, some researchers observed that giving users positive messages rather than showing them the negative effects of their behaviors can be a fruitful strategy (Jaccucci et al., 2009; Petkov et al., 2012). For instance, it is good to show users that they are good resources savers.

To make the consumption more understandable, the designer should find different ways to shape information. Metaphors can help designers represent data in a more understandable and engaging way, for instance by showing the consequences of users' sustainable (or unsustainable) behaviors. Thanks to metaphors, messages conveyed by products could be easier to understood and immediate. Test with users showed that the messages conveyed by metaphors can lead users to be sustainable over a long period of time (Kim et al., 2009).

Designers can take advantage of the evocative potential of dynamic products. Designers can shape the product's aesthetics and the dynamic sensory stimuli (such as visual, tactile, hearing, or olfactory stimuli) in a consistent way, to create cognitive associations with the message conveyed (Fig.4). This way, they can create strong metaphors (Colombo, 2014). Metaphors can remind users some concepts, ideas, and values; for instance, if the designer wants to convey messages related to nature, dynamic products might be metaphorically connected to this world, by conveying the information through sounds and aromas that remind it.

Figure.4 E-plant by Paolucci, Viola, Perna and Incarnate provides easy energy consumption information using the metaphor of the plant.

3. Objective

The aim of this study is to cross the knowledge coming from previous research about dynamic products and energy saving, and to apply it in the field of water saving. In particular, this study intends to explore how dynamic products can be designed as tools for making users more aware about their water consumptions. To this aim, this paper presents three concepts of dynamic products designed by taking into consideration the three information features: metrics, frequency and representation.

4. Methodology

The design activity described in this work aimed to put into practice suggestions and insights coming from previous studies about on both dynamic products and the features of information.

In order to understand if the knowledge generated in previous investigations could support designers during the design process, a design activity within a doctoral research thesis was performed. The activity lasted three weeks and involved a PhD student who belongs to the research group. This design experience aimed to generate dynamic products able to convey information about the user's water consumption.

During the design process, the three information features (metrics, frequency and representation) were taken into consideration in designing a dynamic product able to make users aware of the importance of saving water in their domestic life.

This design activity represents a real case study used to understand advantages and disadvantages of designing dynamic products as media for encouraging users to decrease their water consumption.
The resulting design concepts are analyzed in terms of: (i) inspiration of the idea, (ii) sensorial stimuli used for conveying the information, and (iii) the concept's consistency with the three information features.

5. Design concepts

As a result of the design activity, three concepts of dynamic products were generated by the PhD student.
Concept 1 is an accessory for the shower, which makes user aware about the consumed water. It takes inspiration from water drops. As the water is used during the shower, the accessory changes its shape from flat to texturized. 3D concentric circles appear on the surface, resembling the shape of falling of drops in water.

Figure.5 Concept 1: inspiration

Figure.6 Concept 1

The purpose of Concept 2 is to create a relaxing atmosphere during the shower. This concept was inspired by people that use to have a long shower for relaxing. The idea is to integrate sound and scent diffusors into the shower, in order to generate a multisensory

experience, to make the shower as relaxing as possible in a short time. The designed dynamic features consist of relaxing sound and aromas. For instance, the aroma of lavender, which is fresh and intense, gives serenity and calm. At the beginning of the shower, the user can clearly perceive the sound and the aroma, which however become increasingly imperceptible as time passes. As soon as the sound stops and the aroma disappears, the user is informed that he/she has overcome the amount of water adequate for one shower (estimated as 15 liters for person per day).

Figure.7 Concept 2

Concept 3 takes inspiration from a study carried out by Gleick (1996), in which he estimated the basic water requirement for humans needs. Thanks to this investigation, it is possible to presume the basic amount of water that has to be consumed in the bathroom (35 liters per person per day) and in the kitchen (15 liters per person per day).
This concept consists of a set of dynamic products. The set is composed by little spheres that can be connected to all the faucets of the house, and by a dynamic tangible painting. The spheres are conceived as meters of the water consumption for all the faucets in the kitchen and in the bathroom. The aim of these elements is to tell users the correct amount of water they should use, by means of a blue light (Fig. 8). The spheres change their brightness according to the amount of water used. As soon as the user turns on the tap, the spheres gradually lose their brightness to show users that the amount of water suitable for the kitchen or the bathroom activities is decreasing until ending (the light turns off).
Spheres remind users that they have not an unlimited quantity of available water.

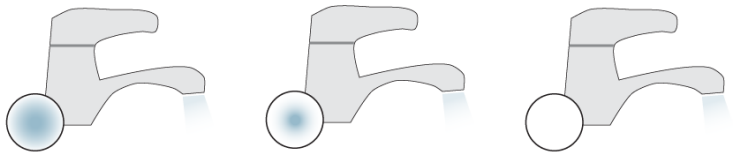

Figure.8 Concept 3: the sphere

The set is also composed by a dynamic physical painting. The painting displays information about the total amount of water used in the house during the day. The amount of water needed for basic household activities (i.e. cooking and cleaning, excluding gardening) is around 50 liters per person per day (Gleick, 1996). Based on this datum, the painting changes its 3D texture to show that the water consumption in the house exceeds the suggested limit. At the beginning of the day, the picture is completely flat. When the user overcomes the limit of 50 liters per person, a texture of arid soil appears. This texture becomes more and more visible as the water consumption increases.

Figure.9 Third concept: inspiration for the painting

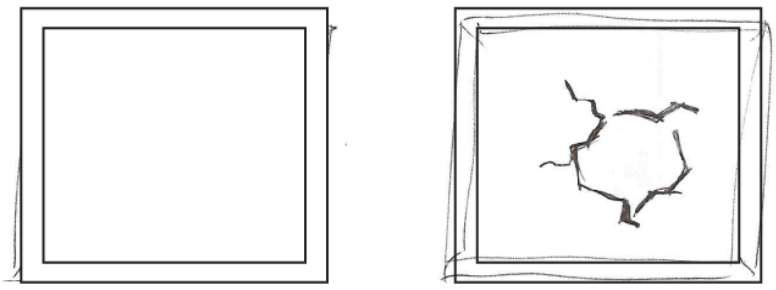

Figure.10 Third concept: dynamic painting

6. Discussion

Inspirations

The inspirations for the three solutions are variable. The inspiration for the Concept 1 derived solely from the natural world. In the Concept 2, instead, the inspiration derived from users' behavior. In the Concept 3, two different inspirations can be found. The first is conceptual: the spheres' lights follow the water availability in continuous downfall. Indeed, the light changing from intense to off means that keeping on using more water than necessary will eventually deplete all the water reserves of the planet. The second one is more direct: the painting, by changing its texture, shows the real consequences of the excessive use of water, that is the earth dried up and no longer fertile. In most cases, the inspiration comes from the natural world and is linked to the message conveyed. Only Concept 2 does not have a direct relationship with the message, but is more connected to the idea of persuading the user by the creation of a pleasant sensory experience.

Consistency with the features of information

The concepts show correspondence with the three information features. All three concepts return qualitative, instead of quantitative, information (metrics). Moreover, they give the user the ability to access the information frequently, because the message is displayed without interruptions (frequency). Finally, they deliver the message either by using a cognitive or sensory analogy with nature or by creating a rewarding experience (representation).

It should also be noted that only the Concept 3 explores the possibility to have two messages tied together. One is immediate and results from the user's action, while the other one gives an overview of the household's consumption. This concept highlights the difficulty to display two different messages by the same dynamic product. Indeed, to resolve such difficulty, the designer designed two separate objects.

Sensory media

The last parameter we analyzed is the variability of the sensory stimuli used to convey the message. This because dynamic products communicate through a sensory language.

Most of the concepts make use of visual stimuli to shape information; only one concept explores the potential of multisensoriality to create product experiences.

This underlines the willingness of the designer to employ visual stimuli when there is the need to return accurate bits of information (e.g., the remaining amount of water, the level of consumed water, etc.). On the contrary, when there is the need to create engaging and persuasive experiences, like in Concept 2, more unusual but evocative senses are used, such as smell.

7. Conclusions

The analysis of the design concepts highlights that the three concepts stem from different inspirations and peculiar interpretations of the features of information. The analysis also underlines that the sensory modalities may have their own limits and potentials in representing information, which should be considered in the design process. For instance, sight was the most used sense to convey specific information about the available water and was used to create powerful metaphors, while other senses, like smell, were overlooked. Sound and smell were used in a more abstract way without any direct connection to water. This also represents a challenge for designers: can information be conveyed in an engaging, metaphorical, but still understandable way, by senses other than sight? Further studies should consider this possibility, fostering designers explore less usual sensory channels.

Despite the difficulty of making different needs (e.g. aesthetics and message) coexist and cooperate, the designer was still able to find different ways to convey messages to users about their water consumption. According to the designer who partake in the process, the inputs about the features of information did not limit her work, on the contrary they were useful constraints which help her guide the design process; they also made her more aware of the quality of the message conveyed by the products she was designing.

This study applied the theoretical knowledge coming from previous research in the field of both energy saving and dynamic products in the area of water saving. By presenting three design concepts, it exemplifies how the three dimensions of information, usually considered in the design of interfaces for energy saving, can be used also in dynamic products, to encourage water conservation. Further studies are going to develop the concepts in order to test them in real domestic environments, to evaluate to what extent such kinds of products can actually motivate users save resources.

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