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CHANGING ENERGY CONSUMPTION BEHAVIOUR THROUGH SUSTAINABLE PRODUCT DESIGN

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1. Introduction

It is widely accepted that consumers' increasing expectation for comfort, convenience, and speed; and their insatiable appetite for more appliances have outweighed the hard-won energy gains in the household from technological innovations, current eco-efficient products and policy instruments [Environmental Change Institute 2005]. Since 1970, although the technical efficiency of buildings, heating systems and household appliances use has improved by about 2% year on year [Energy Saving Trust 2006], between 1970 and 2006, the energy use in the home rose by 24%, far exceeding growth of the overall energy demand in the UK (7%). These trends led the UK government to announce in 2004 that the national target of the Kyoto commitment - to reduce 1990 carbon dioxide emissions by 20% by 2010 will not be achieved [Environmental Change Institute 2005].

However, energy consumption during the use phase of electrical products' lifecycle has a significant environmental impact mainly determined by the consumer's behaviour. It is argued that improving the technical efficiency and editing consumers' purchase and choice have hardly raised the environmental awareness to reach the radical change of usage. Government and NGO measures and a range of information campaigns have been ineffective in creating the long term behavioural shift needed to reduce the impact of product use. Since users have to make the link between the information, their own behaviour and the environmental impact, it is difficult to motivate a change in the majority of consumer's behaviour.

The use phase of products, which has immense potential for decreasing environmental impact, is often neglected in sustainable design. Product designers are identifiably in a position to plan and to shape the way in which consumption occurs as well as to bridge the considerable the intention - behaviour gap between environmental values and consumer everyday action and locked-in occurrence [Sustainable Consumption Roundtable 2006]. To date few attempts have been made to change energy consumption behaviour through product-led interventions to limit environmental impacts.

This paper begins by analyzing some selected behaviour models in social-psychological theories and the barriers to sustainable energy consumption and a model is developed to uncover the factors stimulating change in behaviour. Then by linking the design strategy research with the psychological theories, the breakthrough points that potentially enable design to influence the consumer behaviour and habits are identified. Finally, employing a user-centred approach, the results of a pilot study are

presented that provide an understanding of user perceptions of environmental issues with reference to the specific context: “actual” practices, habits and needs of fridge and freezer use.

2. Understanding Consumer Energy Consumption Behaviour and Habits

Focusing on individual behaviour, a number of existing theories try to answer the question: what factors contribute the behavioural change.

The theory of planned behaviour [Ajzen 2006] illustrates attitudes, the subjective norm together with perceived behavioural control as explanatory factors of human behaviour. Triandis [1977] proposed an integrated model of interpersonal behaviour which not only includes social factors and emotions in forming intentions but also highlights the importance of habits as mediated factor of behavioural change. When the behaviour is “highly automated”, performed with a minimum of deliberation or little cognitive effort and often only limited awareness [Jackson 2005], it becomes habitual. Meanwhile, attitudes, norms and perceived behavioural control become less predictive of future behaviour and people attend less to contextual information [Verplanken & Wood 2006]. As Verplanken and Aarts [1999 in: Verplanken & Wood 2006] defined, “habits are learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states”.

To encourage consumers to break old habits, two factors are suggested: repetition - “how often the action is repeated” and reinforcement - the strength and frequency of the positive reinforcement received [Jager 2003 in: Jackson 2005]. Andersen [1982] identifies three stages in the formation of a new habit - the declarative stage, the knowledge compilation stage and final procedural stage. It has been argued that the cognitive script for a habit to develop should be easy to follow and enable repeat the same action in similar, provided with the regular reinforcing reward as consequences of a new behaviour [Sustainable Consumption Roundtable 2006].

2.1. Habits - environmentally significant consumption behaviour

It has been recognised that although consumers express strong concern about the environmental impacts of their activities in the household, their actions do not reflect their concerns. In reality, the practices ingrained in our life patterns are carried out without conscious deliberation (Jackson 2005). As the studies of Verplanken and Wood [2006] showed, “approximately 45% of respondents’ everyday actions were habits in the sense that they were performed almost daily and usually in the same location”. Much of the literature [e.g. Jackson 2005] argues that inconspicuous consumption has a significant environmental impact in terms of energy and resource consumption. It is argued that what users do with, and how they use, their electrical appliances is important, for habitual and routinising behaviour, it contributes to the awareness - intention - behaviour gap between environmental values and everyday interaction with individual electrical appliances and locked-in occurrence in household energy consumption.

2.2. Barriers to efficient energy consumption

Having examined some of the motivators for behaviour change, it is important to find out what are the possible barriers to energy-conscious practices.

2.2.1. Invisible nature of energy

People often only care about the performance of products [Verbeek and Kockelkoren 1997] rather than the energy and the resources which provide the commodity. Borgamn as discussed in Verbeek and Kockelkoren [1997] identifies two elements of products: “machinery - the device as physical object and commodity-the result it produces when it functions”. The consumables including the energy, resources and associated products should be considered as the third element of the product. Figure 1 demonstrates the relationship between three elements of products and the designers and the consumer. Designers make efforts into improving the results of the object, service and system to meet insatiable

expectation of consumers. Products do not invoke the users' emotional engagement with them as visible physical object. The invisible nature of energy (gas and electricity) and resource (water) supplied for function the equipment not only leads to consumers' disregard of their use but also curbs more circumspect research or creative design concepts to improve efficiency of energy.

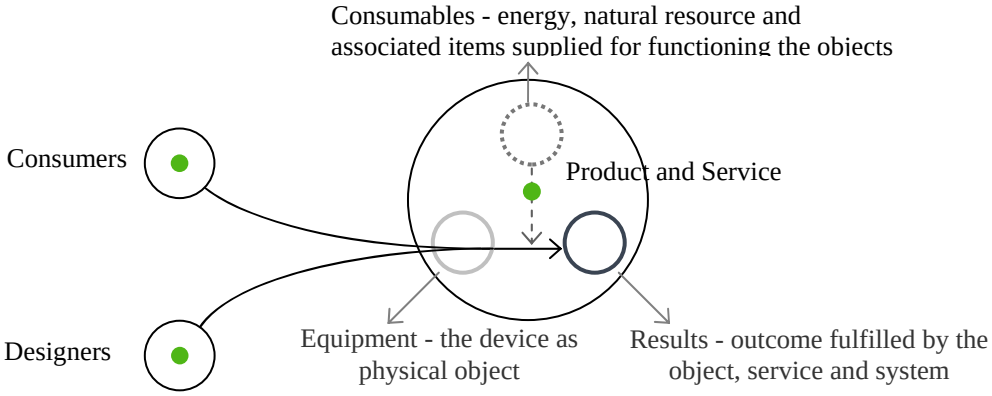

Figure 1. Relationship between designers, consumers and three elements of products

The directed attachment towards invisible consumables consumption should be not only built for the consumers to reflect their use but for the designers to limit the environmental impacts of product at the conceptualising stage.

2.2.2. Unawareness of the link between energy use and its environmental impacts

Consumer understanding of the exact causes and manifestations of climate change is far too limited to make a link to their daily lives and energy use in the home [Sustainable Consumption Roundtable 2006]. To build the bridge between effects and use habits, it is important to provide information to describe what action would negatively lead to environmental consequences. It has been proved in recent projects [Environmental Change Institute 2005] that energy saving can be gained by providing information and feedback through electricity bills and energy display meters. When people were made aware of their situation, they will take action.

2.2.3. Careless attitudes towards energy

According to energy usage report from Energy Saving Trust [2006], 86% of consumers feel guilty about the amount of energy they use. But they are disinclined to do the saving bit by bit. The survey reveals that 42% cite laziness rather than lack of awareness as the main reason for their bad energy habits. Verplanken and Wood [2006] analyse this as simply forgetting. However, the appropriate short-run rewards and incentives need be reinforced to encourage the long term changes to careless attitudes towards energy.

2.2.4. Disempowerment of big change

It is hard to take practical action if consumers do not believe individuals can make a difference. The government has been finding ways to reduce consumer's environmental impacts through cause-related information campaigns. However, the public has been flooded with "global level" messages which have failed to significantly change behaviour [Jackson 2005]. "The issues are too large and too complex" and "consumers do not think that they can make a difference at an individual level [Jackson 2005]. Therefore, emphasis should be placed on helping people to believe that they do control their impacts and make a real difference to the environment in a desired way.

2.2.5. Lack of trust

Clear and reliable information should be provided for people to access adequately and equally [Jackson 2005]. Take energy labels of domestic appliances for example, there appears to be three

"good" categories in the current market, however, instead of recalibrating the categories, two additional groups, A+ and A++, are added and A of the original categories, left in place. This weakens the effect of the label and is also confusing for consumers [Environmental Change Institute 2005].

2.2.6. Lock in lifestyle

Theoretically, new domestic appliances with efficient technological improvements could reduce energy consumption, but luxury lifestyles may push the total energy usage up. Translating this specific excessive consumption pattern into daily life becomes the invisible and inconspicuous energy use habit. Although technical researchers have gone to considerable lengths to record domestic energy consumption, they are generally concerned with the end result, rather than the process. This leaves a real gap in our understanding of how best to influence consumer behaviour when undertaking domestic activities through product design.

2.3 Design Intervention

Seven strategies have been identified, which can be applied within design, Table 1 illustrates these with examples of where they have been applied.

Table 1. Design Intervention and Examples

Eco-Information – design oriented education	
to make consumables visible, understandable and accessible to inspire consumers to reflect upon their use of resources	
1 - Visualizing energy-Expressing the presence and consumption of energy	Examples-Power Aware Cord - Seeing Personal Energy Consumption [Interactive Institute, 2004]
2 - Experiencing energy - Encouraging the user to interact with resource use.	Examples-Tyranny of the Plug Kitchen Machines - Being involved for powering the product [Van Hoff 2003].
Eco-Choice – design oriented empowerment	
to encourage consumers to think about their use behaviour and to take responsibility of their actions through providing consumers with options	
Users have a choice and the product enables sustainable use to take place	Examples- Domestic Energy Display - household system level concept [Design Council 2006].
Eco-feedback – design oriented links to environmentally responsible action	
to inform users clearly what they are doing and to facilitate consumers to make and socially responsible decisions through offering real-time feedback	
Providing tangible aural, visual, or tactile signs as reminders to inform users of resource use.	Examples- Eco-Kitchen [Sherwin et. al. 2000]
Eco- spur – design oriented rewarding incentive and penalty	
to inspire users to explore more sustainable usage through providing rewordings to "prompt" good behaviour or penalties to "punish" unsustainable usage	
Design for showing the consequences of their actions to consumers through "rewarding incentives" and "penalties"	Examples- Flower Lamp - Rewarding Energy Behaviours [Interactive Institute, 2004]
Eco-steer – design oriented affordances and constraints	
to facilitate users to adopt more environmentally desirable use habits through the prescriptions and/or constraints of use embedded in the product design.	
Designing "ease doing" affordances and constraints encouraging users to adopt instinctive sustainable energy use habits or reforming existing unsustainable habits	Examples- Unilever Powder Tablet - Counteracting excessive amounts of consumables consumption
Eco-technical intervention – design oriented technical intervention	
to restrain existing use habits and to persuade or control user behaviour automatically by design combined with advanced technology	
Product design utilises advanced technology persuade or control user behaviour automatically including using new materials; renewable	Examples- Energy Curtain - Interacting with Daily Light

energy resource; and new technology such as advanced computing and science technology.	Cycles [Interactive Institute, 2004].
Clever design	
to automatically act environmentally without raising awareness or changing user behaviour through purely through innovative product design	
Purely design solution for decreasing environmental impacts without changing the user's behaviour	Examples- Integration of toilet and washbasin.

These design intervention strategies whilst providing interesting considerations for designers have not been widely applied and there is lack of real data on the effectiveness in both theoretical and practical dimensions.

4. Hypotheses – correspondence of behaviour/habit model and design intervention

To summarize, intention, habits and controls are considered important to immediate and mediate antecedents of behavioural change. Due to the complexity of motivations for shifting behaviour, different levels of interventions need to be designed accordingly to ensure behavioural and habitual change. The understanding of the behaviour disintegration and formation and relationship between antecedents of change in behaviour/habit and different levels of design intervention is presented in Figure2 below.

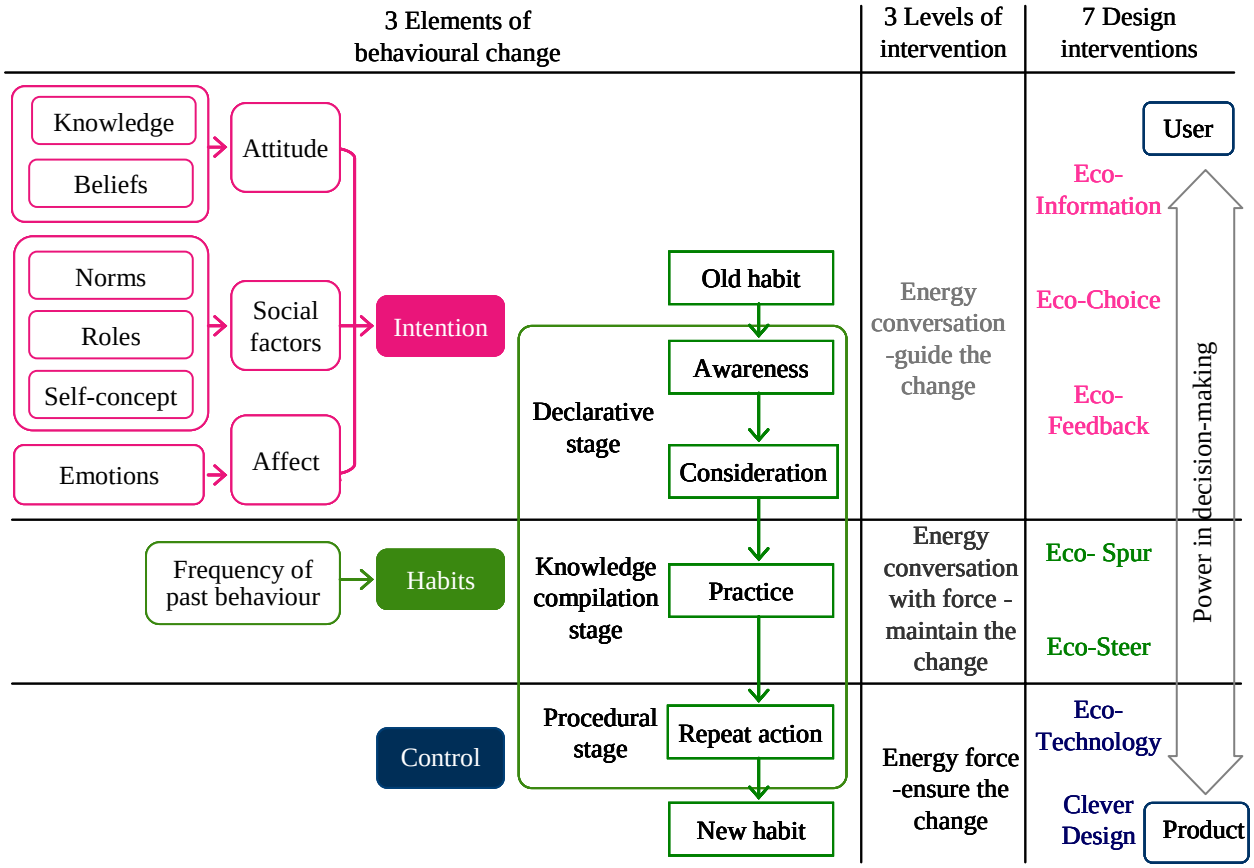

Figure 2. Linking antecedents of behavioural and habitual change with varying levels of design intervention

As demonstrated, design interventions are classified by the degree of power for decision making between the user and product. It is important to develop a balanced and ethical approach: weighing up

the determinates of behavioural and habitual change and designing the sustainable products to bridge this gap.

5. Pilot Study

Having selected the fridge and freezer from the household appliances as the case study, a pilot study was carried out. User centred research methods were employed including questionnaires, semi-structured interviews and product-in-use observation (photographing and videoing) which were specially designed to understand "actual" and "assumed" needs, the diversity in use context and the complex relationship between users and product. The issues considered regarding the user behaviour and habits of fridge and freezer are illustrated in Figure 3 below.

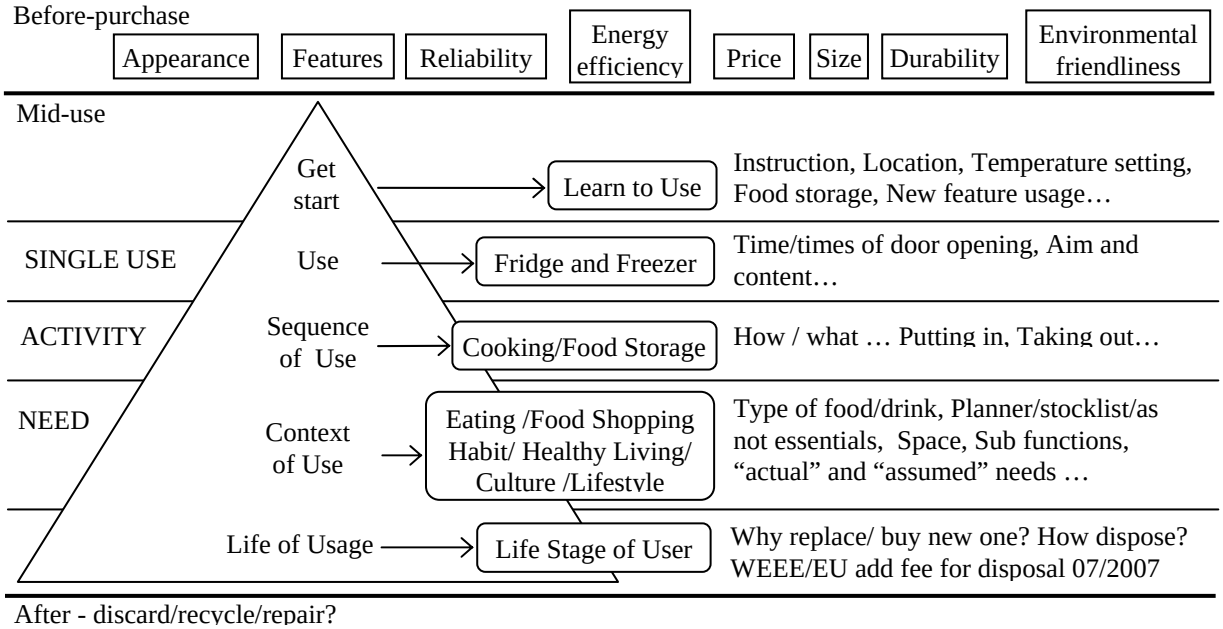

Figure 3. Pilot study – interactions with the fridge and/or freezer

Three fridge and/or freezer users involved in this pilot study were aged between 21 and 40 and had owned their fridge or freezer for between 6 months and 6 years. The study consisted of three phases. Firstly, the participants responded to a questionnaire – kitchen pilot study user profile questionnaire and they were told that the goal of the study was to understand the relationship between the user and their kitchen through observing their activities in the kitchen including the storing food and preparing and cooking a main meal. This cover story was used to reduce the unnatural desirable response tendencies. The second phase was observation of the fridge and freezer and users activities around the product including putting foods in after food shopping and taking items out during food preparation. This was specifically designed to gain an insight into their actual behaviours and habits in operating the product; problems and difficulties they encountered. Finally, post semi-structured interviews and post intervention questionnaires provided a chance for participants to explain their behaviour in the observation section.

Some of the key findings of pilot study are summarized below:

In the purchase phase size, price, energy efficiency of the model, and service/guarantee were considered the most important. Appearance and style were less important; brands additional features and refrigerant with less environmental impacts had least effect on their choice.

At the start of the use phase all the participants set temperature at the first use of the product. None of participants had ever measured the real temperature inside the appliances. During the use phase most

of the time spent putting food into the fridge and/or freezer was used for making room for new items. All of the participants said they cool the prepared food and leftovers before they put them into the fridge. All stated that they had never found the fridge/freezer door left open. Those with an under counter fridge had to bend down to see what is in and what need to be taken out. All participants were more organized on placing food inside the fridge and/or freezer than cooking; because during cooking, they often take out and put in more frequently. Two thirds of respondents guessed that they learnt what and how things needed to be put in to the fridge and/or freezer from their mother. One of the householders divided food into different shopping bags at the store according to the refrigerated food and frozen food and then piles all the food above fridge or freezer separately, before putting them in.

When outlining the useful life of the fridge and/or freezer, people have very different expectations of between 5 years to 15 years. All participants had never cleaned the evaporators to improve performance.

In terms of environmental awareness the disposal of the CFC was cited by two of the participants in answer to the environmental impact of use of fridge and/or freezer. One participant thought that it was the users' responsibility to purchase a fridge and/or freezer with a good energy rating; for the other things during use they considered that it was not user's responsibility. In terms of manufacturer responsibility, respondents suggested the following key points: A –rating, good communication of how to use the fridge and/or freezer efficiently, reminder of door opening times, more understandable temperature indication design, and instruction for efficient use need be to active.

In terms of design features of the fridge and/or freezer often the temperature setting is too low at the bottom edge of the freezer and users have to bend over and see it. One participant commented that they had had trouble with the fridge freezing the contents.

6. Conclusion and Further Research

This pilot study indicates that user centred methods are effective in representing the real situation of the product use. Firstly, it exposed the gap between the environmental awareness and real action, which needs further study in order to understand the reasons for such a gap. Secondly, it illustrates that design has some responsibility towards the incorrect use of the product in relation to energy efficiency. In addition, there is a lack of consumer awareness of the connection between personal behaviour and the direct impact of such on the environment and energy use. Also, consumers assume that product is efficient enough by itself and there is no need for a conscious behaviour to improve the overall energy performance.

These points indicate the need to identify what shapes consumer decision making behind the operation of products in order to detect what influences people to reduce energy consumption. Furthermore, attention needs to be given to the routine use of appliances which remain both obscure and hard to describe, since fridges and freezers are common products there seems to exist a lack of consideration of consumer behaviour, likes and dislikes. This highlights the research purpose, which is to understand how the product can lead to a different behaviour regarding energy consumption, in order to develop guidance for designer to potentially influence user to behave in a more sustainable way. Future work on this project will consist of a series of main user studies to be carried out continually over a 24 hour period. It is anticipated that the findings will be used to generate design concepts and to build a prototypes of the concepts promoting energy conscious use of the fridge and freezer. These will then be tested with consumer to identify whether they can lead to more energy conscious behaviour.

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