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Enhancing environmental friendliness of electrical consumer products: the effects of design-centred measures

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1 Introduction

This paper is concerned with the design of environmentally-friendly electrical appliances. There has been evidence from previous analyses that this product group makes a considerable contribution to the global environmental damage (see Wenzel, Hauschild & Alting, 1997). These analyses have revealed that electricity consumption during product utilisation is a primary contributor to a product's environmental impact score. While there is some support available for engineers and designers to reduce the environmental impact of a product during production and disposal / recycling, there is little guidance for the utilisation phase (Sauer, Wiese & Rüttinger, in press). This is largely due to the high level of uncertainty and interindividual variability associated with user behaviour.

Against this background, the work presented here aims to provide designers with some guidance of how environmental-friendliness of appliances can be improved by optimising user-product interaction during the utilisation phase (e.g., reducing electricity consumption of appliance).

2 Experimental work

The work presented here looked at a number of design-based measures that may be suitable to modify user behaviour. Design-based measures may be contrasted with other means of modifying user behaviour, such as educational measures aiming to improve environmental knowledge and concern. While a number of different means to influence ecological behaviour have been discussed in the research literature (Bell, Greene, Fisher & Baum, 1996), design-based measures are considered particularly effective.

Three studies are presented that examined ways of improving ecological performance of the product during utilisation. The first study examined the effects of design modifications, such as enhancing user feedback and low-level automation of functions. The second and third were concerned with the effectiveness of product information (e.g., product labels, manuals) in modifying ecological user behaviour. Both kind of measures, design modifications and product

information, are to be seen as a close tandem since they need to complement each other. In all three studies, an electrical vacuum cleaner was used as a model product. This was because it is an electrical consumer product that is widely used and characterised by considerable energy consumption.

2.1 Study 1

Rationale

The experimental work examined different ecologically-relevant design options for vacuum cleaners, such as type of suction control labelling and the availability of an automatic reset function. This was to explore the possibility of modifying user behaviour by design-based measures.

Method

Thirty-six participants (aged 19 to 49 years) participated in the study, which was conducted in a laboratory at Darmstadt University of Technology. The two variables of main interest examined in the experiment were *automatic reset function* and enhanced *control labelling.*

Automatic reset function was a simulation of an automatic device that would reset suction control to an energy-efficient setting after the appliance had been switched off. Three levels were compared in the experiment: low (400 W), medium (800 W), and high (1400 W). The latter is to be considered energy-inefficient while the others are regarded as energy-efficient (see Dannheim, 1999). This is because in current vacuum cleaner technology, motor power in excess of approximately 800W does not lead to substantial improve suction performance. For the purpose of this paper, we will focus only on the conditions "medium" and "high" since the "low" condition showed a virtually identical pattern to "medium".

The experimental variable, control labelling, was varied by providing different levels of information about the most energy-efficient setting of suction control. The standard version was a typical label that may be found on a vacuum cleaner (see Figure 1). It was in black and white colour. The notion behind the enhanced version was to provide additional information to the user. First, there was a verbal descriptor that provided a negative connotation for high settings (i.e., high level of dirtiness). Second, the three sections of control had a different colour coding to support the verbal message. Red (meaning: danger, stop) was chosen for the high setting as the undesirable section of control device and different shades of green (meaning: safety) for the desirable sections.

(insert Figure 1 about here)

The experiment took place in a laboratory, in which a 3 x 5 m carpet was fitted. Four pieces of furniture (desk, computer desk, 2 chairs) were placed on the carpet to model a typical private study. 250 g dirt were equally distributed on the carpet. The task of the user was to clean the prepared floor area, representing a testbed for the different design options.

Results

The data showed that generally users did not interact much with suction control. Only 58.4 % of the users carried out any control action during two experimental trials. Generally, users intervened more under high default setting of auto reset (1.04 control actions / trial) than under medium default setting (0.50 control actions / trial). When examining ecological performance, there was evidence for the benefit of an automatic reset function. Mean electricity consumption decreased from 1.10 kW to 0.86 kW. The positive effects were also reflected in the suction control setting chosen by users during the experimental trial. The automatic reset function reduced the setting from 1304 W to 888 W. No significant differences between conditions were found for achieved cleanness levels and duration of the trial. The findings are summarised in Table 1.

Table 1. Effects of auto reset function on performance measure

	Medium setting (800 W)	High setting (1400 W)
Frequency of control action (No / trial)	0.50	1.04
Mean electricity consumption (kW)	0.86	1.10
Setting of suction control (W)	888	1304
Trial duration (s)	238	219
Achieved cleanness (%)	90.5	89.7

Surprisingly, no effect was recorded at all for the enhanced control labelling. None of the performance measures taken in the experiment showed an effect.

Discussion

The results showed that ecological performance clearly improved as a result of the auto reset function. The automatic reset of suction power to the most energy-efficient setting led to reduced energy consumption because a large number of users did not change the preselected setting. Previous research has shown that there is little propensity of users to manipulate suction control but, if they do, they tend to increase the setting rather than decrease it. Overall, this was indicative of the strong prevalence of habits in the domestic environment.

In contrast, enhanced control labelling had no effect on ecological performance (i.e. energy consumption remained unchanged). The findings suggested that users paid little attention to design features that provided enhanced system feedback. Here, the presence of strong habitual behaviour may have worked to the disadvantage of this measure. The very peripheral location of the control label (placed on the cylinder which is usually positioned behind the user) is likely to have reduced sampling frequency and hence the effect of this feature. Indeed, in another study, where suction control was embedded in the handgrip of the vacuum cleaner (i.e. increased spatial proximity), enhanced control labelling had a positive effect on ecological user behaviour (Sauer, Wiese & Rüttinger, 2001).

2.2 Study 2

Rationale

This study examined user behaviour as a function of different forms of information presentation. The authors were interested in whether placing a prompt on an electrical appliance would increase the probability of the instruction manual being read.

Method

Forty-two participants (aged 19 to 44 years) were given the task of unpacking a vacuum cleaner and preparing it for operation. They were assigned to three different experimental conditions, in which they received three kinds of cues about reading the instruction manual of a vacuum cleaner. (a) Ecological cue: instruction manual contains information on energy-saving use of the appliance. (b) Safety cue: information on the safe use of the appliance in the instruction manual. (c) No cue: no information was given on content of instruction manual.

Results

The results of the study confirmed evidence from previous studies that only a small proportion of users actually read the instruction manual before putting an appliance into operation (M = 33.3 %). As expected, the proportion of users reading the manual was significantly higher when a cue was given (M = 42.9 %) than when it was not given (M = 14.3 %). There was no difference between the "ecological cue" and the "safety cue" group. For the "ecological cue" group, the proportion of users reading the manual was significantly higher among people with high environmental concern (63 % vs. 17 %). Users also completed a questionnaire about their use of instruction manuals at home. It showed that generally readership of manuals was rather low (M = 31.8%) and similar to the proportion found in the experimental study. Additionally, there was an effect of appliance complexity, with the rate increasing to 51.2 % for the more complex products.

Discussion

The findings show that a cue placed on a consumer product may be effective in increasing the probability of reading the manual. However, outside the artificial laboratory situation one can expect the readership to be somewhat lower. Nevertheless, the use of product labels is a very cost-effective means (low cost of implementation) to encourage users to make use of the manual.

2.3 Study 3

Rationale

This study examined different ways of presenting ecological product information to the user. In particular, the authors were interested in whether the position where product information is placed affects their effectiveness in modifying user behaviour.

Method

Thirty participants (aged 19 to 37 years) took part in the study. They were assigned into two experimental groups, in which ecological product information presented on labels in different places: (1) on the appliance, and (2) on the packaging. The labels asked users (a) to remove all small furniture before cleaning (i.e. preparatory activities), (b) to choose a low setting of suction control, and (c) to remove the vacuum cleaner bag when indicator is on. The task was to unpack a vacuum cleaner, to set it up for operation, and to clean a prepared floor area.

Results

As predicted, placing the product label directly on the appliance resulted in more ecological user behaviour in the form of preparatory activities than placing the label on the packaging (proportion of users displaying at least one preparatory activities: 47% vs. 13%). Concerning the second message (i.e. lowering of control setting), the overall frequency of compliance decreased from 30.0 % to 23.3%, compared to the first message. For the second message, there was no significant difference as a function of product label position. Interestingly, there was no significant correlation between the participants' recall performance (the extent to which they were able to remember the content of the message after the experimental trial) and their behaviour in the experimental scenario. Overall, only a small number of participants remembered any of the messages (16.7%).

Discussion

The data confirm that there is a slight advantage of placing ecological information directly on the appliance rather than on the packaging. This is likely to be due to increased exposure time of the information to the user when the label is fixed on the appliance. Designers also need to be aware of the effect of a "primacy effect", that is, information presented first is more likely to be processed than subsequent messages. Indeed, there has been supporting evidence of the presence of a primacy effect from another study (Sauer, Wiese & Rüttinger, 2001).

3 General conclusion

On the basis of our experimental work, recommendations for design engineers can be made that improve ecological performance of the user-product system. Overall, measures that are resistant to habitual behaviour appear to be most promising to improve ecological performance, as the implementation of the auto reset function has demonstrated. This kind of low-level automation does not require user knowledge or high environmental concern as prerequisites of adopting more ecological behaviour patterns.

However, it is insufficient to look at product design alone to reduce the environmental impact of consumer products. Not all product information can be conveyed to the user by that means. Some information may only be communicated by labels or, if more complex, by instruction manuals. The use of well-designed product information (e.g., in the form of information labels) complements design-based measures, as it can increase user knowledge of the appliance (e.g., the most energy-efficient strategy of use). However, the designer needs to be aware of the low readership of instruction manuals and should therefore not assume that all users will read critical information referred to in the manual.

While the research was carried out in the context of ecological product design, the findings are relevant to a wider field. Product labels and automation may also represent appropriate means, for example, when addressing health and safety issues.

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