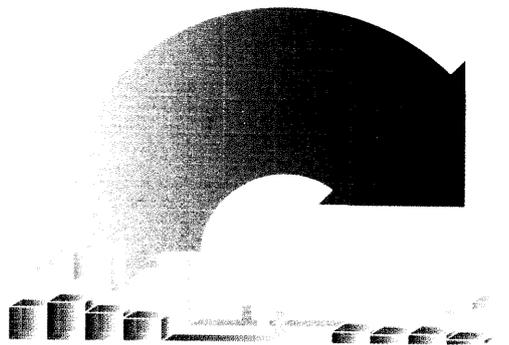


Environmentally-Friendly Product Development



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British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Control Number: 2004112580

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ISBN 1-85233-903-9 Springer London Berlin Heidelberg

Springer Science+Business Media
springeronline.com
© Springer-Verlag London Limited 2005
Printed in the United States of America

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69/3830/543210 Printed on acid-free paper SPIN 11009276

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4. The gathering of all information on product-related success factors in the early phases must be ensured. It is only on this continuous information basis that innovation projects can be started.

Concerning the conventional innovation process, items 2 to 4 are a matter of course and are already realised in most companies. But this is not the case for the innovation process under the influence of sustainable development. Therefore, specific rules and corresponding models must be explicitly formulated. This is the only way to implement and control them in the framework of innovation management.

5.2 Marketability Issues of Environmentally Friendly Products

5.2.1 Consumer Behaviour and Environmentally Friendly Products

Ecological aspects of consumer products become more and more important since the legislation for environmental protection has been tightened and the ecological awareness of the people is increasing. Research in this area mainly deals with two aspects:

- (1) How far do environmentally friendly products fulfil the customer demands? To know that aspect is relevant because the development and production of those products influence the costs and turnover of companies.
- (2) How should environmentally friendly products be designed to become marketable (see Rüttinger, Wiese and Sauer, 2004 a)?

Several surveys show that the ecological awareness of private customers has strongly increased since the 1980's. Many customers stated that they would choose the environmentally friendly product alternative instead of the conventional product if both had the same price (see Preisendörfer, 1996). In fact, customers would pay a higher price for environmentally friendly products (Flynn and Goldsmith, 1994; Umweltbundesamt, 1996). However, in spite of these encouraging results, in some cases, environmentally friendly products cannot be sold successfully (see Langerak et al. 1998).

One reason for the low demand of private customers is that they have problems to find the relevant product information. Another reason is that salespersons have problems to communicate the relevant ecological product information. The salespersons do not know what product characteris-

tics are important for customers to recognize environmentally friendly products. They also do not know how customers judge the ecological product characteristics and how the ecological characteristics influence their buying decision (see Wiese et al., 2001).

The current instruments to evaluate ecologically-oriented customer demands were developed according to instruments that evaluate the requirements for product quality. As a result of this, those instruments are not able to detect the processes of ecological product evaluation. So it is not possible to deduce specific and valid recommendations for product development from the results of studies using these instruments (Rüttinger, 1997; Rüttinger, 1999; Rüttinger and Lasser, 2000).

Due to the existing lack of knowledge about consumer demands and consumer behaviour towards environmentally friendly products the following section will first report the results of a research programme on ecological product perception and environmentally friendly buying pattern. Thereby results will be described concerning methodological problems of the evaluation of the ecological product judgment and the buying decisions of the customers. The next section will report the results of how to segment ecologically-interested customers and environmentally friendly products. Then it will be discussed how buying decisions can be positively influenced by information towards environmentally friendly products. Finally, it will be reported if and how the two kinds of added value (prestige value and value of individual pleasure) can enhance the attractiveness of environmentally friendly products (Fig. 5.9). Concerning the studies on added value there has been close collaboration with scientists from engineering disciplines (Oberender and Birkhofer, this volume).

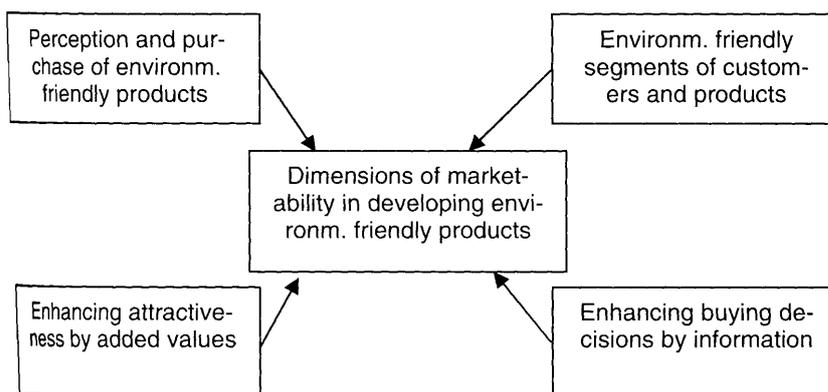


Fig. 5.9. Different dimensions of the research programme on marketability of environmentally friendly products

5.2.2 Perception and Purchase of Environmentally Friendly Products

When creating environmentally sound products it is always important to keep in mind their marketability. If the environmentally friendly products do not meet the customer's expectations they run the risk of becoming ecological non-sellers (Wiese, 2000). One of the first steps towards marketability is to examine how customers perceive environmentally friendly products and which ecological attributes they consider when they decide to buy a product.

Ecological Product Attributes in Buying Decisions

A study of customers buying household appliances proves, that their active knowledge about environmentally friendly products is rather weak. If customers are asked to describe which characteristics represent ecological consumer goods they mainly name the energy consumption of the product and the recyclability of the material (Rüttinger and Lasser, 2000). Thus, the active knowledge of consumers about environmentally friendly products contains only a small number of the product characteristics proposed by experts. The ecological definition of a product becomes more sophisticated when a list of product characteristics is presented after the purchase. Using this list the customers were asked to determine the ecologically relevant characteristics of the product. In that scenario the energy consumption and the recyclability were judged as important again but other aspects of the product use phase and of proceeding and subsequent phases of the product life cycle became relevant. The important ecological attributes of the use phase also are attributes of quality, e.g. durability and low maintenance.

To determine the structure of the perceived ecological product attributes a standardised questionnaire was developed, consisting of 90 ecological attributes from all phases of life cycle. 110 subjects were asked to rate how important the attributes were for their buying behaviour in principle. The statistical factor analysis revealed the following groups of attributes:

- Group 1: Attributes beyond the use phase (consumption of energy and raw materials in the production phase, recyclability etc.).
- Group 2: Attributes of the use phase (energy consumption, robustness and durability, multifunctional design, easy to repair and low maintenance etc.).
- Group 3: Health aspects for the user (toxicity, emissions etc.).

In a second survey the participants were asked to state how far in fact they considered the 90 attributes in their decisions to buy a product. One of the important results is that the customers mainly consider the attributes of the use phase in their buying decision because they do not have adequate criteria to judge the other product characteristics.

This finding is confirmed by another study (Wiese et al., 2001): Again the customers were asked to rate how important some presented product characteristics were for their buying decision. In contrast to the former study they were asked to do that *after* they had bought consumer goods. The most important characteristics were the durability, robustness, easy access to spare parts and consumption of electricity during usage. But these ecological attributes were judged as much less important than the price, the quality and the design of the product.

How do customers perceive environmentally friendly products?

- When customers are asked to describe environmentally friendly products they think of only very few attributes: energy consumption and recyclability of the material.
- Because of an existing lack of information about other ecological attributes, customers mainly consider ecological attributes of the use phase in their buying decision.
- In buying decisions, customers consider environmentally friendly product attributes most when these are attributes of quality as well, e.g. durability.

→ *The marketability of environmentally friendly products can be enhanced by giving more detailed information about those attributes of the use phase which are both environmentally friendly and of high quality.*

Methodological Aspects of Measuring Consumer Demands

As explained within the studies about the ecological understanding of consumers, the referred product characteristics differ depending on the form of questioning (open versus closed questions). Similar methodological effects appeared when analyzing the ecological buying pattern. That methodological aspect was analysed in the following study on ecological oriented buying decisions (see Wiese et al, 2004 a). The results show, that straight after the purchase the price is seen as very important, whereas environmental aspects are judged rather low important. After some time (about 6 months) the participants were again asked to judge the importance of several product aspects for their former buying decision. The later after the purchase

the participants were asked the more the order of importance changed: The price of the product became less, the environmental soundness became more important.

Two aspects can explain the findings: Firstly, the time lag between purchase and survey causes effects of forgetting when the subjects try to reconstruct the buying decision. Secondly, in doing so they are influenced by effects of social desirability. Thus, methodical factors have to be kept in mind when analysing the product attributes that influence the buying decision.

In the next step of the research programme the methodological aspects of surveys and other instruments that are applied to understand the ecological criteria in buying decisions were further analysed. In simulated buying situations the subjects were asked to choose between an environmentally friendly consumer good and a conventional one. In one study the subjects should verbalise their decision by speaking out loudly how they made the decision. In a second study, two subjects discussed with each other what product alternative to choose (method of the dyadic decision). Subsequent to this buying decision the subjects were asked first to state the criteria they considered during the decision-making. Secondly, a list of several product characteristics was presented. The subjects should indicate how important they estimate the characteristics for their decision.

The analysis of the verbalisation and discussion transcripts show again that ecological aspects play a rather secondary role. Again, as in the studies before the price and the quality are most important. The results also support the effects of forgetting and social desirability that are mentioned above. When using open questions the subjects named only a part of the criteria formerly verbalised or discussed as important. When presenting a list of ecological criteria, these criteria were overestimated.

Comparing the methods of decision making (method of free verbalisation and method of dyadic decision making), it could be shown that the method of the dyadic decision-making is more appropriate for measuring the decision making process than the method of free verbalisation. The dyadic decision making brings out better the comparisons considered during the decision making process, e.g. comparisons of the products to former experiences with similar products, demand of usage or own financial status.

When analysing consumer demands it should be noted that...

→ *The tendency of consumers to answer in a socially desirable way and the time lag between purchase and survey can influence the statements of consumers on their buying reasons.*

→ Use the method of the dyadic decision-making to bring out consumer demands and buying reasons.

5.2.3 Ecological Segments of Customers and Products

Just because of the generally low attention towards ecological products it is important to find the most promising market segments to take the full advantage of the existing market potential. Therefore, an important goal of the ecological market research is the identification of customer groups, which are interested to buy environmentally friendly products. If there are statistically significant correlations between characteristics of the customers and purchasing patterns, this might help to determine the relevant market segment of ecologically-interested customers. Another alternative to use the market potential is to identify the segment of ecological products.

Segments of Environmentally Interested Customers

Basically it can be assumed that people who are interested in ecological products show an especially positive attitude towards environmental protection. A study examined the correlation between someone's interest for environmental protection, his ecological daily behaviour and the criteria considered in buying decisions for consumer goods (see Wiese et al., 2004 a). In fact there was a positive statistical correlation between the two eco-variables and the weighting of the ecological buying criteria. Nevertheless, the environmentally-interested participants rated the price and the quality of the product as most important. These results correspond to the assumptions of the low-cost-hypothesis (Diekmann and Preisendörfer, 1992). That hypothesis says that the likelihood of environmentally friendly behaviour decreases when the costs - in this case monetary costs - to behave increase.

A second study analysed whether ecologically-interested customers can be described by psychological, demographic and behavioural characteristics. The 74 participants of the survey could be divided into four segments of eco-friendly customers by cluster analysis. The data were collected by questionnaire:

- *The young and sociable ones.* The members of this customer group are highly educated and interested in social interaction.
- *The conservative ones.* These consumers emphasize social rules and traditional ethical values, they want to behave conformed to standards.

- *The social climbers.* The members of this customer group can be described as very ambitious and successful. They are rather low educated but succeeded to get a remarkable high income.
- *The highly educated ones.* These customers have high graduation at school. In their opinion environmental protection is important and should be the top goal in Germany's agenda.

How can ecologically-interested customers be described?

- Even ecologically-interested customers rate the price and the quality of a product most important.
- Eco-friendly customers often are younger people (18-25 years-old), they can be described as highly educated, ambitious and successful, some are especially conformed to standards.

→ *When developing and marketing environmentally friendly products, it is also important to accentuate their high quality because even ecologically-interested customers mainly emphasise quality and acceptable price of the product.*

Segments of Environmentally Friendly Products

To estimate the market potential for ecological products it is not sufficient to identify segments of interested customers. It is also important to find out the product segment that contains the highest ecological market potential.

A study on identifying appropriate product segments shows the following results (Wiese et al., 2004 a). For complex equipment with high consumption of energy and resources, e.g. washing machine and dish cleaner, ecological criteria are considered more strongly than for equipment that is less complex and resource consuming, e.g. electric kettle and coffee maker. The most important criteria are the energy consumption during usage and simple access to replacement parts. Those criteria are considered more strongly for complex equipment because on the one hand they lead to cost-savings during usage. On the other hand, it is easier to detect the ecological and technical data of these products because they often have labels which indicate the consumption of resources. As a result of these labels, it is easier to recognize and estimate the environmental soundness of complex products.

Which are good targets for the development of environmental friendly products?

→ *Good targets for environmentally-friendly product development are complex products with high consumption of energy and resources, e.g. washing machine and dish cleaner: The eco-friendliness of these products leads to high cost-saving effects for the customers at the same time, e.g. by low energy consumption.*

5.2.4 Knowledge Activation, Information and Buying Behaviour

As the studies on consumer behaviour show (see section 5.2.3) there is a gap between the attitude towards environmental protection and the ecological buying behaviour. So, the question comes up how this gap can be diminished and how the customers can be influenced to buy more ecological products. The studies to this topic concentrate on three ways to influence the buying behaviour:

1. The activation of knowledge about environmentally friendly behaviour;
2. The presentation of explicit information to the customer;
3. The increase of the added value of the ecological product (see section 5.2.5).

Knowledge Activation and Buying Decision

First it was explored whether a stronger activation of the consumer's knowledge about ecological product characteristics leads to a more environmentally-orientated buying pattern.

In a simulated buying situation the subjects had to choose between an environmentally sound product and its conventional parallel version. Half of the subjects were asked, to carry out an analysis of their need of usage and of important behavioural aspects when using the product. It was expected, that because of this analysis the subjects would choose the environmentally friendly product more often than the conventional product. For example, it was assumed, that customers would buy vacuum cleaners of smaller size and lower power because they realized that they only wanted to clean few rooms.

In fact, subjects that carried out the analysis of their user behaviour stated that they felt more secure in their decision for one product. Still the analysis had no effect on the preference for the ecological product. However, in a retrospective survey such subjects that carried out the analysis of user behaviour judged the ecological criteria more important than subjects that did not carry out.

This result supports the fact that an analysis of user behaviour enhances the importance of ecological buying criteria. Due to the fact that the sub-

ject did not know enough about the technical data of the product and its ecological impacts, the higher salience of the ecological criteria did not show an effect on the buying pattern. That means that it is important to present explicit ecological information about the products to the customers.

How to influence the ecologically-oriented buying behaviour (1)?

- There is a gap between ecological attitude and ecological buying behaviour.
- If customers analyse their need of usage, they better attend the environmental aspects of the product and make more considered buying decisions.

➔ *Product descriptions should contain guidance to analyse the actual need of usage and should give more information about the effectiveness of environmentally friendly product attributes.*

Ecological Information and Buying Decisions

A better ecological product description seems to be a promising starting point to direct the customer's attention to environmentally friendly products when they decide to buy a product. Information can affect the buying decision for complex equipment in two ways. On the one hand, knowledge deficits can be eliminated. On the other hand, the ecological hints can activate the customer's motivation to buy an environmentally friendly product. For this reason the influence of ecological information on buying patterns was examined in several studies.

Explicit ecological information was presented by three ways: (1) Ecologically-relevant technical data about the product itself, (2) information about the environmentally friendly buying behaviour of relevant social comparison groups, (3) hints for the environmentally friendly use of the product.

In an experimental study it was examined if and how different forms of explicit information influence the decision to buy the environmentally friendly product variant. Two types of information have been varied: Technical product descriptions and information about the ecological consumer behaviour of so-called "relevant others" (i.e. people from the product group, e.g. friends, to make social comparisons).

The 72 subjects were asked to decide which one of two product variants they would buy. Based on product descriptions, product variant 1 was declared a conventional product, product variant 2 was declared as the e

logical variant. In one case the ecological product information consisted of a commonly well-known “environmentally friendly” label. In subgroup 2 the ecological information consisted of the listing of only little information about the eco-friendliness of the product. In subgroup 3 the product was described by a long and detailed list of eco-relevant information. In addition to the technical product description, half of the subjects received a short brochure from a consumer protection organisation containing data about the ecological behaviour of young adults in Germany. The subjects were asked to make the buying decision for two different products, one for a portable CD system, one for an electric iron.

Concerning the influence of the ecological information, it was shown that there is a connection between the amount of environmental information and the buying decision: The more environmental information, the more often the subjects chose the ecological product. This (marginally significant) interrelation could be found for both products (portable CD system and electric iron).

Similar results arose for the influence of the social comparison: For the portable CD systems there is a slight tendency to buy the environmental product alternative more often when the subjects know that the so-called “relevant others” buy environmentally friendly products as well. For the electrical iron there is no difference between the two groups. Altogether it can be said that detailed environmental product descriptions and the knowledge about the behaviour of relevant others influence the decision to buy environmentally friendly products, but they do only in a small extent.

In principle, ecological information could also be mediated by technical manuals. But normally the technical manuals are not available before the purchase and - as could be shown in a study (Wiese et al., 2004 b) - mostly they are not read after the purchase either.

How to influence the ecologically-oriented buying behaviour (2)?

- Extended information about environmentally relevant aspects of a product can influence the buying decision towards the ecological product version.
- Customers are more willing to buy environmentally friendly products when they know that other people buy those, as well.

→ *Information about the environmental aspects of the product should be as concrete and detailed as possible. Independent consumer protection organisations should give more information about the environmentally friendly behaviour of customers in principle.*

5.2.5 Enhancing the Attractiveness of Environmentally Friendly Products

Environmental products often differ from conventional products in some aspects, e.g. they are made of different, more environmentally friendly materials. Such differences are also perceived by the customers. To make sure that the new ecological product stays marketable, it has to be examined how to increase or maintain the attractiveness of the ecological product to the customer (Ehrlenspiel, 1995).

Generally, it is difficult to raise the attractiveness of a product by pointing out its environmental aspects. Therefore, the value of a product has to be increased by other product attributes. One possibility is to offer some added value, that means to increase the prestige value or the value of individual pleasure (Fig. 5.10).



Fig. 5.10. Two electric kettles with different prestige values and identical functional value

Products with prestige value can be used to demonstrate the customer's own social status to other persons, and to gain acceptance and a better reputation by these people (Berry 1994). In contrast, the value of individual pleasure indicates how much the customer likes a product because it matches his internal concepts and own preferences.

Within the scope of the added value of ecological products, several questions had to be analysed: (1) Is there a difference in the realization of prestige value and the value of individual pleasure? (2) In several cases, the environmental impacts of environmentally friendly substitute materials (e.g. PVD-plated plastics) are lower than those of the original materials, e.g. metals. How do customers accept those substitute materials in comparison to the originals? (3) Do ecological products contain some added value? Which attributes of the product are relevant for social prestige or individual pleasure?

1. The studies of this research programme could show that customers measure the prestige value and the value of individual pleasure by different product attributes (Oberender and Kopp, 2004). High prestige value is predominantly reached by design characteristics. In contrast, high value of individual pleasure is rather reached by the manageability and practical aspects of the product (Fig. 5.11). Additionally, it could be shown that different groups of customers consider different criteria to estimate the added values of a product. This result demonstrates the importance of a detailed knowledge about the target customer groups to create marketable and environmentally friendly products.

Value of individual pleasure Prestige value.

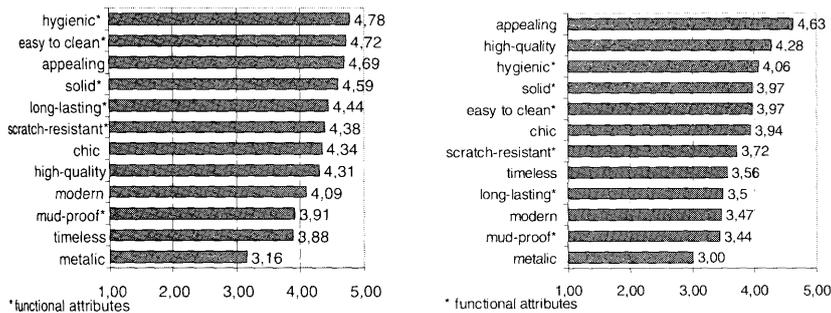


Fig. 5.11. Importance of attributes for the value of individual pleasure (left) and for the prestige value (right) (1=not important; 5=very important)

2. One possibility to create more environmentally friendly products is the application of substitute materials (e.g. chromium-plated plastic). However, the acceptance of these materials by the customers is not very high (Fig. 5.12). Customers accept such substitutes only in case of products for which added value is less important (Oberender, Kopp and Birkhofer, 2003). For these products design aspects are less important, they are rarely used and of smaller size, e.g. an egg boiler. At the same time the metals (e.g. high-alloyed steel) turned out to be exceedingly effective because the customers judged them both as practical and aesthetical. Furthermore, specific metals cause acceptably low environmental damage. Considering these results substitute materials should be applied only if their environmental damage is clearly lower than the one of other materials and if they will be used for products for which an added value is not important.

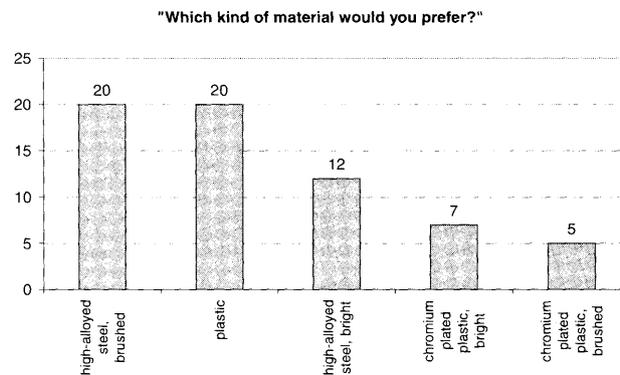


Fig. 5.12. Preference of surface materials (0=low preference, 25=high preference)

3. Furthermore it was examined whether customers use ecological products to demonstrate their social status. The results of the studies (84 participants, data collected by questionnaire) show that environmentally friendly products are not judged as highly providing prestige value. In fact, in a ranking of several kinds of products (e.g. clothing, mobile telephone) products which are marked as especially environmentally friendly (e.g. organic food, products made of recycled materials) take the last ranks.

In a second study, it was analysed which product attributes are suitable to create added value, especially prestige value. In a survey 100 participants were asked to judge different product attributes (e.g. brand, price, eco-friendliness) if they were able to provide prestige value. As a result, attributes that refer to product quality (e.g. leisure, durability, processing) were well qualified for prestige value. In contrast, attributes of eco-friendliness in general were judged rather less important for prestige value whereas in the area of eco-friendliness such attributes were judged most important that provide some personal benefit as well, e.g. "low-emission".

How to enhance the attractiveness of environmentally friendly products?

- Also environmentally friendly products have to provide adequate added value to the customer.
- Prestige value can be reached mainly by design characteristics; value of individual pleasure can be reached by practical aspects of the product.
- Environmentally aspects of the product themselves are not suitable to demonstrate high social status, they do not provide an added value.

- Different groups of customers pay attention to different aspects as indicators for the two types of added value.
- Substitute materials with lower environmental impacts than the original materials are not accepted very well by the customers.

→ *The attractiveness of environmentally friendly products can be enhanced by creating customer-oriented added value. For that it is important to define target customer groups and to examine their specific expectations on the two types of added value. Additionally, product developers should check that environmentally friendly substitute materials do not go against the customers' expectations.*

5.2.6 Conclusion

Within the research programme on marketability issues in designing environmentally friendly products the market potential of environmentally friendly products could be pointed out: Many consumers have a positive ecological attitude, however, they will mainly buy environmentally friendly products when the ecological aspects of the product provide personal advantage at the same time, e.g. cost savings by low energy consumption or health advantages. When analysing customers' demands for ecological products, it is important to have in mind, that there are some methodological aspects which can influence the answering behaviour of the customers and therewith influence the results of an analysis of customers' demands.

Good targets for ecological product development are complex products because for these products the cost-saving effect is larger and ecological information is easier to detect.

Concerning interesting customer segments, four different types of eco-friendly customers could be found. Younger customers (18-25 years-old) are willing to buy environmentally friendly products, as well as rather conservative, very ambitious or highly educated customers. However, also for these customer groups aspects of price and quality are more important than the environmental soundness of a product.

In the research programme two possibilities were analysed to enhance the ecological purchase. Particularly detailed ecological information about the product itself and about the ecological behaviour of e.g. peer groups can influence the buying decision towards the ecological product.

The second possibility to raise the attractiveness of the ecological product is to extend the added value of the product. Unfortunately, the application of environmentally friendly substitute materials often decreases the

added value, so it is recommended to weigh up accurately whether the benefit of higher eco-friendliness outweighs the loss of attractiveness and therewith of marketability. Besides this, the eco-friendliness of a product itself is not an option to provide added value to the customer. The added value has to be provided by other product characteristics, e.g. design characteristics.

5.3 Ergonomics in Environmentally Friendly Product Design

5.3.1 Background

This chapter presents the results of an empirical research programme on the ergonomic design of environmentally friendly consumer products. The main goals of the programme were twofold. First, it aimed to develop new methods and to improve existing ones for ergonomic product development. These methods were then evaluated in research studies. Second, it aimed to derive design measures from the analysis of user-product-interaction and to evaluate the effectiveness of these measures in experimental studies with a view to improve the environmental friendliness of consumer products.

User-product interaction is a central aspect of environmentally friendly product development since studies have demonstrated that, on average, about 80 % of the environmental impact caused by energy-driven consumer products occurs during product use, as opposed to preceding and subsequent phases of the product life cycle, such as production or disposal (Wenzel et al. 1997). Against this background, it is not only important to improve the technical efficiency of consumer goods (e.g. reducing energy consumption through a more efficient electric motor) but also to encourage users to employ the appliance in an environmentally friendly manner (Sauer and Rüttinger 2004b; Schmeink et al. 2004).

The design of consumer products poses particular challenges to product developers since the domestic domain differs from a professional work environment in a number of features (Sauer and Rüttinger 2004b):

1. The group of domestic users is characterised by high heterogeneity.
2. There is no selection of domestic users for their competence in operating consumer products.
3. Domestic users do not normally receive any formal training.