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USING ENVIRONMENTAL SEGMENTATION TO PERFORM ECODESIGN WITH USERS

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1 INTRODUCTION

Global deterioration of the natural environment has been a growing concern over the past decades. Following the first warnings came the first solutions (D. H. Meadows et al., 1972). In fact, the United Nations organized a set of summits to propose global solutions for these global problems, the very first one held in Stockholm in 1972.

The answer of the industrial community to the wake-up call of those summits was the proposal of the ecodesign methodology. By integrating environmental requirements during the design of product, a substantial decrease of its loads on the environment over its lifecycle would be possible.

To support this proposal, industrials and researchers have developed different types of methods and tools in order to ease this integration. The novelty of such an approach lied on two dimensions: firstly on the integration of the environmental issues on different mediums - air, water, soil - and ecosystems and secondly on the forecasting of the product lifecycle during design activities.

The first novelty is supported by joint-research in the areas of biology, ecology and predictive model.

The second novelty is supported by design research. They proposed models which, based on product geometry, give a prediction of the environmental input and output that will be generated over the product lifecycle.

The design research aspect has been, so far, able to integrate most of the lifecycle phases thanks to the integration of the actors of those phases. Communication with suppliers, retailers, customers, recyclers and disposers is a crucial point for ecodesign (ISO, 2003).

Nevertheless, it has been rather difficult to integrate into the ecodesign process non-professional actors such as customers or final users in the business to consumer sector. This difficulty lays one the fact that unlike the others actors, their expectation regarding the product are not driven only by economic requirements. The ambition of our current research is to find a way to integrate the customers and users expectations into the design process of more environmentally friendly product.

2 RESEARCH QUESTION

Our research aims at developing a methodology that supports the integration of users into the design process of any kind of product in order to decrease it environmental impact. Since our method is not specific to a product category, it should support the design of niche product as well as consumer goods.

In the special case of consumer goods, we have numerous users and it is rather difficult to make them all participate to the design process. User centered design teaches us that we can find a restricted number of users that will be the voice of a group of users (ISO, 2011).

In this situation, a crucial aspect is to pick the persons that are capable of representing the diversity of consumers' goods users.

Marketing has proposed a powerful concept with the segmentation approach: by grouping potential consumers that will have the same reaction to one or more marketing elements (Dillon and Mukherjee, 2006) , it is possible to design products with much more appeal to them thanks to a closer compliance to their needs. In our case, segmentation can help grouping users in a cohesive way to be able to easily identify representatives of this segment to support design activities.

Marketing segmentation is based on needs identification. In the special case of ecodesign, we can say that we restrain needs to those toward environmental issues. The segmentation approach that we wish to use should represent the diversity of users view on the environmental issues, i.e. users' environmental sensitivity.

3 LITERATURE REVIEW

This state of the art explores different proposals of segmentation that can be of interest for grouping users in a cohesive way for ecodesigning.

We focused our research on four domains that have used segmentation as tool for the development of product or incentives. Marketing provides the principles of segmentation for product launch success. Sustainable sciences provide segmentation approach based on citizen views of nature and environmental issues. Public policy gives an example of application of segmentation to improve the environment by providing practical instruments to support citizens in their sustainable behavior. And finally, we propose to explore the human values as an argument for segmentation allowing to design product with more appeal to the consumers.

3.1 Segmentation in marketing

For consumer product, marketing experts have recognized for a long time that "one size doesn't necessarily fits all"(Dillon and Mukherjee, 2006). The same authors acknowledged the fact that one challenge of marketing is finding the equilibrium between a product for all and a product for only one person.

Segmentation is one way to balance this equation. Dillon and Mukherjee (2006) defined a segment as being cohesive in their inner characteristics and in opposition to another segment. The most frequent differentiating options are: price, promotion - advertising channels and messages - and product features.

Other authors proposed different axes for segmentation. Bock and Uncles (2002) made a non exhaustive list of parameters for market segmentation: geography, demography, firm strategy, behavior, decision-making process, lifestyle… This long list demonstrates that every project or every company should be able to define its own segmentation option depending on its strategic plan.

In the specific case of ecodesign, that demonstrates that we should develop a segmentation that can represent the different reactions of users to environmental issues. Marketing literature does not provide insight on the specific topic of environment.

3.2 Segmentation in sustainable science

Yet, even if it is not aimed at commercializing a product, environmental experts have tried to separate human being according to their view on the environment and on nature.

Some researchers in sociology and sustainability proposed a cultural segmentation of people's view on nature. The classification of Douglas in (Douglas, 1999) describes 4 different views on nature based on their perception of group - high means collectivist and low means individualist - and grid - high means hierarchist and low means symmetrical -:

- The fatalist is hierarchist and individualist. He is isolationist, and he has every right on the nature within his property limits.
- The hierarchist is also collectivist. He is attached to tradition and to his family. For him, nature is robust but it is also limited.
- The egalitarian is collectivist but has symmetrical relationship with others. He rejects authority and worships simplicity and frankness. For him nature is fragile but a collective management of its resources will benefit the group.
- The individualist also has symmetrical relationship with others. For him, competitive innovation and personal freedom are very important. Nature is robust but is quite unpredictable.

Stern (1992) also proposed a division in personal value that will influence their acceptance of the new environmental paradigm (NEP). Biospheric and Altruistic values influence positively the NEP and Egoistic values have a negative influence on NEP. It was used for modeling the acceptance of certain behavior that have a positive influence on the environment (recycling and environmental citizenship)

Douglas' segmentation was used in environmental assessment to weight environmental impacts according to the view on nature of different group (Goedkoop and Spriensma, 2001). In other words, it balances the importance of three elements, human health, ecosystem, and resources, according to their relation to the concept of Nature.

Even though Douglas' proposal was used for environmental assessment and Stern in behavioral science, both of them are not adequate for product design. There is no evidence that the view on nature of a person may have an influence on the product he uses and the way he uses it. So, even if these proposals can be used for communication on environmental assessment results, they are not usable for modifying product design according to the important environmental issues for users.

3.3 Segmentation in public policy for the environment

Another approach is given by research in public policy for more sustainable societies. DEFRA - Department for Environment, Foods and Rural Affairs -, in the United Kingdom, wished to propose different mechanisms depending on citizens' involvement and interest regarding environmental issues. They proposed, in (DEFRA, 2008), to survey the behaviors - involvement and the attitudes - interest of UK citizens. With the results of the survey, they found that citizens could be grouped into segments depending on their behavior and their attitudes toward the environment.

Based on those groups, each of them being defined according their willingness to act- attitudes and their ability to act - behaviors, they proposed different solutions for public policy deployment:

- For segments with a low ability to act, they proposed solutions such as tax incentives toward green product, in order to enhance actions.
- For segments with low willingness to act, efforts should be oriented toward education and raising awareness on environmental issues.

This approach to segmentation is of high interest for our proposal: it illustrates environmental sensitivity and actions at the same time. So it can be used to identify different users' practices toward product but also different levels of willingness to be involved in environmental improvements.

3.4 Segmentation according to value-system

Rokeach defined values as "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1973). In other words, values are what drive how we behave in our everyday action. Schwartz and Bilsky (1987) demonstrate that values are connected to human behavior and especially to consumer behavior. Rokeach drew up a list of 18 terminal values organized into RVS "Rokeach's Value System" and representing people's ideal end states of existence. That connection between this set of limited values and consumer behavior made it a good candidate for performing a market segmentation. Kamakura and Novak (1992) proposed one of the most advanced segmentation based on value-system. Instead of separating consumers according to their position toward a single observation of one terminal value, they tried to make a correlation between a group of users and a specific set of values. They succeed in grouping consumers in four segments with a particular set of terminal values.

Personal values are part of subjective parameters. They are known to complete the description of users. Integrating an account of subjective parameters is of great interest regarding product design (Mantelet, 2006). In fact, many studies show that linking subjective parameters such as personal values to enrich product design attributes is widely effective and helps designing products which fit with users' internal characteristics. Some examples come from the fields of Kansei and Emotional Design (Bouchard et al., 2009). Value-system segmentation is of great interest for designing with the users because it links the behavior - expression of action - toward the product with an account of the psychological reason that may have lead to the expression of such a behavior. For ecodesign, it will be interesting to associate positive view on environmental issues and willingness to act in the environmental domain, and make them connected with higher level value-systems. By doing this, we will be able to define design strategies in conformity with the users' end-of-life orientations toward the terminal values of Rokeach.

4 A NEW SEGMENTATION APPROACH FOR ECODESIGN

Our objective is to propose a segmentation of product users that is oriented toward environmental sensitivity. As a result, we would be able to make a correct selection of user representatives for the ecodesign activities, allowing designing products which fits users' behavior and environmental sensitivity.

We propose to merge two approaches in order to reach that objective: *environmental behavior* and *human values*. On the one hand, segmentation for environmental behavior exists, as pointed out in our literature review. Especially in public policies, Defra proposed a very detailed study that allows grouping citizens according to their behaviors and attitudes toward environment issues (DEFRA, 2008). On the other hand, Rokeach's RVS approach has been used to segment and develop product that fits consumers' values for a long time in marketing research (Rokeach, 1973). What we propose is to enrich the segmentation proposed by DEFRA by integrating Rokeach's human values, and furthermore identifying potential values group (Kamakura, 1992) that may be associated to environmental sensitivity.
To do so, we needed first to collect data that are interesting to define users' profile. By identifying two kinds of data set, their attitude, habits or everyday-life behaviors toward the environment, and their personal values, we would be able to define such a profile. We will then correlate these two data sets. Therefore, we used environmental segments representation proposed by DEFRA (DEFRA, 2008) as a template and get it enriched with users' terminal values.
In order to define a segmentation of user profiles, an important step is the criterion identification, we first need to identify these criterions, and then extract information that allows measuring these criterions by analyzing users' answers from the collected data. According to DEFRA principles, the criterions, for environmental awareness are the *motivation – willingness to act –* and the *capability – ability to act*. In other words, Environmental awareness can be set up by retrieving information related to ability to act and willingness to act. In that case, the categories resulted from segmentation through Environmental awareness can be represented with a mapping represented on two axes. The two axes represent the criterions: *ability to act* and *willingness to act* (DEFRA, 2008). Although the representation proposed by DEFRA (DEFRA, 2008) already identified the environmental segments, we can use it as a template.

The tool we used to collect data on users was a web questionnaire realized from February to March, 2012. The web questionnaire was designed in LimeSurvey and widely published through a panel of random users. It consisted of 98 questions divided into different sections, including:

1. A basic part with general information, such as age, sex, occupational status, education level, etc.,
2. A series of questions about their lifestyle in general, such as their diet, if they practice a sport or not, etc.,
3. their personal values, and how these values can influence more or less importantly the daily behavior,
4. Their general attitudes regarding their relationship with the environment,

Indeed, the main purpose of these questions was to gather general information on practices, attitudes and behaviors of these individuals on a daily basis and to understand the common attitudes of different users. Questionnaire related to a sample of 72 random people.

Based on the answers from the questionnaire, we selected the 5 most important questions that could be used as the scale for measuring environmental awareness, by associating a relative AA score and WA score on each answer. To trigger the WA, 5 questions on habits regarding energy savings and recycling, for example, were used. And for AA, questions on incomes and product availability were considered.
As shown in figure 1, by retrieving the results gathered from the sample of 72 respondents, we were able to draw an initial map representing the people's *motivation – willingness to act –* and *capability – ability to act –*, according to DEFRA segmentation basis (DEFRA, 2008).

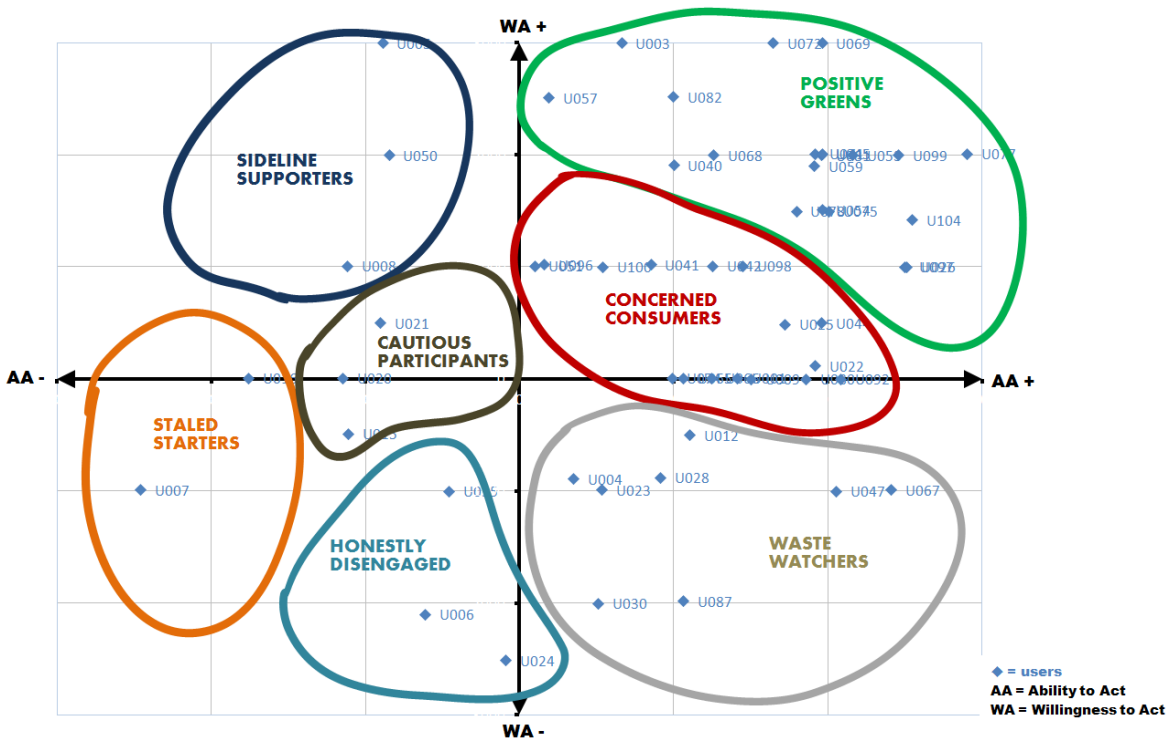

Figure 1. Distribution mapping of a sample of 72 users based on DEFRA segmentation related to WA- willingness to act/AA- ability to act.

In order to enrich the previous segmentation with terminal values, the matching of the *willingness to act/ability to act* axis with the values of the users can be triggered by analyzing data from the section on values. The value part of the questionnaire is where we asked people to give a classification of their end-of-life values (section 3 of the questionnaire).

Thus, by coupling the segmentation map - figure 1 - with the data on values, we were able to identify which values group are connected to each specific segment of user. As the total number of values a person possesses is relatively low (Rokeach, 1973) and ordered by relative importance (Schwartz, 1987), we highlighted the 5 or 6 most important values related to each segment, and then draw the representation shown in figure 2. Each DEFRA segment is represented in this updated WA/AA mapping, in accordance with their highest ranked values. Each value inside a same group does not have the same importance and is represented with a size that is proportional to their importance. The amount of users' representatives is not the same for each segments, each group of values is represented according to the importance of the representatives in the segment and not in the entire users group.

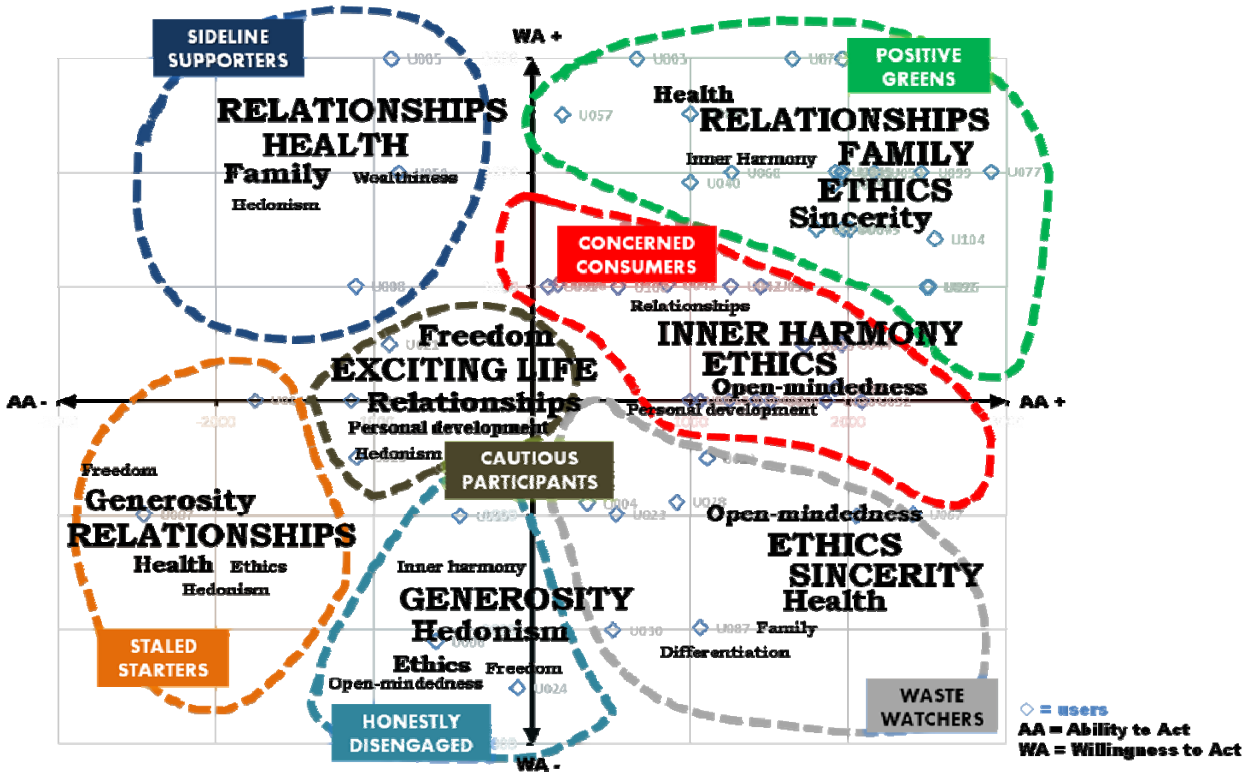

Figure 2. Value-based mapping related to segment analysis of a sample of 72 respondents.

The result shows that it is possible to associate DEFRA segments related to a specific group of values, as shown in the table 1.

Table 1. Segments and Environmental group of Rokeach's values

	Environmental Awareness Segments (Defra, 2008)	Environmental "Group of Values" Segments
1	Staled Starters	Relationships; Generosity; Health; Freedom; Ethics; Hedonism
2	Honestly Disengaged	Generosity; Hedonism; Ethics; Open-mindedness; Freedom; Inner Harmony
3	Cautious Participants	Exciting Life; Freedom; Relationships; Personal Development; Hedonism
4	Sideline Supporters	Relationships; Health; Family; Hedonism; Wealthiness
5	Waste Watchers	Sincerity; Ethics; Health; Open-mindedness; Family; Differentiation
6	Concerned Consumers	Inner Harmony; Ethics; Open-mindedness; Relationships; Personal Development
7	Positive Greens	Relationships; Family; Ethics; Sincerity; Health; Inner Harmony

This association offers a major advantage because it highlights the possibility to define users' behavioral tendencies based on theses group of values.

For example, *ethics* comes as one of the most discussed value related to environmental sensitivity. There is a high rank of *ethics* among the people having a high ability to act – *Positive Greens*, *Waste Watchers* and an important part of *Concerned Consumers*. Thus it means they give an important consideration to the notions of respect of environment, human rights, peace, equality, for example. Opposite to that, this notion of *ethics* is less taken into account or completely disappeared among the people with lower ability to act – *Stalled Starters*, *Honestly Disengaged*, *Sideline Supporters*, *Cautious*

Participants. The lack of minimum integration into the problems of environmental issues that is brought by *ethics* drives their behaviors, even if they have a higher or lesser willingness to act score.

Another example comes from the value *relationships*. *Relationships* is first-ranked among people with high ability to act, and especially *Positive Greens*. *Relationships* value includes the notions of love, friendships, respect for others, for example. However, there is an important distinction regarding their willingness to act. In fact, on the first hand, people having a high willingness to act associate the notion of *relationships* with other values such as *health* or *family*. And on the other hand, those with low willingness to act are more interested in *hedonism* - pleasure, optimism, happiness, sensuality - and *generosity* or *solidarity*. It means that the notion of relationship is not understood in the same way. People with low willingness to act – *Stalled Starters*, some *Honestly Disengaged* and *Cautious Participants* - are more attracted to human concerns, thus more opened to others, and the ones with high willingness to act seems to be more protectionists in various levels, it may include their own health, family, country, or also the planet, the environment.
In the next section, we give an illustration on how segmentation and values can influence the decisions orientation in ecodesign process.

5 APPLICATION TO ECODESIGN SOLUTIONS

Since segments differ in terms of will and act toward environmental issues, the solutions to improve their environmental impact through the product should be different. A coffee machine redesign was used for comparing the different concepts that could be implemented depending on the segment it was designed for. This product was chosen because most of its environmental impact happens during use phase and this impact is influenced by user behavior (Bush et al., 2009).
Ecodesign strategies were compiled from Mac Donald and She (2013) and Tang and Bhamra (2008) to support concept development. Both of them propose a classification of the principles, the first according to cognitive concepts and the second according to user control over the product.

The redesign focused on two segments: the *positive greens* and the *cautious participants*. Table 2 is a comparison of the two profiles in terms of WA, AA and values.

Table 2. Segments and Environmental group of Rokeach's values

	Positive greens	*Cautious Participants*
Willingness to act-WA	High	Medium High
Ability to act-AA	High	Medium Low
Value 1	Relationship	Exciting Life
Value 2	Family	Freedom
Value 3	Ethics	Relationship
Value 4	Sincerity	Personal development
Value 5	Health	Hedonism

If the segment is characterized by a high ability to act and high willingness to act, solutions that give the control to the user should be the most interesting. This solution may be very profitable for the environment if the user gets engaged in the adequate behavior. It is a promising strategy for *positive greens*.
For the coffee machine, a priority should be given to information and ecofeedback strategies for the positive greens. With the additional information on values, the content of the feedback and the information can be tailored to increase relationship and family time. A notification on the weekly or daily consumption of the machine can be provided on the machine, with a small screen. This information can be used on a website that provides additional data and educational tips to encourage exchange among family members on environmental issues.
Additional data can help the user identify bad habits in terms of product use, for example on coffee machine deliming process.

For segment like *cautious participants*, their willingness and ability to act being lower, solutions that relies on more control from the product are more effective. Strategies based on spur are very interesting for those segments. It can help them explore new behaviors with the coffee machine, and

maintain them over time. The complement on values helps creating the concept for the coffee machine. Since this segment is interested by exciting life and freedom, the spur concept can be implemented with an optical fiber that reflects on the coffee container depending on the past environmental efficiency of the behavior. Even so guilt is not an effective strategy, this color reaction of the machine can help creating knowledge on good or bad behavior regarding the environment.
Another strategy for this profile is the eco-steer. In this case, the bad behavior is difficult to perform. In the case of the coffee machine, an automatic switch off can be implemented with a procedure to modify this behavior and turn it more difficult (for example a complex chain of instructions to follow).

The most effective ecodesign strategies for the coffee machine are the ones that modify most the behavior of users rather than the product architecture. In this case, the eco-feedback is the less environmentally damaging solution because it only needs the implementation of an additional small screen to modify the behavior. Nevertheless, it requires the user to respond positively to the feedback information. And this positive answer would not be obtained for people with a lower willingness to act. This is why we propose other solutions for the *cautious participants* segments. They are less effective in terms of environmental performance but will be more likely to be adopted by this type of users.
These adaptable strategies based on segments will help increase the willingness and ability to act of all segments. The addition of values helps engaging users on the adoption of sustainable behavior.

6 DISCUSSION

Segmentation has shown good results in providing products that better fits users' needs. The main challenge for a successful segmentation is to define on what criterion to segment. In our case, we wish to ecodesign product according to user's environmental sensitivity. By coupling a proposal from the public policy area (DEFRA, 2008) with value-system proposal, we were able to define seven group of persons that have a specific position toward the environment through their willingness to act and ability to act and toward the relative importance of terminal values.
Those segments can be used in design activities, especially to choose the most effective strategies. In the case of ecodesign, the characterization of users according to environment and terminal values gives additional information for developing adaptable product. The adaptation illustrated in this paper lays on the level of user involvement into managing the product environmental impact.
Segmentation is also a way to identify users that will be enrolled later into the design activities. By defining segmentation, it is easier to find the characteristics that an individual should have in order to be representative of this segment. This second assumption has not been tested yet. In a second part of this project, we will test the different strategies proposed in section 5 to the representatives of each segment they are aimed at.

The enrichment of environmental segmentation with terminal values measurement is important to design adequate product. In fact, even if the product attributes are ecodesigned, their benefits for the environment would be diminish if they are in conflict with users' terminal values. The loose of appeal of the product due to value mismatch can greatly decrease the benefits of the ecodesign strategies. For example, if the spur rewards is in opposition to the value of *relationships* by increasing competitiveness in a family, the product might be pulled out of service by the family.
The specification of ecodesign strategies depending on the segment characteristics will be a source of an environmental impacts decrease. Even so, standardization decreases the environmental impact of product manufacturing and end-of-life, we stated that the savings of environmental impacts over the use phase, thanks to a product that better fits the user's environmental profile, will be more beneficial.

7 CONCLUSION

This contribution shows that segmentation according to environmental issues is possible. By coupling that segmentation with terminal-values definition, ecodesign strategies can be specified according to what is most important for users according to their personal value-system.
This segmentation was used to define the ecodesign strategies that will be most effective for each specific segment.

The next step for the project is to implement this segmentation approach inside a complete ecodesign methodology. It will be of interest to implement the proposal of Valette-Florence (1994) about mean-ends chain “Value-Function-Solution” in order to implement product functions associated with ecodesign solutions which better fits users’ needs.
The future methodology will provide a pathway to develop specific product for each segment. That potential product will have environmental impacts which are as low as possible for this specific user profile.

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