

Ecology push: a novel methodology in product design

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ABSTRACT

Product design is a function that aims to the satisfaction of the customer needs. Nowadays, that the environmental issues become more and more important, product design should address not only economical issues but environmental and social as well. The present research focuses on the development of a novel methodology called Ecology Push and proposes a step by step approach utilizing this method. Although, it takes into consideration the economical and environmental aspects of product design, it also stresses the importance of its social aspect. Additionally, a case study is presented, which validates the proposed methodology. At the same time a new role for the product designer becomes apparent. The designer through his work is able to educate his customers and motivate them towards a more sustainable way of life.

Keywords - assessment tool, product design, sustainable design.

I. INTRODUCTION

Nowadays, all over the world there are signs of severe stress on the interdependent economic, environmental and social systems. Population is rising, while excessive consumption and poverty continue to put enormous pressure on the environment. Societies want to achieve economic development, in order to secure higher standards of living, together with the protection and enhancement of the environment for the future generations. Sustainable development reconciles these two objectives, in order to provide development that meets the needs of the present generation, without compromising the ability of future generations, to meet their own needs as well.

During the early design stages of a product development cycle, all decisions taken contribute to over 70 per cent of the overall product's cost. Although the pieces of information available are limited at the beginning of the product design, appearance, material selection, innovation, performance, environmental impact and perception of quality have to be dealt with at this early stage [1, 2]. As a result, designers have the opportunity to influence the impact that products have on both the environment and the society. Their decisions can have at the same time positive and negative social and environmental impacts. Designers can influence the decisions that people make about what they buy and why they do. These decisions reflect peoples' perceptions of lifestyle and their associated status in the world. Lifestyle is about identity choices, about how individuals wish to be and how they wish to be seen by others. This is expressed through their consumer habits regarding the material, aesthetic and symbolic perspective of the items they buy or consume. Lifestyles are patterns of actions that differentiate between people. They map onto conventional social

categories of class, income, age, gender and ethnicity and often transcend them [3].

With the right point of view, designers have the opportunity to influence attitudes and aspirations, in order to achieve a cultural transformation on customer demands. They can easily promote a new, more environmental friendly, culture and lifestyle. In addition, they should understand how to make the required changes, in order to develop products with more sustainable values. However, many of these values are openly considered under a range of other factors, such as ergonomics and styling [4]. Sustainable product design faces three major challenges [5]:

- Economic: this can be tackled by creating products and services that are less expensive to produce, transport and use, and better adapted to the customer needs in a variety of countries around the globe.
- Environmental: it reduces the use of non-renewable resources and minimizes the environmental impact. Principal rules are: using low-impact materials, smaller consumption of natural resources, creation of longer-lasting and better-functioning products, which can be reused, recycled or composted after their initial use, and
- Social: it allows for increased usability, user-friendliness and safety. It targets users from minorities (disabled and elderly individuals, children and individuals from cultural or linguistic minorities). It plays a key role for some individuals' ability, to enjoy basic human rights like housing, employment, education e.tc.

Park and Seo developed a knowledge based approximate life cycle assessment system in order to assess the environmental impacts of product design alternatives. They aimed at improving the environmental efficiency of a product using artificial neural networks, which consisted of high-level product attributes and LCA results. The framework allows the users to access the product data and other related information on a wide variety of applications [6].

Jeong and Lee proposed an assessment method for eco design improvement options using global warming and economic performance indicators. A reduction in the greenhouse gases (GHG) emissions in the entire life cycle stages of a product was chosen as the global warming performance indicator of the product. The life cycle cost of the product was chosen as the economic performance indicator to measure the performance of its life cycle cost reduction. The assessment method based on the two performance indicators was applied to a liquid crystal display panel [7].

Donnelly et al. presented Lucent's wireless business unit, Mobility Solutions, that pioneered a product based environmental management system to formally address the impact of wireless hardware products on the environment throughout the entire product life cycle, regardless of where

products are developed. Their approach looks beyond the environmental impacts of manufacturing, to include conceptual design, development, customer use and final product disposal [8].

Aoe proposed eco-efficiency indicators and has actually utilized them since 2001 in companies. He has conducted many case studies of eco efficiency using these indicators [9]. Munoz et al. presented a cradle-to-grave life cycle assessment of a toy, incorporating electric and electronic components following the ISO 14044 standard, aiming to identify the environmental hotspots and suggesting eco design measures to the manufacturer. The toy was designed by a Spanish company, but manufactured entirely in China, being exported to Europe, America and Africa. The assessment includes production of all components in China, maritime and road distribution, and considerations of use phase and end-of-life [10].

Ljungberg reviewed current methods on how to develop sustainable products. Different methods for achieving products with the lowest possible environmental impact and principles for product development with special regards to materials selection, design, the product in use and recycling are presented [11]. Fuller and Ottman demonstrated how sustainable product design can affect ecosystems degradation. As the natural capital conversions that underlie product making are the source of the waste that is polluting ecosystems, it makes sense for the researchers to tackle the source of the problem itself [12].

Luttrupp and Lagerstedt started with the hypothesis that there is a strong need for a tool to facilitate the integration of reasonable environmental demands into the product development process. The presented tool 'The Ten Golden Rules', can be helpful in this effort, because it adapts to the task and as a result, the individual product developer/designer is able to develop personal versions of products from the generic guidelines [13].

Although different researchers have come up with different ideas and proposals about sustainability design methodologies, most of them have dealt mainly with the

financial and environmental aspects of product design. The present paper contributes towards the development of a novel methodology, named ecology push, which can lead designers to apply the principles of sustainability in a formal manner. The main novelty incorporated is that except from the financial and environmental issues of a product design, its social aspect is greatly considered. The outcome is to upgrade the role of the designers and make them educators of their own customers.

II. THE CONCEPT OF ECOLOGY PUSH

In the innovative design literature, there is a distinction between the technology-push and the market-pull approaches (Fig. 1). A technology push approach implies that a new invention is pushed through research and development, production and sales functions onto the market, without proper consideration of whether or not it satisfies the customer's needs. In contrast, an innovative product or service based on market-pull can be developed in response to an identified customer need. In a 'pull' strategy, the customer requests a new product/service and 'pulls' it through the delivery channel. A 'push' strategy in marketing is used, when a new product/service, unknown to the customer, has been developed or improved. As there is no customer demand in the product/service launch, the product and the information are 'pushed' to the consumer by distribution and promotion [14].

The concept of ecology push is generated by the need of ecological consciousness to the majority of people and the rising importance of recycling, especially on children, teenagers and young adulthoods (Fig. 2). The reason that the concept is focused on young ages is that, today's children are tomorrow customers, managers and most important parents. According to this approach, a push strategy in marketing is used, when a new environmental friendly product is developed or redesigned based on a more ecological conscious culture. The term product design implies that the product has been developed in order to satisfy customer needs and desires.

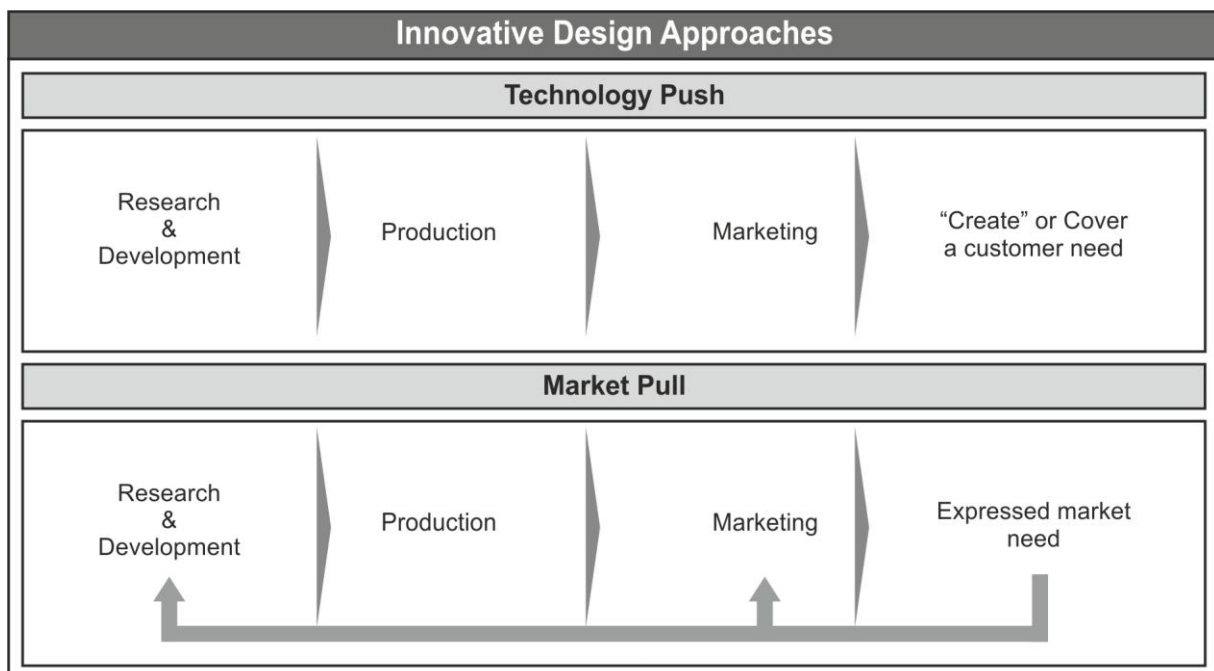


Figure 1. The Technology-Push and Market-Pull approaches

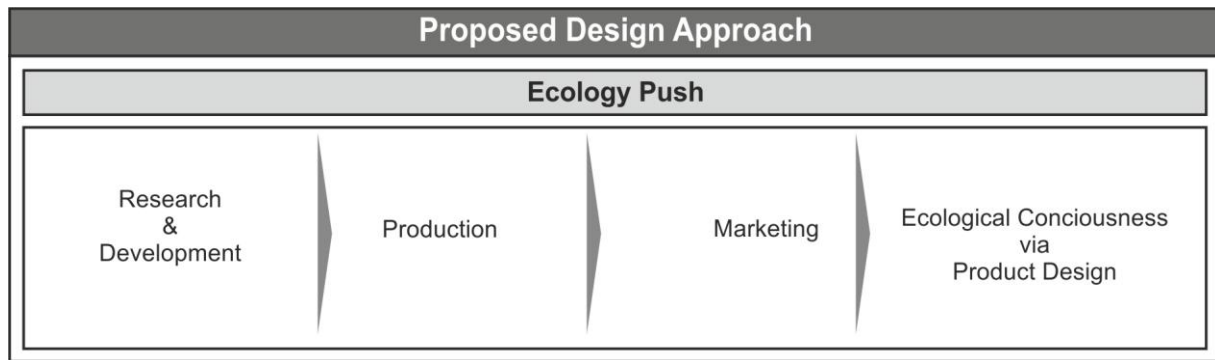


Figure 2. The Ecology-Push approach

Designing for sustainability requires awareness of both short and long-term consequences of any transformation of the environment. Sustainable product design is the conception and realization of environmentally sensitive and responsible expression as a part of the evolving matrix of nature. Moreover product design can encourage recycling and propose solutions. Fingerprinting materials by color or emblem or barcodes allow recognition. Design for disassembly and the avoidance of mutually contaminating combinations, allow economic separation. Clever chemistry (strippable paints, soluble glues) helps with decontamination. Finally design to bypass the need to recycle, longer primary life and more thought, at the initial design stage, towards a possible secondary usage.

Ecology Push can be used as a new model for product design. These products should aim to spread the meaning of sustainable development to consumers in all over the world while at the same time encourage the act of recycling.

III. THE PROPOSED FRAMEWORK

The proposed framework that incorporates the ecology push approach aims in developing a new eco tool which could emphasize the principles of the social impact that a product might have, when it is promoted in the market. The concept of ecology-push was generated by the need of ecological consciousness to the majority of people and the increasing importance of recycling. These concepts suggest that environmental problems in society should not only be addressed via technological innovations (i.e. cleaner production), but also require social changes in the way of living, consumption patterns/levels etc. If such approach is achieved, the most important element of creating a fruitful interaction between technical and social innovation could be found, and place an even greater focus on social innovations when sustainable design is applied.

Based on the need for a new approach in the product design cycle, the proposed ecology-push framework incorporates new roles for both the designer and the customer (Fig. 3). The designer should design or redesign the products keeping in mind their impact to the environment, while the customer offers its feedback during the design process. It is the designers' responsibility to educate their future end-users in order to promote a more environmental friendly thinking.

Further to the feasibility study, designers proceed to the conceptual design of the product. They should incorporate eco-design principles and by the end of that phase, customers come into the picture and assess the designs (stage A). The assessment is based on a questionnaire which has two aims. First, the customers express their idea about the product functionality, worthiness, aesthetics, ergonomics etc, and the feedback is concentrated on traditional issues. Second, the designers are trying to examine, if the ecology issues have been identified from the customers' point of view. The main goal, at this level, is for the customer to understand the eco-messages based on sustainability design, while adapting their way of living and activities accordingly. Together with the questionnaire several interview sessions are taking place, in order to capture the customer perception on the ecological message that the product incorporates. At that stage it is crucial to adjust the product's design and achieve a message transfer through the product's appearance and functionality. It is not enough to design a nice looking or even very handy product, if the ecological message is not clearly defined in a direct manner. In the next step, the product which proved to clearly prompt the customers towards sustainability in their lives is undergoing the proposed changes and then a detail design, testing and prototype building phase follows. It is then that a new customer assessment (stage B) is performed, in order to provide evidence that the expected product is according to the customer needs and at the same time promotes the sustainability principles. Both the assessment activities result in redesigning the product in order to take into account the customer feedback.

The customer assessment tool targets to the customer satisfaction through innovation and cultural transformation, in order to promote the sustainability principles as a way of life. It was developed to support the newly proposed ecology push model. The key issue is the change on customer perception about the product, with an emphasis on eco design and the principles of sustainability. The new designs have to motivate the end-users to change their lifestyle towards a more environmental friendly way. The development of the product could be done in a variety of ways, but the emphasis should be given on the customer perceptions. The main idea is to educate future customers towards sustainability and not actually design eco products in the traditional way.

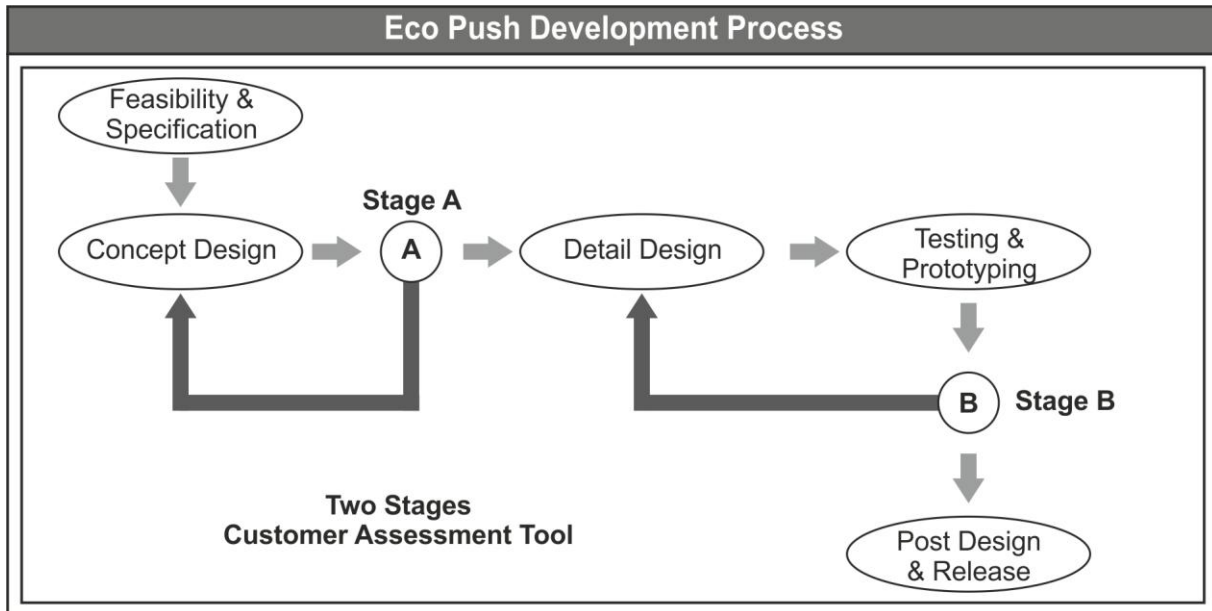


Figure 3. The Eco push framework based on customer assessments

IV. CASE STUDY

A number of different products can be developed based on the proposed ecology push framework. The product under study is called 'Eco-Maniac Bin' (Fig. 4). It consists of a basic bin together with a number of additional parts such as bottle-like, can-like, book-like and tetrapack-like slots. Moulded pulp recycled paper is proposed for all these items because it can be moulded to the desired shape since its fiber is relatively soft and absorbs impacts. It is only recently, that moulded pulp has emerged as the interior packaging material of choice for many electronic and consumer products. It is 100% recyclable, 100% biodegradable, light in weight, safe, sanitary, non-toxic, acid-proof, alkali proof, water proof and finally is easy shaped and practical.

The most important difference, from the material point of view, between traditional toys and the Eco-Maniac bin is the substitution of all plastic components with recycled moulded pulp paper ones. Molded pulp paper is a sustainable product in compliance to ISO 14000 and the European Green Dot standards. The change of the material is targeting to the reduction of the environmental impact during the toy's life cycle.

The development of the product was completed in accordance to design for sustainability within the aforementioned methodology. There was an effort to reconsider the product and its functions. The similar existing toys are targeting to the development of children wit spark and all toy-pieces should be entered successfully based on their shape through the correct slots. Traditionally, the shapes used are cylindrical, conical, cubical, pyramidal etc. Eco-maniac bin, transforms these simple solids to existing products geometry and try to teach the action of recycling:

- The Eco Maniac Bin tries to introduce the children-users in a more sustainable way of life. More specifically, it creates a culture towards recycling and promotes the social aspect of the sustainable design methodology (the child learns to recycle by playing in a very young age with the Eco Maniac Bin).

- Moreover, the use of recycled moulded pulp paper instead of plastic aims to reduce energy and material consumption throughout a product's life cycle and replace harmful substances with more environmentally friendly alternatives. The product may be used more effectively and as a result a reduction of energy can be achieved.
- The designed toy is simple and works manually without the need for external source of energy (i.e. battery).
- The product presents no need for packaging. The main material which is used is from recycled paper and can be recycled again. The principles of design for assembly and disassembly were extensively used in order to be able to be recycled without problems.
- The main bin of the toy could be reused after its main use, as an office bin or as a flower pot. Finally, the toy was designed based on the principle of repairing components instead of replacing the whole product.

The main target for businesses is to design and develop profitable products, which are both environmentally friendly and socially acceptable. Further to the concept design stage, the Eco Maniac Bin went through the first customer assessment procedure based on the proposed framework. An appropriate questionnaire was given to 47 families in order to receive their feedback. The key idea was for the participating families to understand the messages dealing with the social issues of sustainable development. That means, that apart from the traditionally perceived issues (recycled material, pulp paper etc.) the children should be able to discover the importance of separating materials. In such a way, they learn from a very young age the recycle activity and a cultural transformation can be achieved in a very early stage of their life. Studying the results from the first assessment, modifications were made and finally, based on the detailed design a prototype was built and used for a second customer assessment.

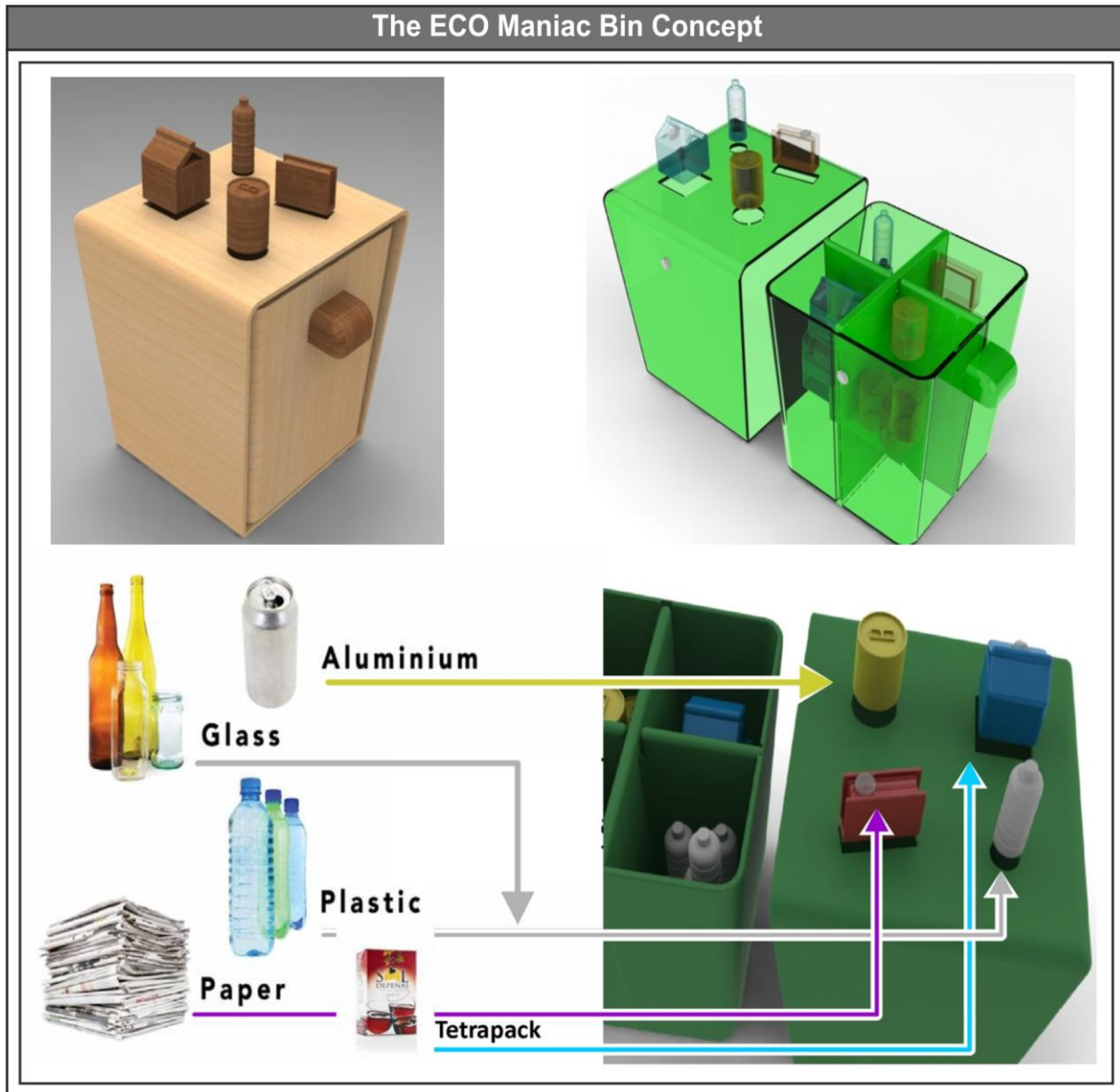


Figure 4. The Eco-Maniac Bin Concept

The results from both the customer assessments can be summarized as follows:

- although the two thirds of the participants were not sure about what sustainable development means, more than 90% understood the aim for the children cultural transformation,
- 75.6% of the family members mentioned that they are willing to purchase the product, even if its price was greater than the similar traditionally designed toys,
- 82.4% of the family members liked the fact that they can participate in the design of a product early enough and thus contribute to its future,
- 64.1% of the participants recognize the need for ecologically designed products, acknowledging the need to become environmentally educated customers.
- When measuring their perception about the importance of the three sustainable development pillars, the results were 65%, 69% and 45% acceptance of environmental, social and economic issues respectively.
- 73.6% of the family members would definitely purchase other redesigned toy which would be based

on existing one, even if that means that must pay 30% more for its acquisition.

Further to the questionnaires, the design team conducted a number of interviews with the participants, in order to have a more direct contact with them and analyse their thoughts and perceptions directly. In addition to that, designers were brought together in brainstorming sessions, in order to consolidate the outcome of the customer participation. The Eco Maniac Bin affects sustainable development to its three pillars but emphasizes its social impact. Furthermore, it motivates young people to learn about sustainable development. The designer can become a kind of sustainable development teacher.

V. CONCLUSIONS

With all the environmental issues people facing in today's world (i.e. the pollution coming either from industrial or from public wastes, the energy consumption of non renewable resources), it is important to grasp the need for a change in our consuming culture and start thinking the promotion of environmental friendly way of life. Product design with environmental friendly techniques and technologies cannot by itself be the solution towards better

resources management. There is a need for cultural transformation, and that need should be addressed to the young people, in order to promote the appropriate culture early enough.

The concept of ecology push aims to spread the sustainable development, especially to children and young people, in order to create the new environmental culture of the young generations. The ecology push strategy via designing environmental friendly products aims in developing ecological consciousness to young consumers. The role of the designer becomes more important because, in addition to the product design issues, he/she is shaping the required attitude of the customers. The customers from their point of view clearly understand the environmental messages and learn how to recycle from a very young age.

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