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CONCEPTUAL DESIGN WITH EMPHASIS ON THE SOCIAL IMPACT OF SUSTAINABILITY PRINCIPLES

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1. Introduction

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. In addition the product appearance, material selection, innovation, performance, environmental impact and perception of quality are dealt with, although the pieces of information available are limited [Fiksel 2009, El-Haggar 2007]. As a result, designers have the opportunity to influence the impact that products have on the environment and society. Their decisions that can have positive and negative social and environmental impacts around the world. For example, the nature and substance of the materials that are specified, will hane an impact to the communities which provide the appropriate labor to deliver these materials and the originating sources. The designers must extend their responsibility because of the key role they play as the industry's connection with the marketplace [Wimmer and Zust 2003].

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 what they consume from the material, aesthetic and symbolic perspective. 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 [Bharma and Lofthouse 2005]. 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.

2. Sustainable Development

Last 40 years people have utilized a more attentive examination of the factors characterizing the processes of the developed countries. Realizing the shortage of supplies and the enviromental pollution is the concept of sustainable development. This points up the necessity of developing processes with respect to the environment, in the interests of future generations. Sustainable development is a development that meets the needs of the present generation, without compromising the ability of future generations to meet their own needs. With this definition of sustainable development, in 1987 the World Commission on Environment and Development (WCED) mapped out what is now widely recognized as the guiding objective of the current process of economic and technological development, in order to ensure, that the use of environmental resources satisfying present demands are managed in a way, that they are not left impoverished and they cannot be used by future generations [Mcquaid 2002, Giudice et al. 2006].

2.1 Sustainability - the triple bottom line

Sustainability was furthermore defined to have three dimensions: an economic, a social and an environmental. In the business community, this has been well known as "the triple bottom line", pointing out that sustainable development for business involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. In other words, businesses have to expand their responsibility to include the environmental and social dimension of sustainability. Sustainability is considered to be more of a direction, than a destination that will be actually reached.

2.2 Environmental life cycle thinking - from cradle to reincarnation

Life cycle thinking and environmental enterprises involve developing products, which have improved environmental characteristics throughout the product's life cycle, from cradle to grave or rather to reincarnation. Life cycle environmental enterprises aim to product improvements in all phases of their development, from raw material extraction and production, to transport and consumption, to re-use or disposal. The main goal is to reduce the amount of resources used and the emissions produced during the different stages. This is true when all different enterprises in the product chain collaborate to each other and when designing a product leads to part and material reuse, recycle or recover. Life cycle thinking is based on the principles that pollution prevention is achieved at the source and reduces the consequent environmental impacts. The main intention behind life cycle thinking is to expand the traditional focus on manufacturing processes, towards an understanding of environmental problems and solutions related to the whole product life cycle. Furthermore, the aim is to underline the positive linkages between the economic and environmental dimension of sustainability [Ashby 2009]. Life cycle management (LCM) is a business strategy to implement eco-efficiency in industry and to develop eco-efficiency in a proactive and strategic direction in order to achieve competitive advantages. In order to achieve this, management systems like ISO 14001 have to be product-oriented, including activities like product chain management, engaging all departments in a firm in the environmental activities etc.

3. Environmental friendly design

Traditionally enterprises and designers face competition with a number of design methodologies and tools based on environmental friendly concepts.

3.1 Design for Sustainability

For companies that are involved in product manufacture, their designers should better understand the negative environmental and social impacts of the products they produce and understand how to make the required changes, in order to develop products with more sustainable values. The main target for businesses is to design and develop profitable products, which are both environmentally friendly and socially acceptable. Over the years, environmental philosophies have evolved from green design to eco-design through the design for sustainability. Good design practices can ensure a product that contains a rationalized number of materials and components.

Design for sustainability goes further still to include the consideration of social issues such as usability, socially responsible use, sourcing and designing for addressing human needs. However many of these issues are openly considered under a range of other banners, such as ergonomics, inclusive design, design for the aged and design against crime rather than under the overall remit of design for sustainability. Furthermore, some social issues such as sustainable procurement, ethical finance and ethical labor sourcing fall outside the remit of the designer, as they need dealing with at a strategic level.

3.2 Design for environment (Eco-design)

Eco-design goes further by aiming to reduce the environmental impact of each stage of the product life cycle. In product development terms, the product life cycle covers the whole life of the product from 'cradle to grave', including: the extraction of the raw materials to make the product, the manufacturing

process, its distribution, product usage and what happens to it at the end of its life. Eco-design is dealing with improving the environmental impact at each of these stages. Eco-design is also known as Design for Environment (DfE). It recognizes that environmental impacts that must be considered during the new product design process, along with all of the usual design criteria. DfE can be generally described as a systemic consideration of design performance with respect to environmental, health, and safety objectives over the full product life cycle [Schneider and Salhofer 2008].

3.3 Life Cycle Assessment (LCA)

ISO 14040 defines the term LCA as the "compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle". Thus, LCA is a tool for the analysis of the environmental burden of products at all stages in their life cycle – from the extraction of resources, through the production of materials, product parts and the product itself, and the use of the product to the management after it is discarded, either by reuse, recycling or final disposal. The environmental burden covers all types of impacts upon the environment, including extraction of different types of resources, emission of hazardous substances and different types of land use LCA is, as far as possible, quantitative in character. Where this is not possible, qualitative aspects can – and should – be taken into account, so that a complete picture is given of the environmental impacts involved. The main applications of LCA are in analysing the origins of the problems related to a particular product, comparing improvement variants of a given product, designing new products and choosing between a number of comparable products. LCA can play a useful role in public and private environmental management in relation to products. This may involve both an environmental comparison between existing products and the development of new products, which also includes comparisons with prototypes [Park and Seo 2006].

4. Proposed Framework

The present paper mainly deals within the limits of Design for Sustainability. The aim is to development a new eco tool with an ephasis on 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 for ecological consciousness to the majority of people and the spreading of recycle importance [Efkolidis et al. 2009]. According to this concept, a push strategy in marketing can be used, when a new environmental friendly product has been developed or when re-designing an existing one being a “greener” product. Ecology-push can become a new trend for product design. The outcome can be products which can denote the meaning of sustainable development to consumers and at the same time encourage recycling.

Between the marketing models of technology push and market pull the newly proposed ecology-push model can change the way products are developed. The technology-push model implies that a new invention is pushed through research and development, production and sales functions onto the market, without a proper consideration of whether or not it satisfies the customer’s needs. The market-pull model implies that a product innovation has been developed in response to the market needs. The newly proposed ecology-push model combines both strategies and in addition supports the idea of sustainability and thus customer needs are satisfied through eco-design principles.

In general, these concepts and strategies 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. These concepts and ideas can become an important part of creating a fruitful interaction between technical and social innovation, and place an even greater focus on social innovations on the journey towards sustainable development.

Based on the need for a new approach in the product design cycle, the proposed ecology-push framework incorporates a new role for the designer and the customer as well (Fig. 1). The designer should design or redesign the products under consideration, keeping in mind their impact on 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 acquire a more environmental 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 their designs. The assessment is based on a questionnaire which has two aims (Stage A). First, the customers express their idea about the product functionality, worthiness, aesthetics, ergonomics etc. At that level, the feedback is concentrated on traditional issues. Second, the designers are trying to examine if the ecology matters have been identified. The main goal, except from the traditionally examined issues, 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 offers. At that stage it is crucial to adjust the product design and achieve a message transfer through the product's appearance. 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 further activities such as detail design, testing and prototype building. It is then that a new customer assessment (B) is executed, in order to provide evidence that the expected product is according to 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.

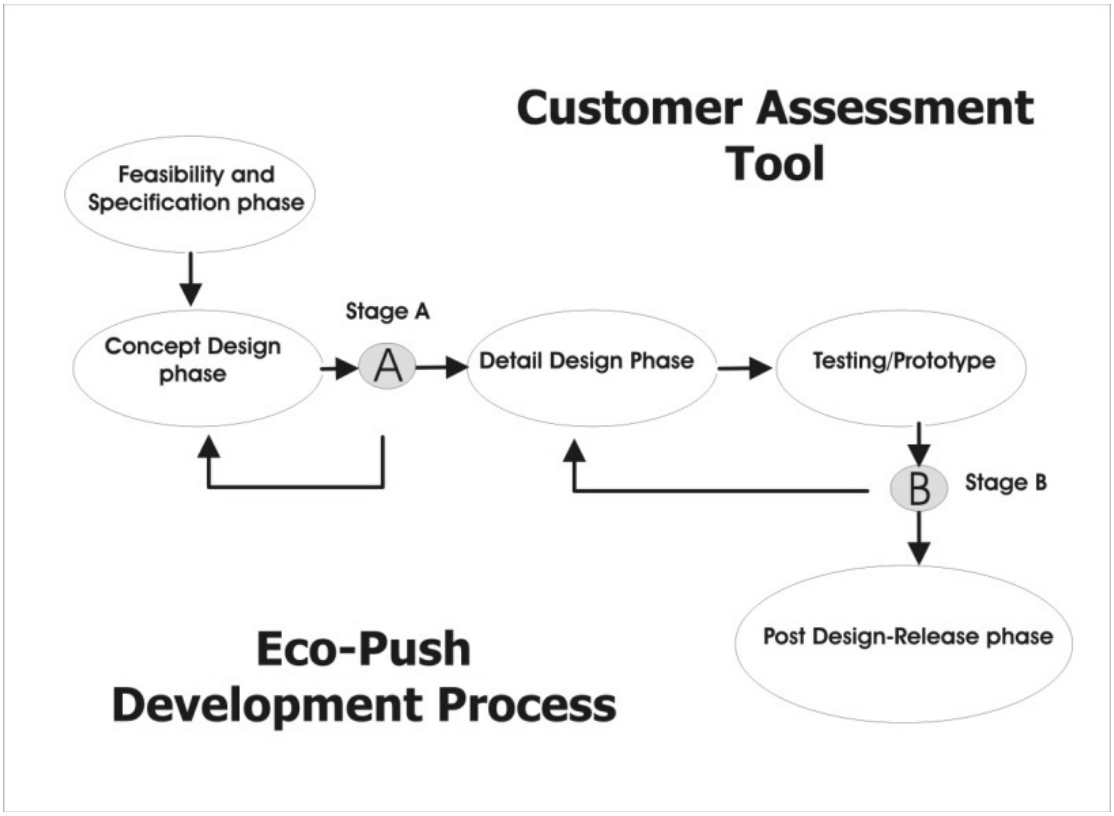

Figure 1. The Eco push framework based on customer assesment

The Customer-Assessment tool targets the customer satisfaction through innovation and cultural transformation in order to promote the sustainability principles as a way of life. The key issue is the change on customer perception about the product, with an emphasis on ecodesign and sustainability principles. The new designs have to motivate the end-users change their lifestyle towards a more environmental friendly attitude. The Customer-Assessment tool is developed to support the model of Ecology-Push. The development of the product could be done in accordance to green design tools (i.e. Life Cycle Assessment), identify the environmental hotspots from cradle to grave etc., but this is not absolutely necessary, since the empasis, according to the newly designed eco tool, is given on the customer perceptions. The main idea is to teach the future customers to be educated towards sustainability and not actually traditionally design eco products.

5. Case Study

A number of different products can be developed as examples of the proposed ecology push framework. In the present paper an eco-toy is developed. The product under study is called 'Eco-Maniac Bin' (Fig. 2). It consists of the basic bin together with a number of additional parts such as bottles, cans, books and tetrapack-like packaging (Fig. 3). All these parts can be made of moulded pulp recycled paper. The moulded paper pulp can be moulded to the desired shape. This is true mainly because the fiber is relatively soft and absorbs impacts. It is only recently, that moulded pulp has emerged as the interior packaging of choice for many electronic and consumer products. Molded pulp paper 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 of the Eco-Maniac bin, compare to the traditional toys is the substitution of all plastic components with recycled moulded pulp paper ones. Molded pulp paper is a sustainable product which compliant with ISO 14000 and European Green Dot standards. The change of the material has as target the reduction of the environmental impact of each stage of the product life cycle

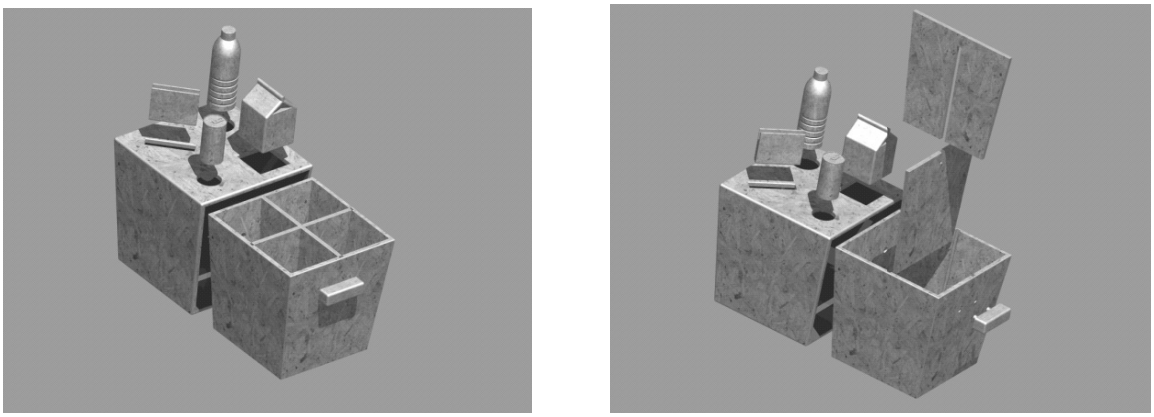

Figure 2. The Eco-Maniac Bin principle

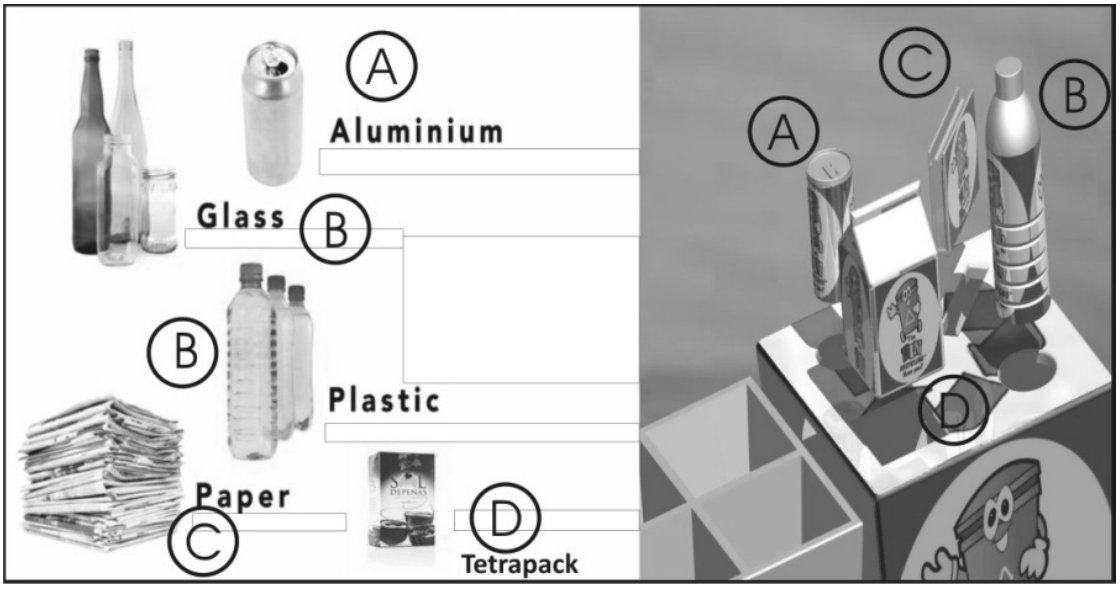

Figure 3. The Eco-Maniac Bin

The development of the product was completed in accordance to design for sustainability within the proposed framework. Life cycle thinking expands pollution prevention, in order to include the whole product life cycle and promotes source reduction. This method can be based on the '6 Re-' philosophy. There was an effort to Re-think the product and its functions. The similar existing toys are targeting the development of children wit spark. All toy-pieces should be entered successfully based on their

shape through the correct holes. Traditionally, the shape of the pieces 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. Moreover the use of recycled moulded pulp paper instead of plastic aims to Re-duce energy and material consumption throughout a product's life cycle and Re-place 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). In addition, the product presents no need for packaging. The main material which is used is from recycled paper and can be Re-cycled again. 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 Re-used after its main use, as an office bin or as a flower pot. Finally, the toy was designed in based on the principle of Re-pairing 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. The Eco-Maniac bin development has passed the conceptual design phase and as a result the customer involvement was necessary according to the proposed framework. An appropriate questionnaire was given to 47 families in order to receive their feedback. The key idea was for the families participated to understand the messages dealing with the social issues of sustainable development. That means that except from the traditionally perceived issues (recycled material, pulp paper etc.) the children should discover the importance of separating materials. In such a way, they learn from a very young age the recycle activity and a cultural transformation is achieved very early in their life.

The results from the questionnaire 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 where 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 executed 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-toy 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.

6. Summary and future work

The proposed ecology push strategy via the design of environmental friendly products aims to an ecological consciousness to consumers in all over the world. The conceptual design of the Eco-toy is an example towards a cultural transformation that promotes a sustainable lifestyle. The role of the designer becomes more important because together with designing according to the green principles a variety of products, he is forming the required attitude of the customers. The customers from their point of view understand and lever the environmental message and learn how to recycle from a very young age.

The customer assessment proposed proved to be extremely helpful and the customers felt that the social issues were well understood. The development of the eco-toy is further continuing and it is expected to be released after the second customer assessment.

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