INTERNATIONAL DESIGN CONFERENCE - DESIGN 2002
Dubrovnik, May 14 - 17, 2002.

ENVIRONMENTALLY SOUND PRODUCT IMPROVEMENTS OF CONSUMER PRODUCTS

V. Lo and W.Wimmer

Keywords: Design for environment, ECODESIGN, design tool, product improvement, sustainable product development, PILOT

1. Motivation

In the fast moving and quick changing Digital Economy (DE), all businesses or manufacturing modes have evolved into a very competitive business, "Products are comoditized in the Real Markets", particularly in the Small Electrical Appliances (SEA´s) Business, every enterprise faces the same problems of globalization and de-regulation. To survive the poor business environment and sustain the corporate image it is important to accomplish business competitive power. The question is what kind of product design tool to use for knowledge sharing in SEA´s industries between engineers during product design and development?

2. Objectives

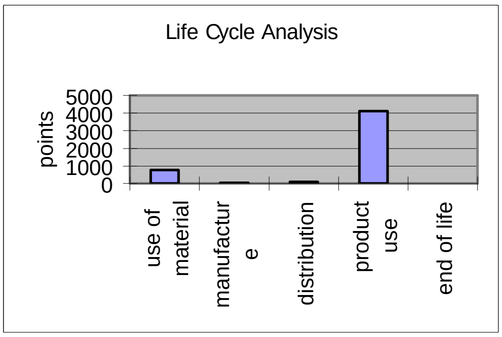
For the project described in this study the ECODESIGN PILOT [1], [2], [3] as a product improvement tool to evaluate SEA´s for continuous improvement was used. The whole decision-making process starting from product marketing, design, development, manufacturing, product use and it's recycling, reuse or disposal after the end of product-life was taken into account. To make sure the product designed is optimized to, and complied with innovation, competitive cost, corporate image, and the knowledge based environmental criteria throughout the product life cycle designers can choose different Eco-design strategies. The aim of this paper is to find out which strategies are appropriate to SEA´s.

3. The Applications of ECODESIGN PILOT for SEA Products

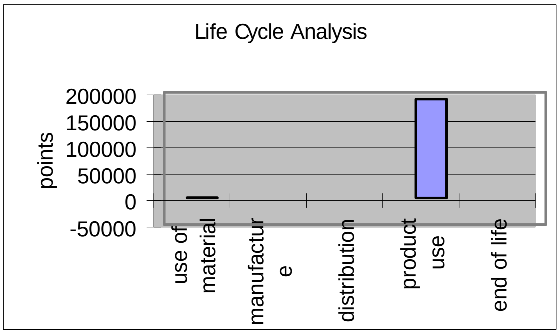
3.1 Life Cycle Thinking and Analysis (LCT&A)

Four categories of SEA´s were used for LCT&A this are electric fan, electric fan heater, electric humidifier and electric air cleaner. From the LCT&A results, all product categories under the normal use conditions show that the "Product Use Phase" has the highest relative environmental impact. From which the "electric fan heaters" amount of the four product groups have highest power consumption. As the result from an Eco-design perspective engineers should first consider the priority on how to lower the consumption during use of these SEA products. In addition, the "Use of Raw Material Phase" will be the second area of environmental impact, the trend to build product on miniaturization in size for lower the material used and distribution cost is another challenge. Figure 1 shows the LCA results of the different product categories:

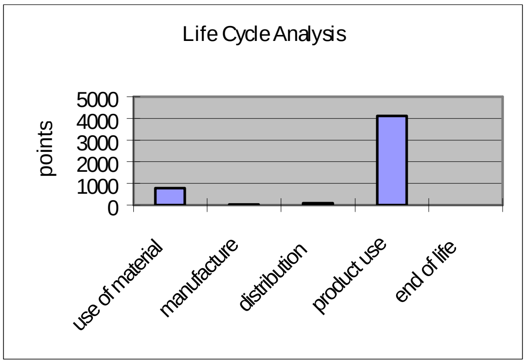
Electric Fan:



Electric Fan Heater:



Electric Humidifier (Warm-Mist):



Electric Air Cleaner:

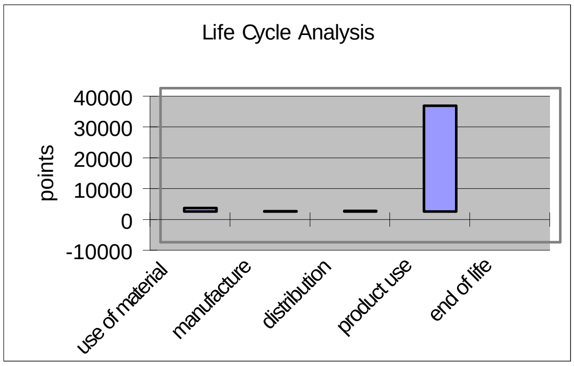


Figure 1. LCT&A results of SEA´s

3.2 Selecting Improvement Objectives and Strategies

The discussion about possible improvement objectives and strategies showed the following results in Table 1. The idea of this study was to give advise for new product designs and developments to meet environmental requirements – see Table 2.

Table 1. ECODESIGN PILOT improvement objectives and strategies

Product Example	**Improvement Objectives**	**Improvement Strategies**
Electric Fan	• Optimize the product life-span. • Design fussy logic to provide adequate wind delivery between day and nighttime. • Low noise emission during use. • …	• Improve the components' reliability and quality to minimize the frequent need of new product replacement. • Add digital control for various functions • Optimization of fan blade design for low noise emission
Electric Heater	• Energy saving in use. • …	• Add inter-reactive temperature controls when temperature reaches the preset temperature and auto-power off or "sleep mode", to reduce power consumption. • Select energy-efficient devices or accessories for the product.
Electric Humidifier	• Use low voltage logic. • Product upgrade in terms of humidification capacity.	• Promote to use low energy ultrasonic vaporizing design instead of heating mode for energy saving.

	• …	• Design in modularization
Electric Air Cleaner	• Minimize filter replacement. • Extend product life cycle. • …	• Design for easier maintenance and repair by building in sensor or intelligent circuitry for the indication on the need of cleaning or component (filter) replacement and Minimize the periodic consumables such as filter or cartridges by using electro-static dust collector as substitution. • Provide clear instruction to users to avoid miss-use, which would shorten the product life span.

Table 2. ECODESIGN PILOT improvement measures including priority

Product Example	**Improvement Measures from Checklist**	**Priority (high or low)**
Electric Fan	• Improve component quality to extend it life-span. • Redesign fan blade for high volume air delivery and noise emission free. • …	- High -High
Electric Heater	• Build in thermo-control for energy saving in use, and • Add digital control for on/off inter-reactive behavioral. • …	-High -Medium
Electric Humidifier	• Priority to adopt ultrasonic vapor generation instead of heat • Modular design for various models of product • …	-High -Low
Electric Air Cleaner	• Build in circuitry for filter replacement indication. • Need new way of air quality improvement process, i.e. Nan-material • …	-High -Medium

3.3 Identifying of ECODESIGN guidelines for Small Electrical Appliances in general

Components, materials used and its manufacturing processes to construct these products are quite similar or basically the same except the size and its specification. The following guidelines based on the material selected, production, distribution, use and the end of life are recommended to the SEA´s industry:

3.3.1 Plastic Materials Selection & Processing

In order to minimize the material inventory and reduce the wastage of virgin material during its processing, when selecting materials and components for the product, it is important to take into the considering of impact on producing and disposing of the plastic parts, the following criteria should be followed:

Avoiding use so many different kind of materials on one product that can minimize inventory control. Choose the materials that are environmentally responsible processed. Minimizing the possibility of material contamination during processing. Restrict to use toxic or hazardous substances, which could have an impact to environment during the product life cycle. Maximizing the content of recycled materials per the part drawing specification and safety requirements. The priority of material selection given to the easier re-use or recycling materials. Reduce the use of non-renewable material resources. Any material chosen for the application, that should not affect or given impact to the open environment during its processing, particularly to restrict the use of ozone depleting substances (ODS). The priority should be given to the one that needs less energy consumption during the

processing of material. Internal plastic parts should minimize the use of color pigment or flame retardant plastic, in which the design should take care and eliminate the need of them.
Build insert on mold that produces the part with information on it for identification of the part material and recycling methodology. Design for assembly and easily dismantle for separation after the end of product life cycle. Try to use the same material or at least the compatibility of polymers for parts in the same product. Strongly consider the product design in modularization or family for mass customization. Maximize the heat exchange to save energy during injection or other processing.

3.3.2 Metal Parts and Fabrication

Trying to use pre-coating steel sheet for metal parts, like the electrolytic cold roll steel instead of electroplating, powder or paint coatings. Consider the die layout for the optimization of material utilization during part design. Use more metal tabs protruding from its surface for clip-fit and self-fixing that can minimize the use of screw fixing. Design metal part with appropriate enhancement ribs or folding edges for strengths and rigidity to minimize the use of thicker cold roll steel sheet, use less material. Part standardization and modularization is recommended to reduce inventory. Identify and use less of the heaviest energy-consumption part during the production process.
Switch off idle machine tools for energy saving in plant. Avoid or minimize the use of hazardous, toxic materials in manufacturing. Use lead-free soldering technology. For any LCD which size is bigger than 100 square mm, have to follow Annex II of Proposal I [HKPC Fan Report], to disassemble and separate prior it to be disposed. Design Electrolyte Capacity on PCB should be ease for separation and treatment.

3.3.3 Electrical Components & Motor

Use standard on/off switch for all products. Design and use proper lengths of lead-wires/copper wires and control-not to be over length. Review and eliminate the number and types of components in the material inventory. Try to use standardized lamination with various stack-high on motor. Motor performance must be optimized and use the right motor capacity for the right job.

3.3.4 Packaging, Inner Cushion & Instruction Manual

Minimize the amount of packaging material and the number of virgin materials in the packaging, use as much as possible on recycle packaging material. Consider using recyclable pulp molding for the inner cushion instead of Ploy- foam. Avoid the use of PVC & Aluminum for any packaging, Packaging materials shall not contain chlorine-based plastics. Use mold insert or stamp marking for product information, rating and approval code monogram etc.
The instruction manual should show the information about the return and collecting systems available to users in the end of product life-instruction for disassembly. The role of consumers on re-use, recycling and other form of recovery of the product should clearly spell-out.

3.3.5 Disposal

In order to achieve a high rate of collection, a marking log that shows the disposal of product is required after the end of product lifecycle. Try not to use riveting, instead of by a snap-fit or tab-fit for the ease of disassembly. Try not to use hot stamping/silk screen/printing on plastic part or housing to minimize the contamination of plastics. Polybrominated Biphenyl’s (PBB) & Polybrominated Disphenyl Ethers (PBDE) must not be used in any product. Reducing the use of fasteners for fixing and replace it with snap-fit or clips. Minimize long distance transport by maximizing work with local suppliers and markets.

3.4 Evaluating and carrying out design changes - do the simple and ease ones first

Traditional thinking talking about “Quality & Price Differentiation” is not enough, this study in the Digital Economy identified one of the competitive powers is the “Eco-Differentiations on Product and Services”. Based on a clear mission and strategy it is an effective direction for all individual employees to commit and to achieve, focusing on current business in Eco-design activities. Based on this study, the following areas beside “Reducing the energy consumption during use” were identified as:

- Selecting the right material: Has the use of toxic material been avoided in the products? The products are made with toxic free materials, however the coating process will consider eliminating by using alternative replacement for the better use of recycle-material after the end of product-life.
- Reducing material input: Are the parts & components of the product made of one single material wherever are possible? Based on the current material input, the products have been used the best combination as some of the products need it specific function and safety requirements, especially for heaters, this is because of the requirements on the product structure & thermal property of resins. However, Eco-design Engineer shall standardize material type wherever possible is their goal, which will help to reduce material input & processing waste.
- Reducing material input: Has material input for the product been minimized (integrated design, integration of structural parts)? The product design had considered the miniaturization with powerful features for competition. However, a simpler and more united design can be further considered and use less separated parts.
- Optimizing product functionality: Is the product’s principal of functioning simple, does the product have simple design with minimum of structural parts? Few of the selected products still can have room for improvements. The table heaters designed with multiple functions such as LCD display & indicator, this is a kind of product feature for delighting customer. There will be a need to design the ease of separation of electrolytic capacitor out from the PVB in future design and functions.
- Improving maintenance: Is the product relatively insensitive to soling/ease to clean? There are much room when have chance to re-design the product that provides a highly and flexible cleaning features. However, the SEA is designed not for self-maintenance and cleaning the internal parts but under the safety conditions, there will be one of the challenge for the Eco-design Engineer, i.e. design a enclosed and well safety protected power-pack with detectable fan-blade and fan guards for the easy-clean feature.
- Reuse of product parts: Is assembly simple and does the products consist of only a minimum of components? Some of the product samples are hard to assembly & with complex structure, a chance for Eco-designer to work on for new project.
- Recycling of materials: Does the product provide for thorough information on material used and for labeling conforming to standards? This is one of the high priority improvements on the existing samples. Many parts are missing of labeling/marking on material used. This is a simple and easy job for any of manufacturer who commits on Eco-product recycling.

4. Conclusion

During product design and development, the Eco-design review playing the same importance as the other reviews like patent, legal, safety, quality and manufacturing. The well formulated guidelines of the Eco-design PILOT will help to promote the future product be more environmentally sound. When designing a consumer product, designing “green” products is not enough, it is important to design environmentally sound life cycles from material selection, manufacturing processes, distribution, product use and the end of its life in terms of materials, energy and toxicity. In order to reduce the consumption of material for complying the environmental requirements, for SEA´s, the product size should be in the trend of miniaturization as the product cost structure of consumer product usually material content is over 65% the product cost.

The energy consumption can be reduced by considering the effectiveness e.g. of heat conversion from electrical energy to heat energy, by far Infra-red heating element claims to save 25% of energy compared to traditional radiation heater. An more reliable and effective heating element is a critical consideration, but also sensitive sensor like thermostat and fussy logic control for heaters can help to improve the energy consumption and time of use to reduce the environmental impact.

For the best result in Eco-product design and development, collaboration between supplier and customer through global networking is the key of success. Alliance with eco-strategic countries for building up eco-digital data bank through knowledge capture, sharing, refined editing, implementation and control should be the next step for researchers. Eco-logo mark legislation on products, manufacturing and services (ISO14000) will be a source of energy in promotion on environmental control.

The advantage of the ECODESIGN PILOT is the provision of ideas and innovative momentums on product/process/services plus environmental and cost considerations. However, it is recommended to connect the tool with the current common used design software and build up an integrated knowledge based with the current CAD/CAM/CAE products like UG, ProE, Catia & iCAD etc. this can provide Eco-designers a free hand on eco-product design.

References

Wimmer W.: Ecodesign PILOT product, Investigation, Learning and Optimization Tool, 7th CIRP International Seminar on Life Cycle Engineering, November 27-29, Tokyo, 2000.

Wimmer W. et. Al.: Identification of environmental improvement options with the new ECODESIGN Product Investigation, Learning and Optimization Tool (PILOT), International Conference on Engineering Design ICED01, Glasgow, 2001.

Wimmer W. Zust R.: ECODESIGN PILOT ProduktInnovations-, Lern-und Optimierungs Tool fur umwiltgerechte Produktgestaltung mit deutsch/englischer CD-ROM, Verlag Industrielle Organization, Zurich, 2001. (ISBN 3-85743-707-3)

http://www.pre.nl/ecodesign/ecodesign.htm

Hong Kong Green Label Scheme, Hong Kong Productivity Council, Issue Date: 05 Feb. 2001.

http://www.cfsd.org.uk/cfsdpubs/med/med-training.html

http://www.ihrt.tuwien.ac.at/sat/base.edolife/main.shtml

http://www.cordis.lu/en/home.html

http://www.daedclus.edc.rmit.edu.au/

Victor Lo,
Honeywell Consumer Products (Hong Kong) Ltd.
Room 1705 Kodak House II, 39 Healthy Street East, North Point
Hong Kong SAR
Email: victor.lo@honeywell.com