

Ecodesign of a dispensing closure for plastic packaging

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ABSTRACT

Environmentally friendly product development is one of the main challenges for companies due to new consumer demands. Several methods for its practical implementation have been developed. Among them ecodesign is one of the most commonly used methods. This method includes the environmental aspect in the product design step. As well as environmental benefits, ecodesign usually means company image improvement and less associated costs. The cost reduction through the optimisation of energy and raw material consumption is one of the ecodesign benefits.

This paper shows a practical approach about how the ecodesign methodology could be applied in companies and to packaging products, particularly to a dispensing closure. The use of IHOBE's ecodesign method allowed TUBOPLAST HISPANIA S.A. to identify in a first step the main environmental aspects to consider in the design and manufacturing processes of the dispensing closure. In a second step, process-engineering improvements (less electric consumption, industrial oil use, waste generation, etc.), cost minimization, and company image improvement were identified and quantified.

The "2004-2006 Ecodesign Promoting Programme" promoted by Basque Country Regional Government and coordinated by the IHOBE S.A supported this project.

Introduction

Ecodesign is an innovative product design methodology that includes the environmental component as well as traditional design criteria (costs, safety, utility, processing) without affect other properties of the product [1]. Several definitions about ecodesign concept can be found in the literature. Rieradevall [2] defines ecodesign as «actions aimed to product environmental improvement in the first design stage by means of functionality improvement, more environmentally friendly material selection, use of alternative processes, improvements on transport and use, and environmental impact minimization at end-of-life stage».

At present, lot of companies are aware that environmentally friendly products from their conception imply environmental benefits and better products. Furthermore this kind of products implies a better company image as well as costs minimization as a result of the optimisation of energy consumption, raw materials and ancillary materials.

Nevertheless, real application of ecodesign methodology in companies is not easy. This fact is due to the difficulties that companies show when starting an ecodesign project. Some of these difficulties are absence of specialized staff, initial investments, management department reticence's and the effort that an ecodesign project implies.

Because of the environmental improvement opportunity that ecodesign offers to companies and the society, some public initiatives have emerged. One of these initiatives is the "2004-2006 Ecodesign Promoting Programme" supported by the Basque Country Government and coordinated by the Basque Country Public Society for Environmental Management IHOBE, S.A. The aim of such programme is focused on new framework creation that encourages the ecodesign of products and services.

Additionally, the programme was carried out to apply ecodesign methodologies in 40 Basque companies at least in 2006. This fact is considered as a preliminary step since an objective of 200 companies working in ecodesign in 2012 is expected. Such programme was focused on creation of a supply of products and services which environmental criteria is considered in the ecodesign step. Furthermore, ecodesign methodology covered a wide range of industrial sectors i.e.: electronics, machinery, packaging, furniture, building materials, automotive, household goods and textile.

As a result of this programme, IHOBE, S.A. cooperated with the Packaging, Transport & Logistics Research Institute (ITENE) all together with TUBOPLAST HISPANIA, S.A. in the ecodesign of a dispensing closure for plastic packaging. TUBOPLAST HISPANIA, S.A. is a Spanish leading company that produces plastic tube packaging for cosmetics, pharmaceuticals and food products.

The ecodesign project began considering an existing plastic tube (tube and dispensing closure) which ecodesign was applied to redesign it. Conservation of resources ecodesign strategy [2] was selected, through minimization of plastic material used in manufacturing of the dispensing closure. Some other design aspects such as finish of the products (colour, stamping, use of plastic seal) were also considered.

Methodology

The ecodesign project was carried out following the methodology established by the IHOBE's Ecodesign Manual, which is based in seven stages:

- a) 1st stage: Project team selection and definition of motivating factors.
- b) 2nd stage: Environmental aspect determination for products.
- c) 3rd stage: Generation of ideas for improvement
- d) 4th stage: Development of different concepts for the product
- e) 5th stage: In depth development of the selected product
- f) 6th stage: Action plan set up
- g) 7th stage: Evaluation of the project and its results

All these stages are described in detail for the ecodesign of a plastic closure selected by TUBOPLAST HISPANIA S.A.

1st stage: Project team selection and definition of motivating factors

In this stage, an agreement between TUBOPLAST HISPANIA S.A. and IHOBE S.A. was signed in the framework of 2004-2006 Basque Country Ecodesign Promoting Programme. Such agreement arises from the interests on environmentally friendly products of TUBOPLAST HISPANIA S.A. Straight on, a project team for the ecodesign project was created. This team was composed by:

- TUBOPLAST HISPANIA S.A. that assigned a multidisciplinary team consists of departments involved in product design: Management, Sales, Engineering and Quality.
- Packaging, Transport and Logistics Research Institute – ITENE, which acted as technological partner, offering their know-how and experience on packaging ecodesign. The environmental evaluation of the product and proposals for improvement were lead by ITENE.
- The Public Society of Environmental Management IHOBE S.A., which coordinated the project, working together with TUBOPLAST HISPANIA S.A. and ITENE in the meetings.

Furthermore, selection of the product to be ecodesigned was developed by the project team. Such decision was based on several motivating factors both internal and external. These factors are described in Table 1.

Table 1: Motivating factors in the ecodesign project

EXTERNAL MOTIVATING FACTORS	INTERNAL MOTIVATING FACTORS
Legal requirements	Product and company image improvement
Market conditions	Cost minimization
Competency products	Company environmental responsibility

Corporate environmental responsibility	Motivation of employees
Supplier requirements	

Eventually, TUBOPLAST HISPANIA S.A. decided a dispensing closure for plastic packaging as goal for the ecodesign project. The ecodesign strategy was focused on minimization of the amount of plastic used in the manufacturing of the dispensing closure. Nevertheless, other aspects such as finish of the dispensing closure were considered (colour, stamping and use of plastic seal).

2nd stage: Environmental aspect determination for products.

Rieradevall [2] defined several actions on ecodesign: environmentally friendly materials, improvements on transport and use, and use on alternative processes. Following such objectives an environmental evaluation and generation of ideas for improvement of the plastic closure were carried out by ITENE under the supervision of TUBOPLAST HISPANIA S.A.

The environmental evaluation was developed not only over the plastic closure. The plastic tube was also considered since a tube and a plastic dispensing closure comprise the product.

Life Cycle Assessment (LCA) was chased as environmental evaluation technique among others (Environmental Assessment Strategy, Evaluation of Design Changes, Priorisation Matrix) [2] [3]. This fact was due to:

- i. LCA is a quantitative technique for prioritisation.
- ii. LCA allows comparing the environmental aspects of several alternatives of a product.
- iii. LCA allows analysing products with a huge manufacturing complexity.
- iv. LCA allows establishing a continuous monitoring of environmental improvements.

In accordance with the scope of the LCA a simplified LCA was carried out. The use and end-of-life stages were discarded since their heterogeneity. For instance, TUBOPLAST HISPANIA's plastic tubes can be sold both in Spain and France (largest markets for the company) and for different purposes (cosmetics, pharmaceuticals, etc.). Furthermore end-of-life of the plastic tube can be different depending on the geographic area considered. As result of that the LCA was focused on raw and ancillary materials stocks, manufacturing processes, finish of the products and distribution of the final product. Different combinations of plastic tube and dispensing closure were considered. Main conclusions from the environmental assessment were:

- I. With regard to dispensing closure:
 - a. If the amount of plastic used to manufacture it reduces at 30%, a 20% less environmental impact is observed (Figure 1).
 - b. Environmental impact minimization took place in every stage of the whole life cycle of the product.
 - c. Main environmental impacts arise from raw material production, power consumption at dispensing closure manufacture, transport of raw, ancillary and packaging materials, as well as final product distribution (Figure 2).
 - d. Differences on environmental impact have been observed accordingly to the finish of the product. A minimization from 2% to 7,52% has been detected. As much colour, decoration or seal higher impact has been noticed (Figure 3).
- II. With regard to plastic tube + dispensing closure, the best combination was the ecodesigned plastic closure without seal affixed to a single-extruded plastic tube finish with UV varnish (Figure 4).

Results on impact assessment allowed identifying which environmental aspects for the life cycle of the product were more relevant. These environmental aspects are summarized in Table 2:

Table 2: Environmental aspect identification

ENVIRONMENTAL ASPECT	LIFE CYCLE STAGE
Plastic pellet feedstock	Raw material extraction
Binder pellet feedstock	Raw material extraction
Power consumption	Manufacturing
Fuel consumption	Transport of raw, ancillary and packaging materials Final product distribution
SO _x generation	
Soot generation	
NO _x generation	

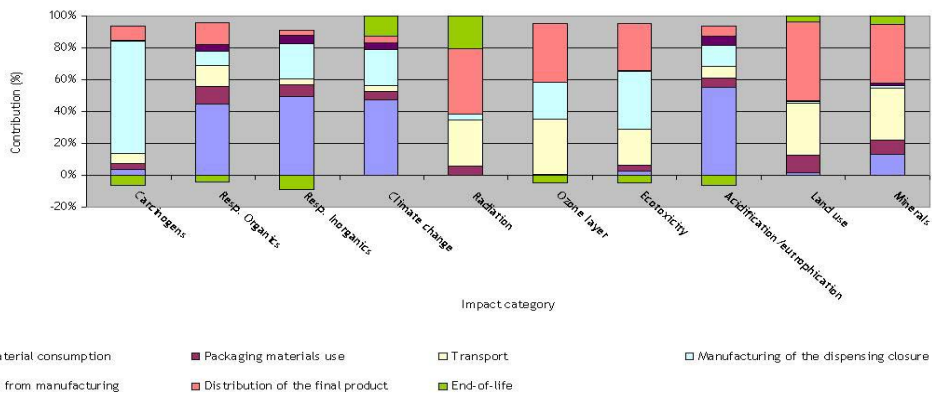
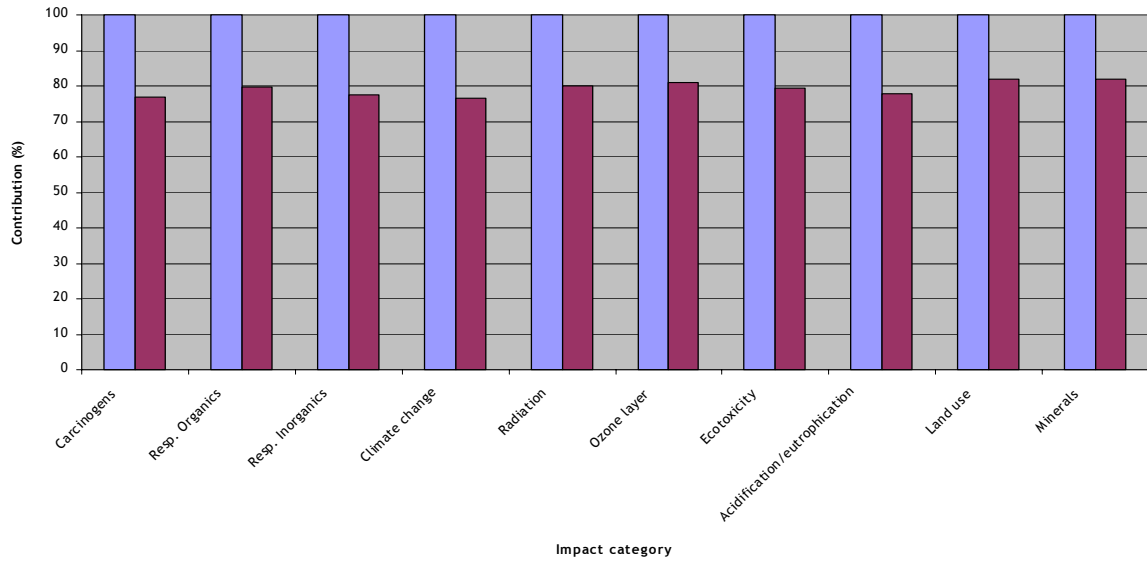


Figure 2: Relative contribution of each life cycle stage for the ecodesigned dispensing closure.

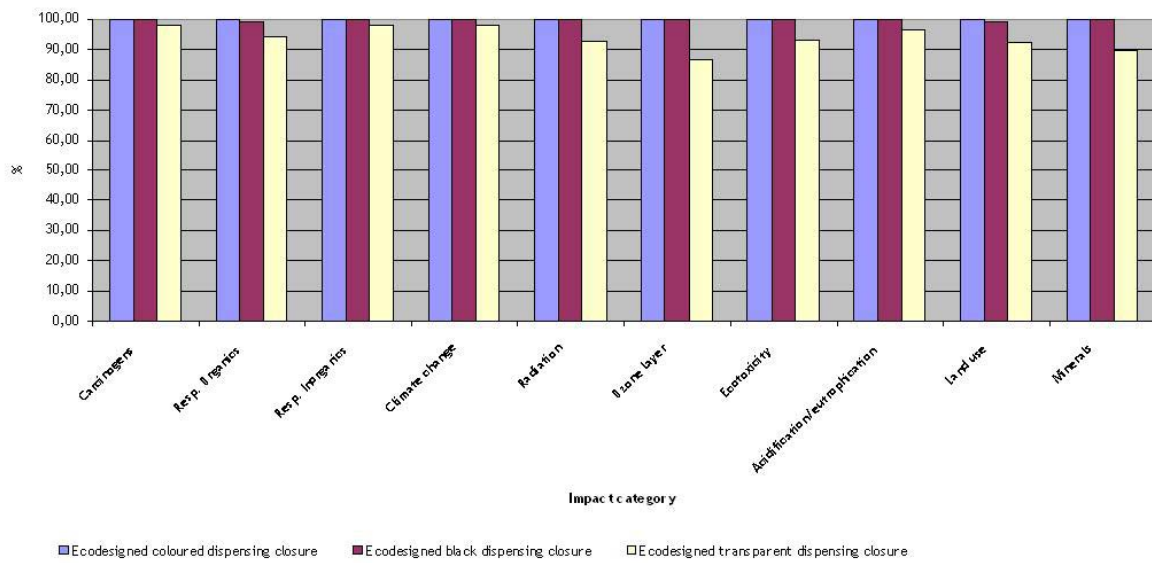


Figure 3: Comparison of the life cycle of the ecodesigned dispensing closure as function of their colour.

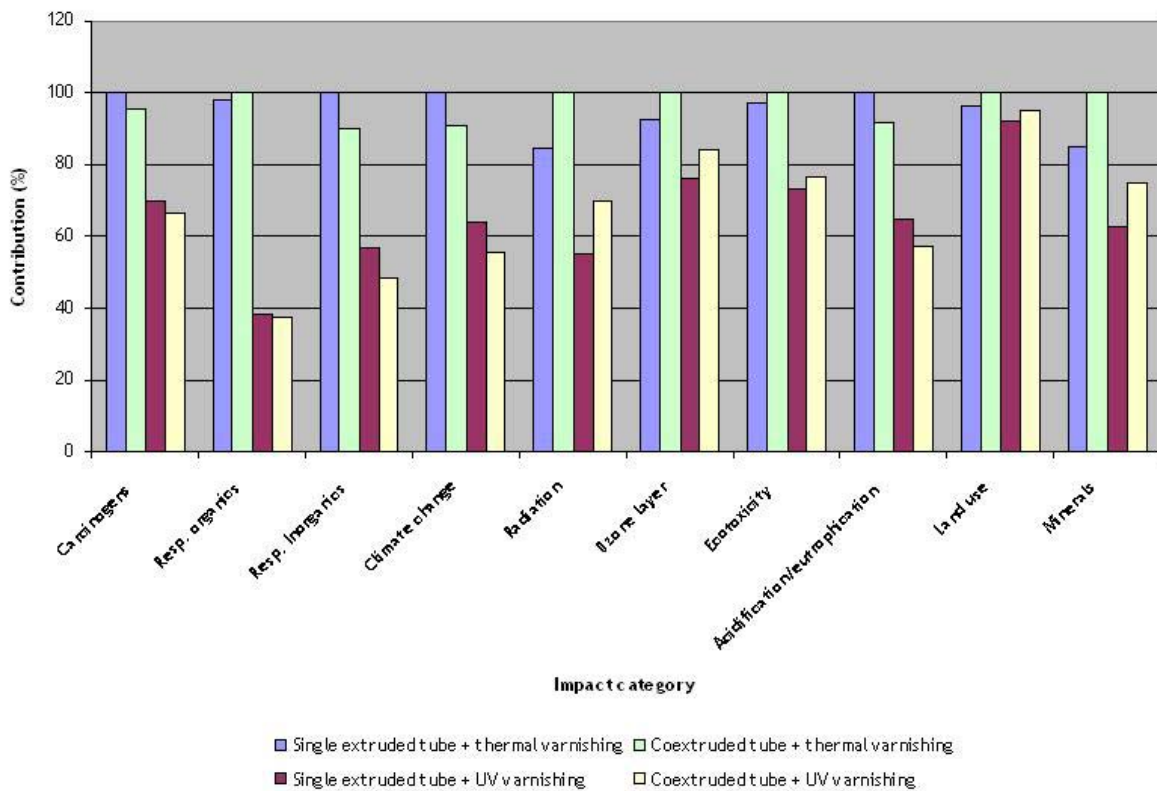


Figure 4: Comparison of the life cycle of the plastic tubes

3rd stage: Ideas for improvement.

As a result of the environmental impact determination some ideas for improvement have been defined:

- a) To minimize the thickness of the plastic closure.

- b) To do not use colours, decoration or seals.
- c) To increase the efficiency of manufacturing machines.
- d) To optimise distribution routes.

The next step was to establish an action plan aimed to both product and company. Three different types of actions were identified: short term implementation actions, half term implementation actions and long-term implementation actions. Subsequently these actions were assessed from environmental, technical and economic point of view. A quantitative assessment scale was established. Results of the assessment are show in Table 3

Table 3: Priorisation of ideas for improvement

Selected measure	Technical feasibility	Economic viability	Environmental benefits	Positive answer	Priorisation	Preselection
Minimizing plastic closure thickness	1	1	2	2	Short term	ACCEPTED
Do not use colours, decoration or seals	2	-1	1	2	Long term	REJECTED
Increasing manufacturing machinery efficiency	1	1	1	2	Half term Long term	ACCEPTED
Optimising transport routes	-1	0	1	0	Long term	REJECTED

2 = Totally feasible; 1 = Feasible; 0 = Neutral; -1 = Little feasibility; -2 = Unfeasible

4th stage: Developing of different concepts for the product.

In accordance with IHOBE's methodology [3] "the ideas for environmental improvement generated in the previous stage can define what are new design requirements". The new environmental requirements were included in a set of environmental and technical specifications.

5th stage: In depth development of the selected product

TUBOPLAST HISPANIA S.A developed general assembly plots and prototypes for the new dispensing closure in this stage. Such prototypes were subsequently tested.

6th stage: Action plan set up

An action plan was created in order to set up the ideas for improvement that were accepted. A period of two months was set for dispensing closure redesign and six months to increase machinery efficiency.

7th stage: Evaluation of the project and its results

A monitoring plan for the product was set. This monitoring plan allowed TUBOPLAST HISPANIA S.A. improves the efficiency for new and existing products. TUBOPLAST HISPANIA S.A. tracked raw material minimization and power consumption in order to follow up the environmental impact minimization for the product. Further improvements, which were considered in the monitoring of the ecodesign project, were: to adapt the new technologies in manufacturing, to reduce manufacturing time, to be on the side of current and future legislation, to optimise raw and ancillary material consumption, and to minimize wastes on manufacturing.

Conclusions

Following IHOBE's ecodesign method [3] TUBOPLAST HISPANIA S.A. -20% environmental impact was observed as well as -38% power consumption. Other important item is that TUBOPLAST HISPANIA adapted the ecodesign strategy inside their organisation, bringing also chances for new and existing products. Furthermore company image improvement was also observed.

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