USING THE ECO-DESIGN APPROACHING TO REALIZE THE FRIENDLY PRODUCTS FOR THE AUTOMOTIVE INDUSTRY

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ABSTRACT:
In this paper we present an Eco-Design study. In the design stage can be estimated until 80 % of the environment impact of the product. In order to realize the study, a number of design directives were considered, such as: minimizing the number of parts, optimizing the logistic chain, reconsidering the assembly methods whit the goal to reduce or eliminate the joint elements, use the new materials "friendly" whit the environment, reducing the energy spending, reduction the waste of water, reduction of the pollution during the whole life of the product, etc.
The experimental study was made at the CCIA Research Center and our goal was to establish the role of Eco-Design in the product process development and the impact to the environment. For this study was choosing a car vacuum cleaner.
The results of this study lead us to understand the contribution of each Eco-Design directive to realize an Eco-Product.

KEY WORDS:
Eco-Design, environment, design experiment

INTRODUCTION

Our work demonstrates the application of Eco-design techniques in redesign of a car vacuum cleaner. This assumes the diminution of components number, reducing consumption of raw materials, the optimization the manufacturing process and reducing the environmental impact. The Eco-Design approaches assume the inclusion of environment variables in its efforts to design and place at the same level of importance with those of efficiency, aesthetics, ergonomics, cost and functionality.
The Eco-Design study is not new on the market. The designers were always motivated to search new challenges. Since 1972 the designers shows the impact of design in the environmental in the book Design for the Real World (1). Different strategies were developed possible for the implementation of eco-design, depending on the intended goals and impact on environmental. An appropriate development of the product imposes a new attitude of the concept: is not sufficient a simple recognition of materials and manufacturing process. Is strongly necessary an approach witch consider environmental issues, as new directions to rethink, to find, to reduce or to recycle a product (2).
Since the mid-1980s these environmental considerations initiated primarily in the electronics sector and have been influencing the manufacturers of other types of products. Companies such as IBM, Phillips, Apple Computer, Sun Microsystems, and Sony began to design products with advanced technologies that eased disassembly and recycling of materials at the end of life. The use of alternative materials such as non-lead solder (materials selection), efficient use of energy and casings made from biodegradable polymers are included in design process. Volvo and Baxter, the manufacturers in the medical and automotive sectors, also began to use Eco-design principles (3), (4), (5).

Technical papers in annual conferences facilitate the exchange of information throughout these sectors.

ECO-DESING IN AUTOMOTIVE INDUSTRY

Eco-design or design "responsible" expresses the idea of designing products that comply with the principles of sustainable development, the products with low environmental impact, as rationally as using raw materials, making use of clean manufacturing processes. It is an innovative and promising approach that provides solutions for current and future generations.
To make a request in good conditions eco-design should consider the main aspects of all life stages of the product, from raw material extraction, production, distribution, consumption, elimination and recycling.
Several factors contribute to reduce environmental impact:

- Consumption of raw materials (eg recycled materials can be used instead of raw materials?);
- Consumption of water, solvents and other fluids or greenhouse effect on the ozone layer;
- Energy consumption;
- The quantity and type of waste;
- The volume of pollutants, etc..

Integrating environmental aspects into the design phase can be achieved in a progressive manner: continuous improvement of product and its manufacturing process, distribution, maintenance, recycling, etc.
Eco-design is normalized by the international standard ISO 14062. This standard is addressed to designers and product developers, proposes general principles for taking into account the environment in the steps taken by them in various stages of design and product development.
The Eco-design approach is realized within limits related to:

- Priorities: certain types of environmental impacts are difficult to measure or quantify the short term incorrectly (eg the impact that they have genetically modified organisms), and others not be subject to a consensus (eg, electromagnetic field);
- Credibility: checking claims requires a minimum of transparency, often not granted to those able, under the pretext of trade secrets;
- Culture: Enterprises need to "acquire" new skills or time to devote to training, staff motivation and mobilization. Teamwork is more profitable, especially when working with external experts, the risk of leaking some information to competitors;

For the actors involved in the life cycle of the product, eco-design is not just a different cultural approach, but also create new opportunities:

- For the manufacturer of the product:
  - Knowing and manage a raw material and energy flows;
  - Answering the new expectations of the market;
  - Increasing the consumer confidence.
- For consumer product:
  - To benefit from sustainable and tailor its products;
  - Improving the standard of living;
  - To realize economies of product.
- For the community:
  - Energy savings;
  - Reducing pollution and costs of various risks;
  - Effectively manage natural resources

In each stage of the product lifecycle, the designers look for the possibilities to reducing the impact of the product on the environment.

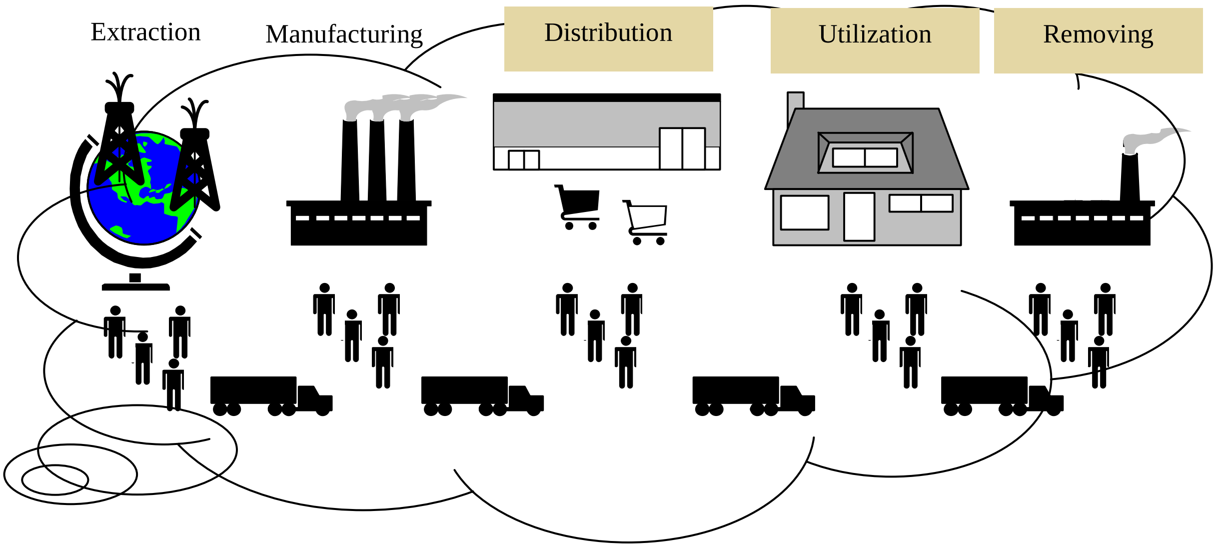

Figure 1. The lifecycle of a product

In the table 1., are presented, for each stage of the lifecycle, the actions proposed to reducing the environmental impact.

Stage of the lifecycle for the product	Improvement actions
Evaluation	▪ Identifying the types of impact assessment on the product may have on the environment; ▪ Identify the most influential stage in the product life cycle; ▪ Identify and evaluate improvement limits the advantages and disadvantages they present different ways to improve.
Manufacturing	▪ Using clean manufacturing technologies; ▪ Quality assurance and material requirements (selection with suppliers of materials with the lowest environmental impact); ▪ Optimize manufacturing technologies; ▪ Reduce energy consumption.
Distribution	▪ Reduce the volume and distribution of product weight; ▪ Use less polluting means of transport; ▪ Shape optimization of packaging and logistics; ▪ Replacing the hard material to manufacture bio-degradable packaging materials (eg petrochemical resins is recommended to be replaced if possible rosin resins from the manufacture of paper).
Utilization	▪ Increased use of the product life cycle; ▪ Reduce the impact on the environment.
Removing	▪ The product must be easy to disassembly ▪ A lot of parts or pieces, can be utilized for a new product, or in the maintenance process for a similar product ▪ The materials used for the parts of the product must be easy reused

THE ECODESIGN EXPERIMENT

The experiment analyzed in this paper was made at the University of Piteşti, in the “Automotive Engineering Research Center”, by a local team (the leader of the team, a designer, a materials specialist, a logistician). The goal of the design experiments was to analyze an existent car vacuum cleaner, in order to identify, for each stage of the lifecycle the possibility of reduction of the environmental impact. After this analyze, the team made the different propositions to redesign the product.

A virtual prototype was made in Catia V5. This prototype was used by the participants in the redesign process:

- to understand and to analyze the functionality of each part of the product;
- to verify some of concepts in trend;
- to propose the new solutions in order to solve the identified issues;
- to made: the geometrical tests, the finite elements analysis, dynamic tests.

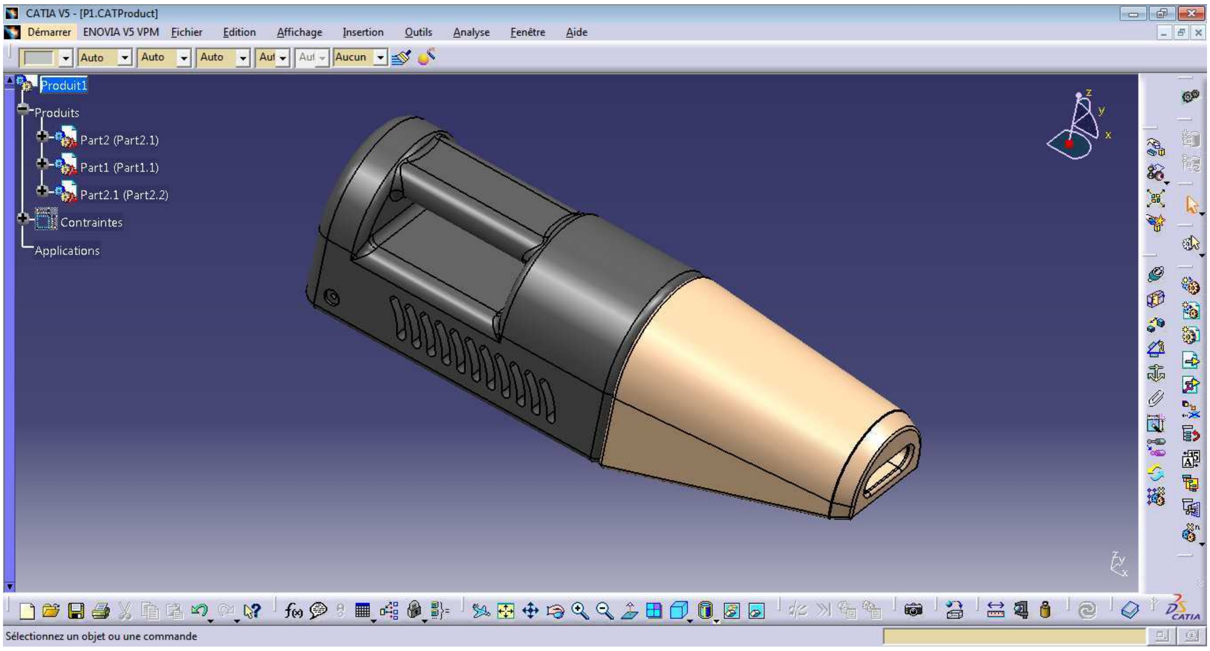

Figure 2. The virtual prototype

During the design process the designers cooperate in order to perform together the redesign of the product.

THE MODEL USED FOR STUDY

The model Function, Behavior, Structure (FBS) allows an explicit representation of:

- the functions of the product (the problem);
- the structure of the product (the solution);
- the internal behavior of the product (6).

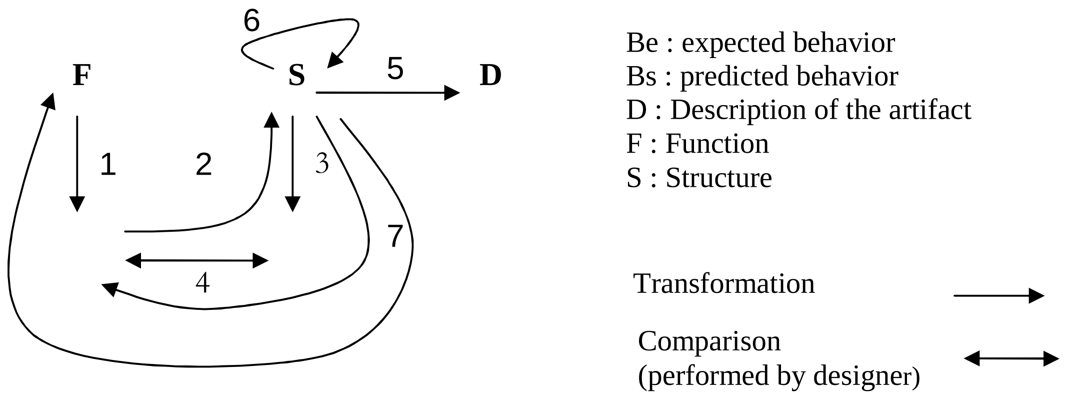

Figure 3. The FBS Model

Functions: they describe, in an abstracted way, the finalities of an object (process, product or resource). The functions of service are formulated independently of any particular solution (in particular of any choice of structure), whereas the technical functions are tributary of a choice of solution.
Behavior: it describes the dynamics of an object. It can include a whole of laws and rules (model continuous) as well as a sequential succession of states (model discrete) representing the evolution of a structure following an excitation (or stimulation) during a given process.
Structure: it makes it possible to specify the elements which make the artifact and the attributes of these elements. The behavioral fields **F** and **S** are distinct. The behavior **F** indicates what is waited from the structure and the behavior **S** what is noted by it. These fields are the variables and are connected by comparison or transformation (simple arrows) (arrow doubles).

FINDINGS

After analyze, the redesign team was identify the issues premature engine wear due to loss of tightness of the bag. For this reason, dust and fine particles penetrate the filter. Due to relatively low surface air filter, it is obscure prematurely, leading to lower levels of satisfaction function (dust removal), and electric motor to wear prematurely. To prevent this problem, we resorted to an innovative two solutions:
1. an increase in active surface air filter, through its adoption of a cave forms;
2. a special filter placed directly on the surface connecting the electric motor. Thus, another principle is used technically for seal that of self-sealing, air pressure due to the bearing surface of the filter press. This solution has several advantages: simple construction, less attention from the user to change the air filter, accessibility and removal of seals.

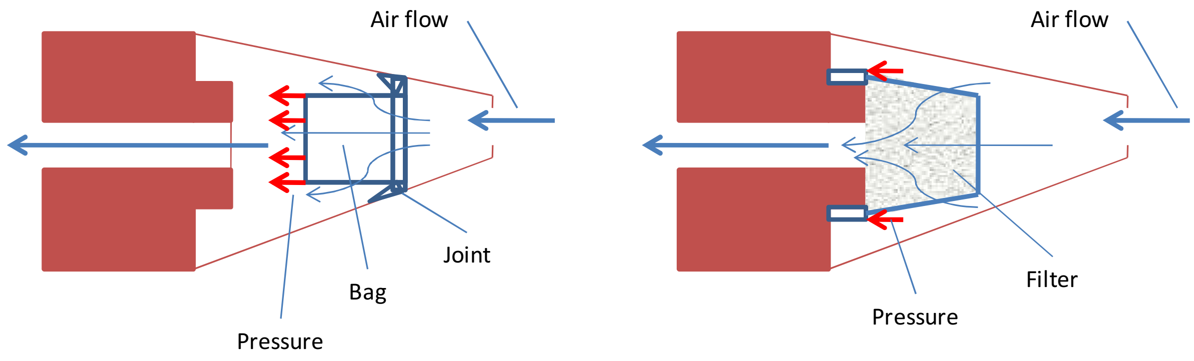

Figure 5. An innovative solution for the fonction F (storing the dust) and F1 (protection of the engine)

The function (F – storing the dust) claims a B_{eF} behavior (1). At its turn, this leads to the structure S (2). This structure has its own behavior, B_S (3). The designers proposed for S a bag. The structure's behavior is compared to the expected one (4). For this function, the structure not satisfies correctly the imposed requirements.
The designers proposed a new structure S_{new}, to satisfy the requirement Be_F.
Comparing B_{Snew} with Be_F (7), we can notice that, in this case, the structure satisfies the requirements imposed by the function F.

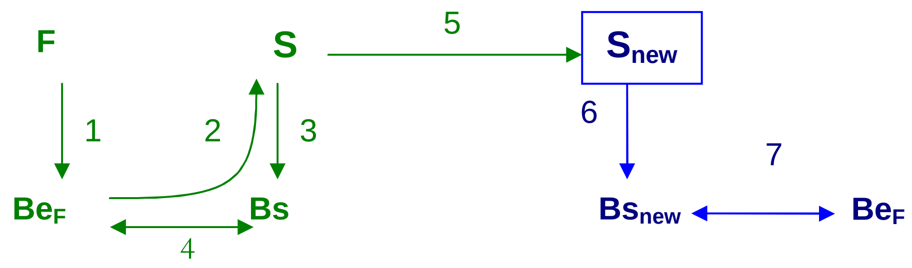

Figure 6. FBS representation of a "problem-solution" F (storing the dust)→S_{new}(special filter)

CONCLUSIONS

The design product is a dynamic and complex process. It is complex because it involves combining a large number of problems to be solved, for both product engineering and design activities and tasks management. Dynamic aspect is related to frequent disturbances affecting the achievement of its activities and to make a request in good conditions eco-design witch should consider the main aspects of all life stages of the product, from raw material extraction, production, distribution, consumption, elimination and recycling. The eco-design study involves some important aspects such as: context definition, objectives, team researchers, durations, planning, customer needs, recycling of raw materials, cost of materials and project.

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