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THE INTEGRATION OF CUSTOMER NEEDS AND STANDARD REQUIREMENTS IN THE DESIGN FOR ENVIRONMENT

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Introduction

Problems related to Environmental Impact of products and processes have become more and more relevant both for companies and researchers, because of the implementation of new specific laws and regulations aimed at reducing the environmental impacts, and also by the ever greater popularity of “environmentally friendly products” on the market.

In this context, the achievement of the optimum agreement between technical aspects and characteristics, and environmental aspects has become very hard. Moreover the need to be competitive has significantly reduced the products’ “time to market”, even though the necessity to offer a diversified production able to satisfy different customer needs, nowadays has become more and more fundamental.

It is deemed, then, that the “Design for Environment” (or “Ecodesign”), considered as a gradual and systematic way of proceeding, appears to be the most interesting and useful tool for Designers. In fact, it is well known that the main characteristics of a product are already set in early design stages, and any corrections or modifications become more difficult the more advanced the stage of its development.

1 Background and Motivations

At present the research work carried out at scientific institutes and companies has provided some rather influential results, because they demonstrate key design schemes, which can be followed for a wider action aimed at solving those problems related to the environmental impacts of industrial products, that are very numerous and often linked together with unclear modalities.

In most past situations, the effects of a lot of products and processes on the environment were neglected or significantly underestimated throughout the design phases: only recently, singling out such problems have brought to the use of technologies which are more oriented towards the environment, with the aims to make up for both the past, and the present effects, and mainly to take into account the future ones.

In this ambit, publication of the recent EU norms concerning recycling (first of all the RoHS Directive, i.e. “Directive on Restriction of the use of certain Hazardous Substances in electrical and electronic equipment”, and the WEEE Directive, i.e. “Directive on Waste Electrical and Electronic Equipment”) show indeed how significantly the problem is felt not only by the technicians, but also by the public opinion. The task of Design for Environment is to develop environmentally friendly products and processes in the most efficient way.

It is clear, then, that the valuation of the whole life cycle of the product is necessary, from raw material acquisition, through production, use and disposal, as each phase can have a greater or lesser influence on the products environmental sustainability: within this task, many authors in the field [Hesselbach et al.,2002; Gruner & Birkhofer, 1999, Kimura, 1999, Pighini et al. 2001] have shown that by operating from the first stages of the products’ design and development, it is possible to increase the environmental performances of machines and at the same time make their development economically feasible. ISO TR 14062:2002 ("Environmental management – Integrating environmental aspects into product design and development"), concerning the design and development of environmental compatible products, also underlines the importance of planning the entire life cycle of products (e.g. foreseeing their re-use, disassembly and recycling) as early as the initial stages of design activities, as well as the marketing and management aspects.

2 Method

On the basis of these considerations, the study was particularly focused on investigating the design methodologies aimed at evaluating and improving environmental impacts related to the entire product life cycle during the first design stages, in order to integrate the "Life Cycle Thinking" within the Methodical Design approach [Hubka, Eder, 1988; Pahl, Beitz, 1996; Pighini, Fargnoli, 2001].

The first step in this direction was to define a design process able to guarantee the compliance with recent ISO standards (ISO 14000 series): for this purpose the classical methodical design process was integrated with verification, review and validation stages.

Of course, it should be underlined that this strategy tool, as shown in Figure 1, is of a general nature: in fact, depending on the complexity of the product that is being designed, intermediate verifications and reviews can be introduced within sub-phases and even in the process steps.

Secondly, the use of Design Tactics within the design stages was analyzed. In fact, in order to make the use of traditional eco-tools more efficient we tried to introduce a life cycle analysis tool to be used in the early stages of the design process: such a tool can be considered as a support for the further application of design management and other Ecodesign methods, such as the Quality Function Deployment for the Environment (QFDE) [Masui et al. 2003]. With this aim in mind, an ease-to-use procedure for the evaluation of the life cycle of the products was developed, according with the standards ISO TR 14062:2002, which allows us to define the main environmental inputs and outputs of the system since the early stages of the design activity.

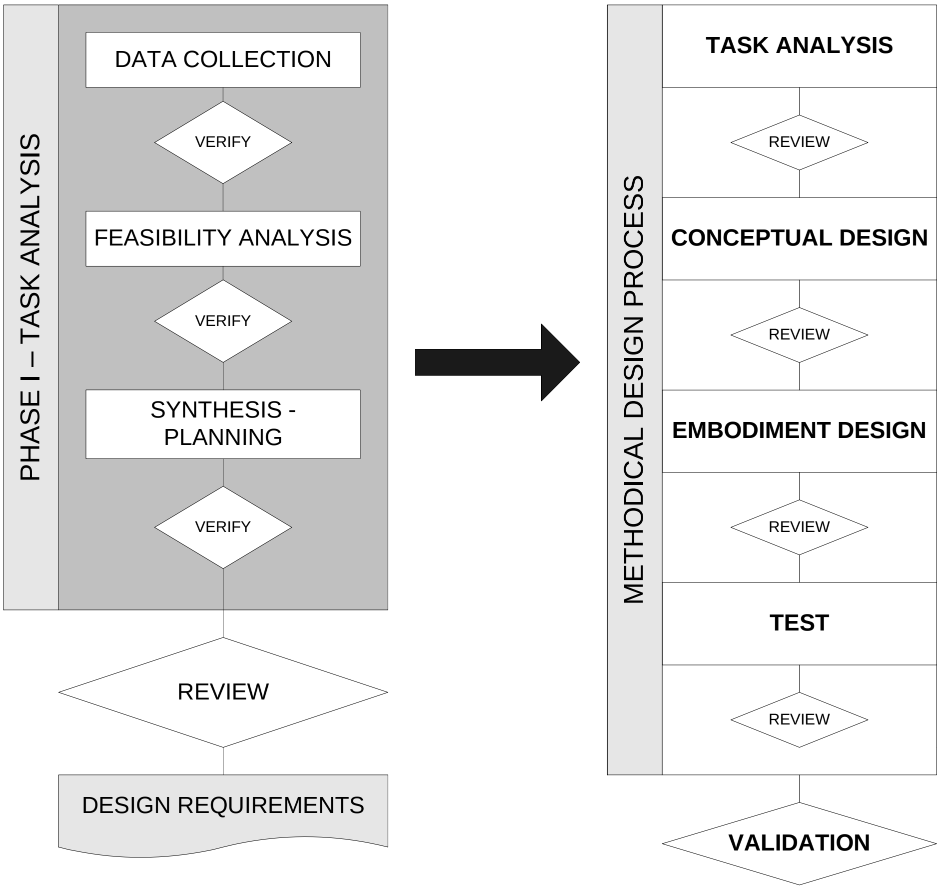

Figure 1: The modified Design Process

This analysis can be carried out using a checklist as shown in Figure 2, in which also specific information regarding particular needs (in particular law and standards limitations) can be added, as well as information concerning costs related to each phase.

Moreover, the introduction of life cycle aspects in the initial stages of the design process can help designers in achieving better design in a more effective and efficient way, defining a correct “environmental product profile”, identifying critical design options, optimizing at same time the marketing strategies and adapting the traditional design concepts to the producers bottom line. For instance, not always extending the product’s life time can be the optimal solution in order to reduce the environmental impact: in fact, the larger and larger use of electronic components in modern products makes them technologically out of date in a shorter time.

For this reason, even if increasing the durability and the life span of machines represents a “golden rule” for designers; on the other hand, reducing the use phase of the product can allow us to obtain the advantages, such as: more efficient reuse of parts and components, as well as recycling of materials; easier upgradeability. Such aspects lead to a higher customer satisfaction, since the user can always have the latest model, and also in compliance with the latest laws and regulations.

#	PHASE	INPUT	OUTPUT	NOTES	LAWS	COSTS
01	RAW MATERIAL/PARTS ACQUISITION					
02	MANUFACTURING/ASSEMBLING					
03	DISTRIBUTION (Trade and Delivery)					
04	USE					
05	MAINTENANCE					
06	COLLECTION/ SORTING					
07	REUSE/RECYCLING					
08	ENERGY RECOVER/DISPOSAL					

Figure 2: Preliminary Life Cycle Analysis checklist

The result of this second stage of the research work was a design module which is particularly suited for the completion of the first phase of the design process (Figure 3).

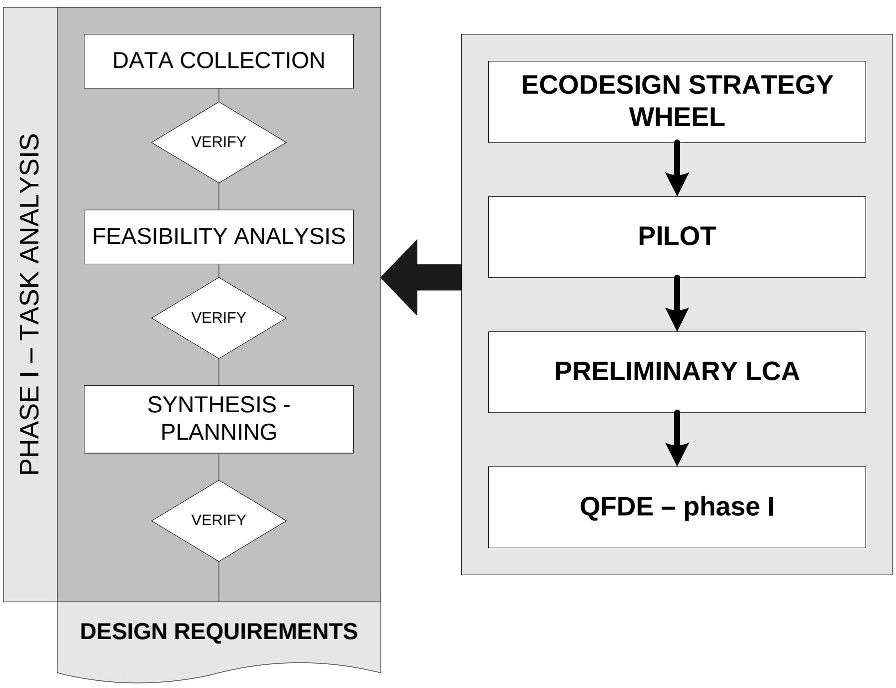

Figure 3: Design Module: Design Tactics integration

In Figure 4 a practical example of the QFDE method is shown: the “whats” column (“Customer Needs”) obtained by the above mentioned procedure.

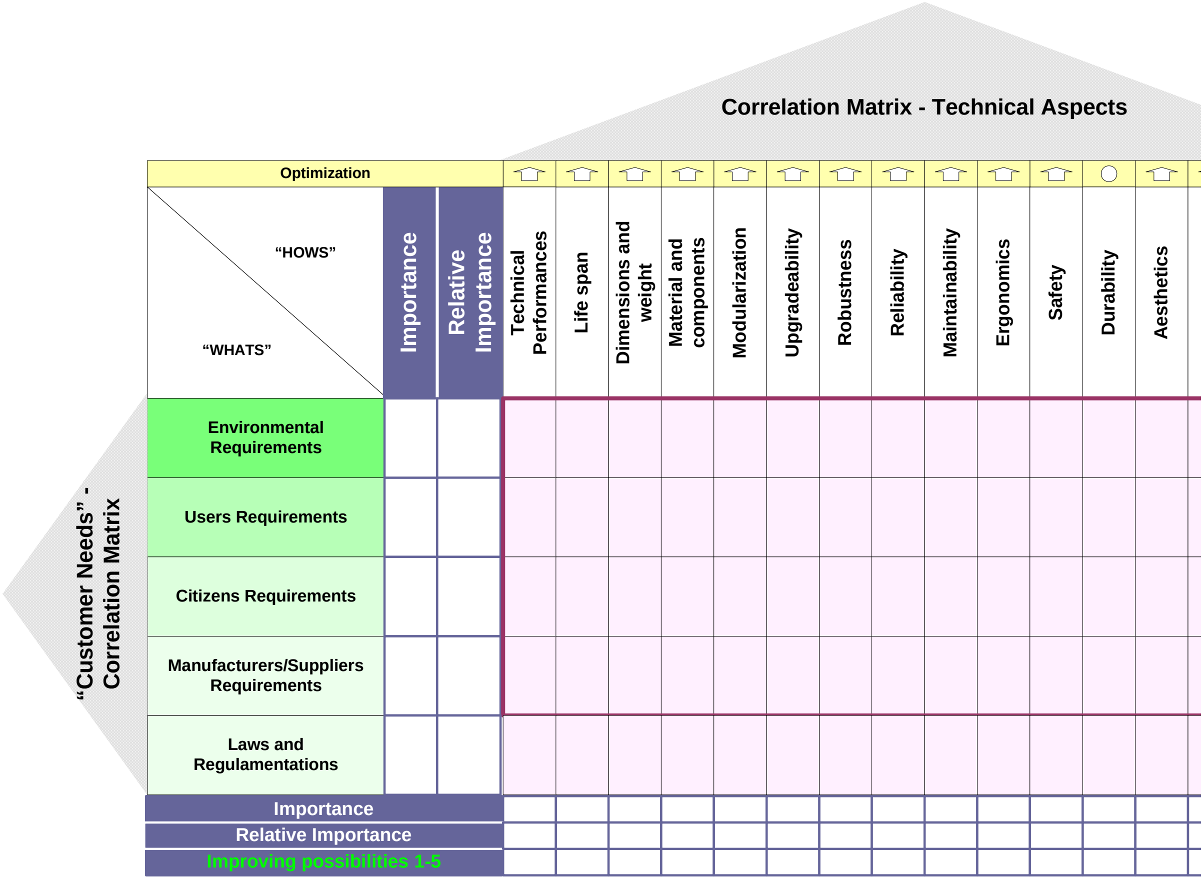

Figure 4: Example of QFDE matrix

3 Results and Conclusions

Even if the research is still in an initial development stage, the first results show that the design approach developed can certainly be applied to any type of product, increasing its environmental performances as well as improving its market competitiveness.

The study allowed us to define an effective design procedure able to lead designers to carry out a list of optimal design choices as solutions of design conflicts and constraints caused both by the plurality and diversity of technical and technological requisites, and by the necessity to be in compliance with environmental standards and regulations.

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