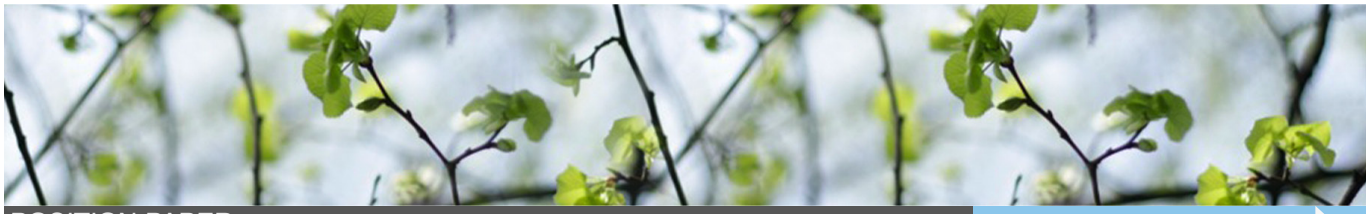
LC Engineering Studio Ingegneri Associati
Life Cycle Engineering



POSITION PAPER

Eco Design

FROM ECO-EFFICIENCY TO ECO-EFFECTIVENESS

The evolution of the worldwide scenario, the new challenges arising from globalisation, climate change, resources depletion and rapid technological and social development call for radical changes. Suitable action is necessary in order to adapt to new needs.

The 40th edition (2010) of the World Economic Forum in Davos [1], in Switzerland, was titled: "Improve the State of the World - Rethink, Redesign, Rebuild". The goal was to outline solutions that may improve the worldwide economic set-up, enhancing global cooperation and highlighting pressing challenges and oncoming risks. It is interesting to highlight that almost 40 years ago, at the 3rd edition of the Davos Forum (1973), Aurelio Peccei [2] explained the results of the first report titled "The Limits to Growth", published in 1972 by the Club of Rome [3].

There is the strong need to rethink the economic and social system, whose limitations are nowadays dramatically clear.

Wonders arise also from the design sector in terms of conceptual and operational tools able to meet the high degree of complexity of the emergencies related to environmental sustainability, also from a social and economic point of view.

Nowadays Ecodesign is used to emphasize the relevance of environmental issues within project planning. In this sense, Ecodesign goes beyond the mere aesthetic and functional dimensions of artefacts, structures, processes and services. It also considers the flow of energy and material resources needed in the development and use phase. Therefore, Ecodesign is not an "environmental specialisation" of traditional design, but it is its natural evolution. Ecodesign involves a mature methodology that already considers the impact of a product or a service will have on the external environment.

Nevertheless the term Ecodesign is still widely used in order to emphasize a reference to a design methodology that pays great attention to the environmental performance of products or services.

There are many approaches and different methodologies, which have been developed to improve the environmental "performance" of a product.

The most common approach provides a better eco-efficiency by adopting technical or technological measure in order to reduce the environmental burdens.

Over last 30 years, eco-efficiency has became the term to specify the link between a better use of resources and a lower environmental impact. This attitude has determined the fundamental guidelines for a reduction of the environmental impact of products. Eco-efficiency is now an increasingly common concept that encompasses a multitude of variations, aimed at improving and optimising the existing system. There is a need for sustainability from the environmental, economic and social points of view (design for disassembly, services design, dematerialization , Factor 10 [4], etc ...).

An eco-efficient use of resources is one of the main goals that politicians as well as technicians have to fulfil if they want to establish a sustainable development model. This model has to be capable of overcoming the problems linked to the current linear system. For example, as the Club Factor 10 studies showed, the present development model can potentially reach a 'factor of ten' reduction in input of raw materials and energy for the production of goods and services, ensuring the same level of welfare. Therefore the main criteria for the development of eco-efficient products deal with the reduction of inputs such as material consumption and energy, the reduction of toxic and/or harmful resources, the use of biocompatible and local renewable resources, the product life optimisation by means of easy updating and maintenance procedures, a reduced semantic and functional obsolescence, the life extension of materials and the strengthening of the use phase of products [5].

It is possible to summarize some generic criteria provided by a common efficient Eco-Design approach that consider

whole product life cycle [6,7]:

• Definition of the real human need.

• Consumption minimization of input resources, which can be obtained by avoiding scrap production (which is nowadays a well-established process) as well as by the precycle approach (which is the practice of reducing waste by attempting to avoid its 'actual' production): material and energy inputs should be renewable rather than depleted.

• Dematerialization of the product, which refers to the possibility to integrate and reduce the components number to create a flexible product-system in which some parts can be shared by different models in a modular way. It is better to prevent waste than to treat or clean up waste once it is formed. Design of products, processes and systems must include integration and interconnectivity with available energy and materials flows.

• Material Diversity Minimization in multi-component products in order to promote disassembly and value retention, ensuring that all materials and energy inputs and outputs are as inherently nonhazardous as possible.

• Choice of low environmental impact resource, by using of materials and energy.

• Product life optimization, making easier the upgradability and the maintenance of the components and promoting the reuse at end-of-life phase in order to extend and intensify the product useful phase. Targeted durability, which is not immortality, should be a design goal.

• Extension of material life span, using recyclable materials and encouraging their recovery at the end of life.

• Designing the service by offering the solution instead of the product: using robust and state-of-the-art machines at maximum capacity would create a whole new dimension to saving resources.

• Design for disassembly, planning the product disposal in order to promote the recovery or recycle of its components.

• Raise the environmental awareness of users through the correct use of the product.

• Design considering different users that will interface with the product during all his life cycle (skilled worker, end user, maintenance man, etc.).

During its short history, the Eco-design has gradually redefined its own theories and practices by learning from successes and failures, until the most recent recognition of the need to face the complex dimension of Society [8]. At the beginning, the environmental variable was essentially considered from a reductionist perspective, that is to say as just one project requirement linked to some life phase or specific components, materials or processes.

Step by step the design approach has acquainted a systemic perspective in which the environmental impact is evaluated in its complexity. The project activity is therefore characterised by an increasing complexity that determines a different approach to the project by the designers.

The interest moves from a product-oriented approach to an approach focussed on the social and environmental network in which the product is conceived.

This is then referred as Life Cycle Design, which is the process responsible for assessing and defining all stages of the life cycle of the product with a 'cradle to cradle' circular pathway.

In the current scenario the role of eco-designer is really complex because they must evaluate and manage the environmental, social and economical impacts that the product or service will have among the different steps of the whole life cycle.

Fortunately, there are some tools both quantitative and qualitative, that help the designer to manage this complexity and to support the choice of the project hypothesis. One of the most important tool that helps the designer in the decision making phase to reach the ecoefficiency is the Life Cycle Assessment (LCA)[9,10].

However there was a remarkable effort in terms of research and social commitment to attain eco-efficency, but the overall framework has to be improved. As a matter of fact current products and services, use far less energy and materials than those of some decades ago, but the overall consumption of environmental resources continues to increase [11].
This tell us clearly that even if the existent improvements are increasing, they are not enough: the translation towards sustainability requires a systemic change.

It is not a question of doing what we already do better, but of doing different things in innovative and different ways.

During the last decades, there has been a radical change in the concept of Eco-design that William McDonough [12] has defined as the transition from eco-efficiency to eco-effectiveness. Indeed, if the goal of eco-efficiency is to eliminate or reduce the damages caused by processes and products not designed considering the environmental impact, eco-effectiveness aims to outline a new design approach inspired by the natural system that encompasses a cultural, social and economic change, commonly referred as the Third Industrial Revolution [13].
Humans have always looked at Nature as a model to answer their questions. Eco-effectiveness approach aims to "learn from nature" [14] to establish a change in the point of view in which we consider the environment. Industrial development has always been based on the intensive exploitation of natural resources and consequently on the dangerous emissions to the environment.

The eco-effectiveness produces "Zero Emissions" systems, in which the concept of waste does not apply anymore: any process output is fully employed as input in other processes [15]. It is not an "end of pipe" approach oriented to limit the damage of a system no longer sustainable, but a radical change that releases opportunities and highlights perspectives, quite unthinkable only few decades ago.

The understanding of the raising complexity, resulting by the discoveries occurred during the last century in Physics and Biology [16], made the reductionism view inadequate: as a consequence the designer point of view moved from "the parts" to "all". The resulting design approach is then made up by the product design and the strategic design, and it is oriented to design and manage the entire product system taking into account the relationship with the environment.

To be able to manage this new complexity, the designers have to increase their level of knowledge of ecological literature, or eco-literacy, carefully evaluating the impact of design choices on the environment. According to Janine Benyus this change "introduces an era based not on what we can extract from nature, but on what we can learn from it" [17]. From this point of view, the research in the field of biomimicry (from 'bios' meaning 'life', and 'mimesis' meaning 'to imitate') is offering interesting ideas to transfer the production mechanisms developed by nature, over millions of years of evolution, into possible applications that can meet human needs. For example, there are studies concerning the processes for which the spider is able to make a silk "similar" to Kevlar, acting at the temperature and pressure of the surroundings and with no damaging output to the environment [17]. Despite the actual environmental, economic and social crisis calls humanity for radical changes to ensure the survival of the mankind, there are new prospects that encourage "designers" to rethink the entire socio-productive system in a sustainable manner.

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