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A DYNAMIC DATABASE FOR THE ENVIRONMENTAL ASSESSMENT OF HUMAN ACTIVITIES

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ABSTRACT: *New challenges arising from globalization, climate change, resources depletion and rapid technological and social development call for radical changes. Designers need adequate tools to manage the increasing complexity that is closely connected to the availability of supplies of raw materials, energy (human and otherwise), environmental impact and waste production and disposal requirements (inputs vs outputs). Thus, it is necessary to implement a dynamic database to have an easy implementation and a geographical reference of resources availability and local environmental and social pressures in real time. To provide reliable and updated data, sharing platforms should be made to create a specific database tailored to a local area, providing information to drive design hypotheses.*
KEYWORDS: *ecodesign, LCA, dynamic database, reserves, planet boundaries*

INTRODUCTION

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

The 40th edition (2010) of the World Economic Forum in Davos [1], in Switzerland, was entitled: "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] presented the results of the first report titled "The Limits to Growth", published in 1972 by the Club of Rome [3].

Today, scientific analysis gives us the opportunity to define, in a highly reliable way, our planet's resilience point. A Prominent Research Group [4] estimates that humanity has already transgressed three planetary boundaries: for climate change, rate of biodiversity loss, and changes to the global nitrogen cycle. (Rockström J. et.al, 2009).

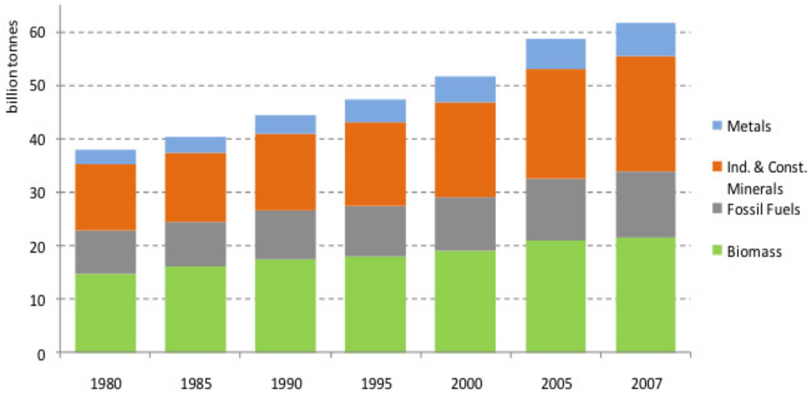

Figure 1 - Global extraction of natural resources, 1980 to 2007.
Source: SERI Global Material Flow Database. 2008 Version

Climate change is now widely recognized as one of the major environmental problems facing the globe. The Stern Review [5] estimates that the overall costs and risks of climate change could be equivalent to losing from 5% up to 20% of the global Gross Domestic Product (GDP) each year.

A large part of the Scientific Community imputes human behaviour as a fundamental aspect of climate change. The growth in CO2 emissions closely follows growth in GDP corrected for improvements in energy efficiency [6]. (P. Friedlingstein, 2010).

Global average temperature increases need to be kept below 2°C compared to pre-industrial levels in order to avoid dramatic consequences. This equals to a benefit in emissions to around 2 tonnes of CO2 each year for each person on our Planet by 2050 [7] (UNEP, 2011). In 2010, the average emission pro capita in Europe (EU 27) was around 10.3 tonnes [8].

As the world's population and economy continue to grow, we are exploiting our ecosystems and buried resources at ever increasing rates. In 2011, the Earth Overshoot Day was fixed on September 27th. This means that we are eroding our natural capital by limiting its availability for future generations.

According to the Global Footprint Network's calculations, we are now using the Earth's resources at a rate that would take between 1.3 and 1.5 planets to sustainably support. In 2007, the total weight of all the materials extracted and harvested around the world was around 60 billion tonnes [9]. This equals around 25 kg each day for each person living on our planet.

THE DESIGN ROLE

There is a strong need to rethink the economic and social system, the limitations of which are nowadays so dramatically clear. What is the designer's role at this crucial turning point?

Unfortunately, designers[1] have been one of the protagonists of the materialistic culture that caused the present social, economic, and environmental crisis. They must rethink their role in a profoundly changing society which has great challenges awaiting it.

Designers have to start their design process from real human needs and reflect the times and conditions that have given rise to the process, and, therefore, must fit in with the general human socio-economic order in which they have to operate [10]. Designers must, therefore, also evaluate and manage the environmental, social and economical impacts that the product or service will have along the different steps of the whole life cycle.

Nowadays, the term "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 artifacts, 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 specialization" of traditional design, but it is its natural evolution. Ecodesign involves a mature methodology that already considers the impact a product or a service will have on the external environment.

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 measures in order to reduce the environmental burdens. In this context, Life Cycle Assessment (LCA) [11,12] is the most internationally recognized methodology to evaluate environmental burdens, related to a product or a service throughout all the life cycle stages, from the extraction of raw materials to the end of life ('cradle to gate' approach). LCA is frequently used to support policy making and to develop thematic areas such as integrated product policy, waste prevention and recycling, sustainable use of energy and natural resources, as well as Ecodesign.

The LCA methodology and the Life Cycle Thinking approach drive the Ecodesign choices through more eco-efficient solutions. In this way, product designers are called to select design pathways not only according to material and performance criteria, but also according to the energetic and environmental burdens of those choices.

Over last 30 years, eco-efficiency has become 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 optimizing the existing system.

Although "eco-friendly" products and services use far less energy and far fewer materials than those of some decades ago, the overall consumption of environmental resources continues to rise. This clearly tells us 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, going beyond mere eco-efficiency.

Designers can no longer only focus on making more eco-efficient products, but they must look out of the box to rethink a system and a model of consumption exceeding the linear thinking that led us into the crisis we are experiencing.

We need a transitional period to move towards a truly sustainable society in order to gain new environmental awareness and knowledge. Then, we need to regain rapidly the cultural knowledge and experience that allows us to monitor our consumption by changing our needs and behavior.

[1] The term "designer" is used here in a broader sense and refers to decision-makers about the product.

THE FEATURES TOOLS SHOULD HAVE

The designer needs adequate tools to manage the increasing complexity that is strictly connected to the availability of supplies of raw materials, energy (human and otherwise), the environmental impact and the waste production and disposal requirements (inputs vs outputs).

The LCA methodology is a useful tool to assess the environmental burden of a product or service, but there is a strong need to connect the LCA results with the physical limit of our Planet.

LCA usually shows some useful impact indicators as Global Warming Potential, both non-renewable and renewable resources use, water use, land use. However, these results are not linked with the admitted limits of emissions of greenhouse gases (GHG) or with resources availability at local, regional and global scales, and so on.

The setting of the limit values is the most important step, albeit a very difficult one to locate, because the Earth System is very complex. However, until we no longer refer to a limit value, it will be extremely hard to reduce our ecological footprint below the boundaries, because we have no perception of how our actions really affect the environment. As long as we are below the boundary, we are below the threshold value. If the boundary is crossed, we enter into a danger zone.

To implement the information about environmental limit values into common Ecodesign tools it might be useful develop a dynamic database in order to have an easy updating and a geographical reference of resources availability and local environmental and social pressure in real time. In order to provide reliable and updated data, sharing platforms should be made to create specific databases tailored to local areas, providing information to drive design hypotheses.

In this way, the data would be available to designers to evaluate their design choices for both the environmental impacts generated and to the availability of resources within the limits of sustainability in order to guarantee the renewability of these resources for future generations.

A useful Ecodesign tool should provide, for example, both the analysis of environmental impacts (as a common LCA tool) and information regarding the availability of resources, an indication of limit values about GHG emissions pro-capita, about the Environmental and Water Footprint, and reference information about the environmental burden of the best available technologies. Consequently, the designer would be able to choose less critical materials and processes ensuring the renewability of resources.

Among the Ecodesign tools commercially available, the Cambridge Engineering Selector developed by Granta-Design Ltd. UK (hereafter CES)[14] offers some interesting data regarding both the environmental impact of material production and resources availability (reserves).

The current reserve of an ore or a deposit is the known quantity of usable material that can be extracted profitably at today's price using today's technology (Ashby, 2011) [13].

CES is basically a material selection tool that includes a simplified environmental performance assessment useful in either a preliminary design analysis, when it is necessary to outline the current situation and to define future strategies. Data about the material abundance in the earth's crust and oceans allows the designer to be aware of the physical limits of the Planet. By using CES, the designer is able to manage the decision making phase by taking into account both functional aspects and the environmental issues.

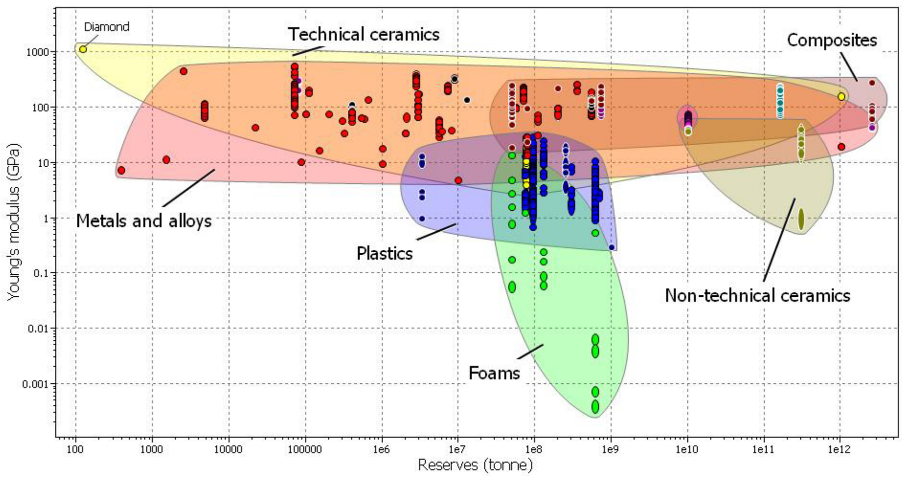

Figure 2 - Material Selection bubble Chart (Reserves vs Young's modulus)

The Figure 2 is a bubble chart performed by using CES to compare different materials by functional characteristics (Young's modulus) and environmental limits (reserves).

One of the most suitable features of the eco material selection performed by CES is that the environmental assessment is conducted at the very same time as the materials selection which is traditionally performed taking into account the standard set of indicators, constraints and objectives (cost, energy demand, mechanical behaviour, corrosion resistance, shaping feasibility etc…) [15].

By adopting the CES procedure, the eco-designer is able to assess a product's environmental burdens, according to the availability of the materials by which it is composed. Unfortunately, the CES does not refer to the other Planet Boundaries such as GHG emissions, fresh water availability, biodiversity, and the environmental footprint, etc…

Therefore, some other useful features might be implemented such as, for instance, the introduction of some reference values of the environmental impact of the best available technologies for different product categories. In this way, designers would have an immediate feedback on the environmental quality of their design choices.

These features should be implemented by paying particular attention to reliability and quality by carefully selecting data sources.

Obviously, the reliability of the environmental assessment of a material or product strictly depends on the quality of data (usually very good for conventional materials and progressively lower for the most recent, tested, and/or adopted materials). The reliability of the database used to assess the physical limit value (reserves, GHG emissions, water footprint, etc...) is fundamental.

CONCLUSIONS

Step by step, the design approach has acquired a systemic perspective in which the environmental impact is evaluated in all its complexity. The project activity is therefore characterized 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 focused on the social and environmental network in which the product is conceived.

The framework of planetary boundaries and the associated planetary safety zone is both new and evolving. It is drawing strong responses from scientists and advisors. To be able to manage these new complexities, 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" [16].

Although today environmental, economic and social crisis call on humankind for radical changes to ensure the survival of our species, there are new prospects that encourage "designers" to rethink the whole socio-productive system in a sustainable manner.

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