

Design for sustainability: A methodological approach for the introduction of environmental requirements in the furniture sector*

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Abstract: This article presents a method entitled “Design for environmental sustainability: design strategies, methods and tools in the furniture sector”. This method was developed by the research unit DIS – Design and System Innovation for Sustainability – of the Politecnico di Milano, Italy, directed by Prof. Carlo Vezzoli. This study consists of a presentation of the method for the development of design and environmental sustainability tools focusing on a given sector of product type. It is particularly relevant since it may be applied in different production sectors. The study was divided into three steps: life cycle assessment (LCA), environmental design priorities indicators (EDPI), and the creation of guidelines through a participatory research. Among other results, it proved to be an original abridged LCA tool and furniture-specific LCD guidelines.

Keywords: design for sustainability, office furniture, life cycle assessment, design guidelines.

1. Introduction

Discussions on the environmental problematic highlighted the planet limits and the conviction of the impossibility to continue the existing model of development. In general, ways to a sustainable development are being investigated and evaluated.

Designers have not been cut off from these issues. Parallel to the insertions of the environmental requirements in the producing companies, the designer gradually received an even more relevant role, once it has been observed that the best results in environmental and costs terms would be obtained from preventive actions instead of the end-of-pipe ones, as it has been up to now. The design phase has been considered the best means for preventive actions in the development of a product.

Initially the designer’s activity related to the insertion of environmental requirements was focused on the selection of materials with low environmental impact. With time, it has been noticed that more effective results, regarding environmental issues, may be obtained by observing the entire life cycle of the product. This happens because each product has its own characteristics (e.g., raw material, production process, consumption of resources in use) which affect their life impact. As a consequence, each type of product or sector requires different interventions.

For example, a common mistake in the furniture sector regarding environmental requirements is the belief that the selection of material with less environmental impact could be the best choice to a product with less environmental impact. This is not always true. The following example may illustrate the issue: comparing the environmental impact of the life cycles of two chairs, one made of recyclable cardboard paper and the other one of wood. At first, one may imagine that the cardboard paper chair has a smaller environmental impact in relation to the wooden chair in the preproduction and production phases (that is, in the phase in which the material is selected e in the fabrication process). However, if the entire life cycle of the chairs is considered, it is known that the wooden chair lasts around 12 years, whereas the recyclable cardboard paper chair lasts much less. Therefore, in order for the recyclable cardboard paper chair to fulfill the same function as the wooden chair, that is, to be used for 12 years, it will have to be reconstructed several times. As a consequence, the value of the initial environmental impact the chair made of recyclable cardboard paper should be multiplied by as many times as it would need to be reconstructed, which leads to a higher impact value than that of the life cycle impact of the wooden chair.

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The insertion of environmental requirements in design activities is known through many expressions like ecodesign or design for environmental. At this work it was chosen the life cycle design (LCD) terminology because highlights the life cycle phases approach. DIS*** general guidelines and criteria for product LCD were adopted (VEZZOLI; MANZINI, 2002).

Despite the already consolidated discipline of design for the environmental sustainability in the academic field and several already existing examples applied in companies, it has been noticed that the most effective results would be reached if the discipline specialized in a certain sector or product type. In order to do so, there is a present tendency to create know-how as well as methods and tools focusing on a given sector or product type. The advantage of this specialization is in making the application of these tools and methods more efficient and effective because they indicate, as precisely as possible, design decisions and solutions that have the highest potential to be environmentally sustainable (VEZZOLI; SCIAMA, 2006).

In this sense, as design for sustainability can be applied faster and generate more efficient results, it could be more easily inserted, demanding less time and at a lower cost. The reduction of costs can be an especially important factor to attract companies into introducing and applying this discipline.

Besides the presented advantages for the creation of sustainable design tools for a determined sector, the motivation for the present research is also due to the results of a master's research made by the author. The research aimed at analyzing the use of environmental parameters in the planning of products in the Brazilian serial furniture industry. The results indicated that there is a lack of data and tools that may help designers insert environmental requirements in product planning. This doctorate thesis was an answer to these results (CHAVES, 2003).

2. Type and structure of the research

The doctorate research created supporting tools for designers' activities in the furniture sector regarding design for sustainability focusing on office furniture. It is fundamentally considered applied research as it has a practical finality. The method was developed by the research unit DIS – Design and System Innovation for Sustainability – of the Politecnico di Milano, Italy, directed by prof. Carlo Vezzoli.

The first research phase consisted of the creation of a theoretical milestone regarding design for sustainability, its tools and methods and the furniture sector. The following strategies were used:

- bibliography research regarding design for sustainability and furniture sector issues;
- mapping of tools/methods used in Design for sustainability; and
- case studies – best practices – of design departments of companies or design studios that develop or have successfully developed office furniture using the design for sustainability (or a similar terminology) approach.

The case studies are presented in Table 1.

The second part of the research was developed in three phases, using different techniques:

- LCA - life cycle assessment;
- EDPI – environmental design priorities indicators; and
- guidelines creation – participatory research.

The LCA e EDPI are quantitative strategies. In other words, the results are numeric indicators. The former is composed by environmental indicators, or the environmental impact of each phase, material and process of a product; the last presents the Environmental Design Priorities Indicators method developed by DIS. These quantitative results were used as framework for the creation of guidelines and enable the prioritization of the decisions to be taken in the next research phase.

The results of these phases were used as a framework for the creation of a design orienting tool. In order to do so, a brainstorming involving four specialists on the furniture sector was carried out. The following scheme (Figure 1) shows the route of the research.

2.1. Life cycle assessment

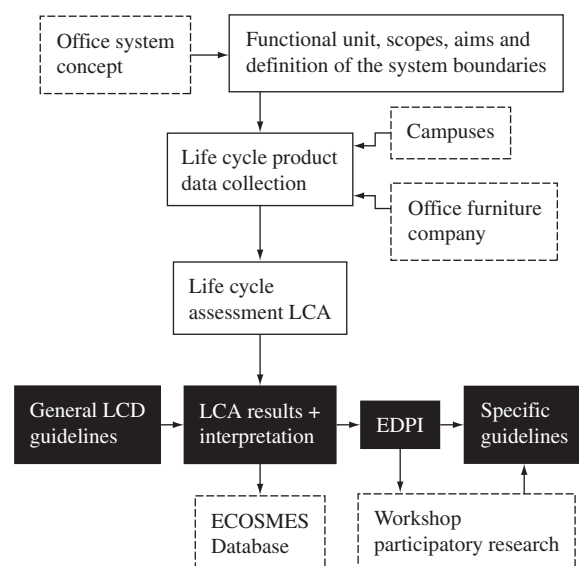


Figure 1. Route of the research. Source: by author.

*** DIS is the Research Unit Design and system Innovation for Sustainability by Politecnico di Milano.

Table 1. Case studies presentation. Source: by author.

	Place where the design for sustainability is developed	Contact person and position	Internal/ external intervention of design for sustainability	Department responsible for integration of environmental requirements on the product development
Office furniture enterprises				
Herman Miller	Zeeland, Michigan – USA	Paul Murray (Environmental manager)	Internal and external	Internal by – environmental department external by MBDC–McDonough & Braumgart
Upper	Ancona (Marche) -Italy	Mauro Gemini (Quality and Environmental responsible)	Internal	Quality and environmental department
Knoll	East Greenville, Pennsylvania - USA	Ute Zimmermann (marketing)	Internal	Development and construction department
Fritz Hansen	Lyngø, Denmark	Christian Grosen Rasmussen (Product design manager)	Internal	Product design department, interdisciplinary team
Design studio				
Lundberg design	Stockholm - Sweden	Olle Lundberg (manager owner)	For external consulting in product approach	
Econcept	Cologne - Germany	Martijn Verkuijl (researcher/consultant)	For external consulting in ecodesign approach	
Consortium				
Consorzio Casa Toscana	Navacchio (Pisa) – Italy Poggibonsi (Siena)	Giuseppe Lotti (Centro Sperimentale del Mobile e dell’Arredamento responsible for project Ecofuture)	Ecodesign label for external assessment regarding ecodesign in enterprises	

The product life cycle assessment (LCA) is a quantitative method for the analysis and assessment of environmental impact considering all life phases of a system/product – pre-production, manufacturing, distribution, use and disposal. The Life Cycle Assessment is performed in 5 consecutive steps (GOEDKOOP, 1995):

- Step 1: establishment of the purpose of the LCA;
- Step 2: definition of the life cycle;
- Step 3: quantification of materials and processes;
- Step 4: filling in the form; and
- Step 5: interpretation of the results.

The data was collected by Inforline, a Brazilian enterprise which produces office furniture and is located in Colombo, Paraná. For the data collection, a previous test regarding the protocol formats was done. The test was part of an educational activity of a life cycle design course carried out at the Faculty of Design of Politecnico di Milano. During the course an exercise was carried out with various Universities, as listed below:

- Department of Industrial Design Faculty of Architecture King Mongkut’s Institute of Technology, Thailand;
- USP, São Paulo, Brazil;
- Hong Kong Polytechnic University, School of Design, Hong Kong;
- Indian Institute of Technology, Delhi, India; and
- Istanbul Technical University, Department of Industrial Product Design, Turkey.

Those Universities sent data regarding their furniture systems to the Politecnico di Milano. The data was used by the Italian students in a product/service system project for the different countries’ campuses. As a result, nineteen LCAs were generated.

The generation of the LCAs and of the LCA of Inforline enterprise required the development of a specific sector database. The materials database of the LCA software was also tested in the course.

The data of the sector was acquired from a database of another software called eVerdee, available on the Internet. This software is part of the project eLCA sponsored by the European Community. The eVerDEE is a web-based software tool designed to support the use of LCA by small and medium-sized enterprises (SMEs). The tool is available on the website: <http://www.ecosmes.net>. Ecosmes is a portal that offers a practical response to the demands of the SME to adopt the Integrated Product Policies (IPP). The portal provides information, tools and services for the development of the “green product” market.

The software has a furniture database that lists the materials mostly used and generates simplified LCAs (Figure 2). The results of the LCA generated by eVerDEE are characterized or normalized. In other words, the results show the analysed product’s contribution to the greenhouse effect, acidification and other environmental problems. For a designer, these results are very difficult to interpret, because stipulating a mutual weighing of environmental effects is not viable. For

this reason, the characterized results of eVerdEE LCA were converted into environmental indicators by Ecoindicator 95, a weighing method that “has enabled one single score to be calculated for the total environmental impact based on the calculated effects” (GOEDKOOOP et al., 1996, p.2).

The database originated an abridged LCA tool specific for the furniture sector. This LCA tool is formed by indicators of environmental impact of each one of the “new substances” (materials and processes) originated from the software eVerdee, inserted in the Simapro software.

2.2. Environmental design priorities indicators (EDPI)

The environmental design priorities indicators method was developed by DIS. Based on the general strategies of life cycle design, it takes into account all the life cycle phases. The method adds the results of the life cycle assessment best known as LCA to the life cycle design strategies.

The method of Environmental Design Priorities Indicators links the LCA results to the LCD strategies. The LCD strategies adopted by DIS that were used are as follows (VEZZOLI, 2004):

- reduction of material consumption;
- reduction of energy consumption;
- reduction of toxicity and harmfulness;
- conservation of bio-compatibility and resources;
- product life optimization (extension and intensification);
- material life extension (recycling and energy recovery); and
- design for disassembly.

Some formulas were used to achieve a value. Each criteria heading is computed, according to a potential environmental improvement, and compared to each other. The highest potential will receive a value of 100; the other



Figure 2. Simplified LCA ecoindicator tool for furniture sector strategy. Source: by author.

criteria values found will be proportionally compared to that higher value.

2.3. Participatory research

After identifying the priority strategies regarding the office furniture sector, the general guidelines were transformed according to a hierarchical arrangement into specific and applicable guidelines. In order to do so, a group of specialists of the furniture sector were invited to participate in a workshop to generate the new guidelines in a participatory research.

Essentially participatory action research is research which involves all relevant parties in actively examining together current action (which they experience as problematic) in order to change and improve it. They do this by critically reflecting on the historical, political, cultural, economic, geographic and other contexts which make sense of it (WADSWORTH, 1998).

The workshop happened on August 18, 2006 at the CETMAM location in Arapongas, Paraná, Brazil and was developed in three phases:

- presentation of the first research results to the participants, as well as of the work plan to be followed in the workshop;
- reading of the general guidelines, introduction of changes and new guidelines specific to the sector; and
- re-elaboration of the results generated by the workshop, with the creation of specific guide lines for the furniture sector.

After the results of the workshop were re-elaborated, they were arranged in a booklet. In the booklet, the first part contains an explanation on how to use the guidelines. After the introduction, in an order of priority for the furniture sector, the LCD guidelines, now specific for the furniture sector, were presented (Figure 3).

Before each LCD guideline (and it’s sub-guidelines), a first page presenting the main environmental aspects related to the furniture sector to be considered in the guideline was added. After the sequence of specific guidelines and sub-guidelines for the furniture sector, some boxes, graphs, and tables were added containing information related the guideline applied to the furniture sector. The objective of these boxes, tables and graphs is to aid the designer in his/her decision process.

3. Results and final considerations

In particular, the research originated the following results (tools):

- a map of tools for design for sustainability. The map shows some tools/methods which are classified according to the level of interference in the design activity, the possibilities of use in the furniture sec-



Figure 3. Life cycle design guidelines for office furniture sector. Source: by author.

tor and the kind of application regarding design for sustainability (assessment, prioritizing or orienting action plans);

- a catalogue of the best practices (described with a given format protocol). The format summarised the data collected in the case studies such as: the level of interference of the designer on the introduction of environmental requirements, the tools used by the interviewee, the expertise required for using the tools, the weak and strong points of the tools used, the phases of the low environmental impact products development method and the LCD strategies used;
- the results of life cycle assessment of some office furniture pieces, showing the materials with higher environmental impact, process and life cycle phases;
- an original abridged LCA tool with the most common materials and processes used in the furniture sector based on the ecoindicator method. This contribution makes the access for an easy LCA tool available by little and medium enterprises, as well as by designers;
- the environmental design priorities indicators (EDPI) for furniture sector, based on the strategies of life cycle design (LCD). These indicators help the designer in the decision making process;
- furniture-specific LCD guidelines: a handbook which presents the specific guidelines for the sector. It indicates the design decisions and solutions that have highest potential to be sustainable regarding the furniture sector; and

- the innovativeness of the research and the value of its original contribution do not only consist in a deeper exploration of the problematic of a specific sector. It consists mostly in helping the designer in his/her decision making by prioritizing the interventions in environmentally sustainable design leading to efficient results. As a main contribution, the research presents in details a methodology for the creation of tools for a specific context or product. Such method can be applied in other sectors or products.

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