Available online at www.sciencedirect.com
SCIENCE DIRECT
Journal of Cleaner Production 14 (2006) 1319–1325
Journal of Cleaner Production
www.elsevier.com/locate/jclepro

Life Cycle Design: from general methods to product type specific guidelines and checklists: a method adopted to develop a set of guidelines/checklist handbook for the eco-efficient design of NECTA vending machines

Carlo Vezzoli*, Dalia Sciama

Research Unit, Design and Innovation for Environmental Sustainability (DIS), INDACO dept. Politecnico di Milano University, via Durando 38/A, 20158 Milano, Italy

Accepted 11 November 2005
Available online 10 January 2006

Abstract

This paper underlines and debates the importance of developing specific guidelines and checklist per product typology, as tools to make eco-efficient design become a reality.

The argumentation is accompanied by the description of a project commissioned by the NECTA Vending Solutions (the European leader of drinks & food vending machines) to the DIS research unit (Design and Innovation for environmental Sustainability, Politecnico di Milano University – The DIS research unit of Politecnico di Milano University is offering, since 10 years, applied researches and company consulting on Life Cycle Design and eco-efficiency improvement. Typical consulting activities are: Life Cycle Assessment; handbook for LCD and eco-efficient product, service and product-service system development; procedure and tools to integrate environmental requirements into company existing product, service and product-service system development process; courses on LCD), resulting in such tools, currently integrated into the company product development process. The considerations are based upon on primary data and experiences.

The final results of this project are two handbooks of guidelines and checklists for the eco-efficient development of two types of vending machines: one for Snack & Food (spirals model), the other for Hot & Cold drinks.

In order to achieve these results an LCA has been developed and a system to prioritize guidelines has been adopted; this system has led to a procedure which moves from general to specific guidelines and checklist. Finally these tools have been integrated within the company procedure.

The method adopted by DIS in this applied research is described, highlighting the observed key success factors in a project between a University research unit and a company.

Final considerations expand upon the matured experiences to demonstrate the importance and efficacy to go from general methods and tools to more specific ones (e.g. specific guidelines and checklist), in order to implement Life Cycle Design principles, in the real company practices and culture.

Keywords: Life Cycle Design; Design guidelines; Environmental criteria; Checklist

1. Life Cycle Design: a practice to be diffused

There is a clear need to disseminate a more consistent approach to design methods, in order to implement a low environmental impact design in the real company practices and culture. This should be done through a broader diffusion of effective methods, support tools and operative know-how, having a *functional* and *life cycle* thinking approaches.

Now, this paper reviews what is generally meant by the Life Cycle Design approach.

In the second half of the 90 s the discipline that faces in all its dimensions the design of low environmental impact products, began to be defined more clearly and exhaustively. It

* Corresponding author. Tel.: +39 2 2399 5983; fax: +39 2 2399 7203.
E-mail addresses: carlo.vezzoli@polimi.it (C. Vezzoli), dalia.sciama@polimi.it (D. Sciama).
URL: http://www.polimi.it/rapirete

0959-6526/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jclepro.2005.11.011

also began to be clear what we should mean by *Environmental Requirements of Industrial Products* and the concept of *Life Cycle Design (LCD)* was introduced.

The meaning of *Environmental Requirements of Industrial Products* became clear after studies and new methods for the environmental impact assessment of products became available, i.e. methods to assess the input and output between the *technosphere* and the geosphere/biosphere[1].

As well, most authors (Brezet H, van Hemel C. [1]; Mont O. [2]; Tischner U. [3]; Vezzoli C. [4]) agree that the leading *LCD* principles are:

- the extension of the design horizon: from product design to the (systemic) design of all product life cycle stages;
- a new design *reference*: from product design to product *function* design.

Within this framework products have to be designed considering all phases of the life cycle. All activities related to the product, from the production of materials to its distribution, to its use and finally its disposal, are considered as a single unit. This leads to a shift from the design of the product to the design of the product-system, as the whole of processes characterizing its life cycle.

The second criterion of *LCD* is to design with regard to product *function* delivered by the product, more than from the physical product itself (Mont [2], Manzini, and Vezzoli [5]). In fact, it is in relation to this function (functional unit) that it is possible (e.g. with LCA) to assess whether the environmental impact has been reduced and how. Function, a fundamental and historic theme in the culture and practice of design, acquires, in this context, a new meaning and a new vitality.

Nowadays *Life Cycle Design* is a discipline with a fairly clear theoretical framework and (environmental) requirements definition. Anyhow, as for every emerging discipline, it needs a broader diffusion both in design practices and education.

A survey[2] of Italian design practices, including both individual design practices and design departments within companies, highlighted a general lack of environmental competencies on staff; e.g. few design centers know what a *Life Cycle Assessment* (LCA) is; even fewer are those who make use of it. However, what is positive is that most of those surveyed showed a growing business commitment to access such competencies in relation to both product design and communication tools and methods (Costa, Vezzoli [6]).

In the last decade several tools have been developed to support, with different foci and for different purposes, the design process in reducing environmental impacts: a) tools for environmental life cycle *assessment of products*; b) support tools for product design *conceptualization and development*; c) *strategic design tools for sustainability*; d) environmental *communication* tools[3].

Among this considerable quantity of tools, this paper focuses on guidelines, i.e. **product type specific guidelines** (and related checklists), as essential and effective *support tools* for the orientation of products' *conceptualization* and *development* processes.

The theme of guidelines for Life Cycle Design (LCD) is first addressed in general terms and on what is meant by the authors with *product type specific guidelines*.

The argumentation was accompanied by a description of a method of developing specific guidelines, and by its implementation in a project commissioned by the *NECTA Vending Solutions* to the Design and Innovation for environmental Sustainability research unit (DIS – Politecnico di Milano University).

This is followed by feedback on project and final considerations.

2. Guidelines for Life Cycle Design

Generally speaking, the term **guideline** is used to indicate a set of procedures and tools to *orient* a *decision making process* towards given *objectives*.

Being our concern to design products for environmental sustainability:

- the *decision making process* is intended as the design activity, from the briefing, to the conceptualization, to the product development;
- the *objective* of concern is the minimization of the environmental impact.

Using the above classification of tools, the *guidelines* for LCD can be defined as support tools for the design process of product *conceptualization* and *development*.

The guidelines should inspire and indicate those design decisions/solutions that have the major potential to be environmentally sustainable. They should also give a *promising* direction to achieve environmental gains in the product that has to be designed. This does not always happen. Even though guidelines are based on a matured experience and knowledge on sustainable assessment, sometimes guidelines can be misleading. This has to be evaluated case-by-case.

Furthermore, it should be kept in mind that guidelines are not fixed, but can and should evolve in time with the knowledge up-dating; particularly important for the less consolidated knowledge, such as those connected with the assessment of sustainability.

[1] Even though it is still being discussed, the most accepted environmental assessment method is the Life Cycle Assessment (LCA).

[2] The survey was conducted in 2000 by the DIS Politecnico di Milano and funded by the Italian Environmental Protection and Technical services Agency (APAT). A questionnaire was mailed to a representative sample of 200 Italian design practices (both design practices and design departments within companies).

[3] Similar classifications have been proposed by various authors, such us Simon M. [8]; Tischner [9].