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INVESTIGATING THE USE OF ECO-DESIGN GUIDES: PRESENTATION OF TWO CASE STUDIES

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ABSTRACT
This paper first describes barriers and success factors to implement eco-design in industry. The designing phase is critical for the integration of environmental issues. Methods and tools for designers are examined and complementarity between quantitative assessment tools and qualitative tools is underlined. Two qualitative eco-design guides created in collaboration with industrial designers, Information/Inspiration and the new French framework Ecofaire are presented. Results of two academic tests based on both tools in comparison with novice and expert designers are exposed. This finally leads to a new point of view on eco-design tools where dynamic environment learning for different actors of companies should be taken into account.

Keywords: eco-design, qualitative approach, eco-design guide, industrial design, learning.

1 INTRODUCTION
The integration of environmental issues implies deeper and deeper questioning on products. Bras [1] proposes a four-level approach of these issues from the most applied to the most global: "Pollution Control and Prevention", "Design for Environment", "Industrial Ecology" and "Sustainable Development". Different time scales involve product development, human life and eventually civilization time. Historical classification of Millet et al. [2] proposes three categories depending on the level of transformation of the company: "Partial eco-design" (and associated DfX, for instance Design for Manufacturing, for Maintenance, for Assembly, for Recycling, for Remanufacturing), "Classical eco-design" since the nineties and "Innovative eco-design" (Figure 1). The equivalent of this classification is suggested by Dewberry and Goggin [3] with "Green Design", "Eco-design" and "Sustainable Design". Bhamra [4] also adds that, whereas "Green design" is focused on modifying a single criterion of the product (for instance the material or the energy consumption), eco-design favours a multi-criteria and multi-stepped approach (i.e. on several steps of product life cycle) to avoid pollution transfer. The scope of environmental issues is extended within sustainable development. Notions of ethics and corporate social responsibility are implied, and products are considered as services to the user. The same view is shared by Abele et al. [5] with the terms of "direct strategy", "indirect strategy" and "innovative strategy".
As eco-design was introduced in companies, operational and organizational difficulties were pointed out by several authors through different case studies. The most frequent statements can be summarized as followed:

- Designers have little, or even no time to allocate to environmental information query or to eco-design education [6], [7],
- Environment is obviously not a priority issue, but a factor among others [6],
- Clients do not express any direct environmental requirements to the companies [7],
- Organization of services is not appropriate and cooperation between these is seldom instituted [7], [8].

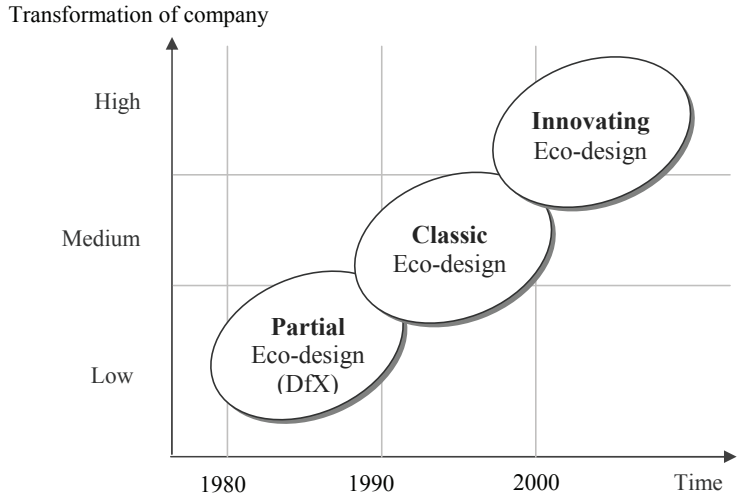

Figure 1: Classification of different environmental approaches. After Millet et al. [2]

Set against these, success factors can be underlined: dynamics of cooperation, deep support from managing team, customization of eco-design methods and tools, dissemination of environmental values in all services of companies [7], [8]. A durable and efficient integration of eco-design has to involve internal actors of the company (design team, marketing, management), external actors (suppliers, sub-contractors) and stakeholders (final users, policy makers).
Design is a generic word. As a practice, it is shared by various disciplines (mechanical engineering, architecture for instance) with multiple points of view [9]. According to this, eco-design is a new variant of design with an environmental point of view. Designers have therefore a key-role to play in the integration of eco-design in companies [10].
In section 2 a synthesis of methods and tools for designers will be seen. Section 3 will introduce two qualitative tools. An empirical work based on both tools in comparison with novice and expert designers is summarized in section 4 and 5. Lastly, conclusions and perspectives will be exposed.

2 METHODS AND TOOLS IN ECO-DESIGN

Research on eco-design methods and tools is a widespread field. What designers can expect from methods and tools with a systematic approach will be presented in this section.

2.1 Terminology

It is relevant to define the exact meaning of the words “method”, “methodology” and “tool” in a design context. According to Pahl et al. [9], two meanings are to be considered to describe the concept of methodology. The first one (the narrower) refers to procedures and prescriptions a practitioner must follow to achieve a certain goal. It is also the meaning of the word “method”. Chronological steps are included in this definition. The second meaning is wider. It is connected to a reflection (logos) on practice and implies that designers must show awareness and reflexivity when designing. According to Akermark [10], using a method benefits designers in several ways:

- structuring and making goals visible,
- limiting the risk of forgetting significant elements,
- proposing a common language to different actors.

Within this framework tools can be seen as a system of techniques associated to a method as well as a way to achieve aims. Families of methods and tools in eco-design will be presented first. Then our analysis will be focused on a selection of qualitative tools.

2.2 Classification of methods and tools

Expected outcomes of methods and tools are qualitative, quantitative or half-quantitative: it is a first type of classification. In order to qualify goals, Le Pochat [11] suggests making a distinction between assessment tools (Life Cycle Assessment or LCA, matrix, checklists), improvement tools (guidelines, "E" creativity) and also tools offering both possibilities (LCA, eco-indicators). Communication tools on environmental issues complement this picture [12]. Lagestedt's classification [13] can be compared to the previous. Nevertheless it provides some extra-information on whom is the tool aimed at and when in the product design process it can be used. This is a specific and complementary problem designers have to cope with in industry. They would often complain about lacking visibility of the right tool to be chosen at the right time, as well as in a clear vision of the expected outcomes [6]. Eventually methods and tools can either be used in early phases of the design process (but are less numerous [10], [13]) or in advanced phases, also called "detailed". Although being a reference in environmental assessment, LCA happens to be inappropriate in early phases since insufficient data on products are available. This statement is also true for an innovative product [2]. LCA is time-consuming, costly and complex, thus the intervention of an expert is required [7]. But such an analysis is mandatory to obtain reliable and comprehensive data to compare products. Should their limits be clearly defined, qualitative methods and tools may constitute an interesting alternative solution on a first approach.

2.3 Qualitative and half-quantitative approaches

Well spread qualitative tools include: simplified qualitative life cycle assessment [14]), general or dedicated checklists, guidelines. They fit in the basic toolbox to which a multidisciplinary team can refer. These tools are likely to be combined and enriched in order to build a new collective, tailor-made tool. A typical example of this trajectory [15] was held in the "Bombardier "company where the so-called "10 Golden Rules" were introduced. On a first level rules were customized by the design team with help of the environment manager, and marketing management team. On a second level new design rules were clarified by engineering designers. Fargnoli et al. [16] also rely on checklists and Environmental Effect Analysis (EEA) to create another integrated methodology of assessment and improvement of products. Three free-access eco-design guides can be mentioned: Eco Design Pilot, Information Inspiration and Ecofaire (Table1). Ecodesign Pilot is an initiation tool to eco-design allowing designers to aim environmental improvement. In a project developed by Pamminger et al. [17], Ecodesign Pilot is combined to QFD (Quality Function Deployment) and HPO (Holistic Process Optimization) to address respectively stakeholders and production process requirements. Finally the idea of a "systematic approach for sustainable product design" with a clear link to the product development process appears to be shared by authors.

Table 1. Characterization of 3 eco-design guides: Ecofaire, Information/Inspiration and EcoDesign Pilot.

Name of the tool /author	Date of publishing	Language	Addressed to	Objectives
Ecofaire /SEM Pays de Loire	2008	French	Engineering designers, Industrial designers, Research department, Marketing … Teachers, Students.	Introduction to eco-design Diagnosis/ First environmental assessment Solution finding/Evaluating solutions Communication
Information Inspiration /Loughborough University	2005	English	Industrial designers	Introduction to eco-design Environmental strategies Examples of eco-products
Eco Design Pilot /TU Wien	2001	10 languages	Designers, Industrial designers, Manufacturers, Environment managers.	Introduction to eco-design Environmental strategies Tracks for environmental improvement

Information/Inspiration and Ecofaire based on similar principles as Ecodesign Pilot are detailed in next section.

3 PRESENTING TWO ECO-DESIGN GUIDES: "INFORMATION/INSPIRATION" AND "ECOFAIRE"

Both tools compared in this section were developed in collaboration with industrial designers. Hence a holistic qualitative vision of the design problem is proposed. More precisely Information /Inspiration is purely qualitative whereas Ecofaire is half quantitative (since a few simple numerical assessments are integrated).

3.1 OBJECTIVES AND AIMS OF TOOLS

Study of the Information/Inspiration web tool [18] originated in a collaborative work between Loughborough University and Electrolux and was carried out for three years. The first statement was that existing eco-design tools are not appropriate for industrial designers for two main reasons. On the one hand using tools and looking for environmental information tend to be time-consuming; recommendations are also found to be too general. It is to be noted that these facts are sources of dissatisfaction for engineering designers in industry. On the other hand specific culture of industrial designers based mostly on case studies and examples does not seem to be taken into account. The synthesis of this study by Lofthouse ended up in the Information/Inspiration prototype. It combines in a well-balanced way traditional eco-design information and examples of eco-efficient product and services. This tool shows two "streams" accessed via homepage. Within each stream, "Information" and "Inspiration" can develop up to three levels of documentation with transversal links. Chronologic architecture was not chosen here, as industrial designers are known to be keen on free navigation [19], [20]. As far as content is concerned three criteria are underlined: Guidance, Education and Information. The original value lies in the combination of these elements in:

- Guidance and education ("Where to find education?"),
- Guidance and information ("Where to find information?"),
- Information and Education ("Using information for education").

As to the form (i.e. presentation of the tool), analyzing practice of industrial designers leads the author to emphasize: a free dynamic access via internet, a non-scientific language with "nuggets" of information, and visual interfacing [19], [20].

HOME		
ECODESIGN INFORMATION		PRODUCT INSPIRATION
Getting started		Electric&electronic
Tools		Consumer product
New ways of doing it		White goods
Materials		Packaging
Distribution		Textiles
Use		Alternative Energy
Optimal Life		Furniture
End of Life		Concepts
Legislation		Green design
Ecolabels		Interesting materials
		Systems/services
		Cool links

Figure 2. Structuration of Information/Inspiration web tool

The French program Ecofaire [21] was organized and conducted by SEM Pays de Loire in collaboration with the environment consultancy EVEA (www.evea-conseil.fr) between 2006 and 2008. This program seeks to "favor and facilitate the development of environmentally friendly products". A collaborative study was carried out with companies, industrial and engineering designers. The methodological tool Ecofaire is part of this research work. It is composed of two introduction

sheets followed by 18 others to be used in five chronological steps: “Scope and stakes”, “Initial environmental assessment”, “Solution finding”, “Evaluating solutions”, “Results and Communication” (Table 2). Non-experts users are targeted here, should they belong to industry or to academia.

Table 2. Structure of methodological tool Ecofaire

Stages	**Description of sheet**	**Alpha-numerical sheet identification**
Introduction	*Step-sheets* *Instructions for use*	*1 to 5*
1- Scope and stakes of project	*Step-sheet* ECOFAIRE self-diagnosis Check-list of information gathering Strengths, weaknesses, opportunities, threats matrix **Environmental expectations and requirements of different actors**	*1* CE1 CE2 CE3 **CE4**
2-Initial environmental assessment	*Step-sheet* **Description of life cycle in first approach** Environmental stakes on first approach Analysis of reference product: benchmarking Simplified mass analysis Evaluation of recycling ability Environmental impacts: pedagogical presentation Identification and hierarchical organization of environmental aspects Characterization of environmental aspects Selection of free access tools	*2* **E1** E2 E3 E4 E5 E6 E7 E8 E9
3-Solution finding	*Step-sheet* **Eco-design wheel** **Check-list of search for solutions by product categories**	*3* **R1** **R2**
4-Evaluating solutions	*Step-sheet* Comparison of solutions according to identified environmental indicators Help in decision-making Visualization of design through life cycle environmental consequences	*4* ES1 ES2 ES3
5-Results and Communication	*Step-sheet*	*5*

3.2 DEALING WITH EXAMPLES

Examples of the section “Inspiration” illustrate remarkable, and even innovative strategies adopted by international companies for concepts or real products (for instance Tectan speakers by Sony). More details are available through useful links to the companies’ websites. The concept of guidance through examples is consistent with the analogical reasoning of the industrial designer. Within Ecofaire’s framework, examples are used to clarify certain steps of the method. They are excerpts from real case studies (Moderna kitchen E9) or common products (cheese packaging, ES1, urban window box, ES3). An equivalent to the successful products from the “Inspiration” section can be found in eco-design sheets published by ADEME [22].

4 FIRST EXPERIMENT WITH NOVICE DESIGNERS

4.1 INTRODUCTION TO THE FIRST EXPERIMENT

It is proposed to test both tools in academia with future mechanical engineers. On the Ecofaire context, seven groups of four second year students with homogenous background in mechanical engineering were involved. On the Information/Inspiration context, a dozen of students with similar background participated individually. In both cases few questions to guide the environmental analysis were given. Students were asked to return on a separate sheet. It is important to stress that the choice of the four relevant Ecofaire sheets for this study (in bold on Table 2) was made by the experimenter.

The theme of the study had to be carefully chosen due to the short duration of the experiment: two hours. Therefore we chose to deal with a common food product and its packaging: yogurt in a cup. Although being apparently ordinary this product raises fundamental questions on packaging (and its consequences on logistics and end of life) and milk production. It should be noted that milk food consumption has dramatically been increasing since 1970 in France (according to INSEE [23]). The same kind of enthusiasm is currently noticed in a country like China. The extent of environmental concern due to massive consumption of milk products can therefore be estimated.

Students were introduced in a two-hour course to eco-design and its key-concepts. Few examples of packaging solutions were provided as well. Students are expected to:

- clarify the concept of environmental value for the involved actors (company, distributor, consumer, suppliers),
- express the environmental issues for this product,
- suggest improvement solutions on different levels.

Our analysis is focused on three topics: problem clarification through choice of frontiers and functional unit, interpretation of found solutions, discussion on methodology of these tools.

4.2 PROBLEM CLARIFICATION

In a prior stage several yogurt cups are carefully observed, polystryrene cup being the reference. With Ecofaire, the problem is clarified thanks to E1 sheet (life cycle) and CE4 (environmental expectations of actors). Many important questions on frontiers of the study are raised. Are we supposed to consider packaging itself or milk product and its packaging? Are farming facilities or road network supporting traffic of trucks part of the study? The choice of a functional unit is also discussed. It differs depending on selected point of view and frontiers. With regard to packaging, “Deliver X kg of yogurt to the distributor” or “Preserve X kg of yogurt for four weeks” are possible units. “Satisfy average consumption of yogurt per week of a four-person family” (equals to 1.6 kg [23]) can describe the whole product. Using Information/Inspiration, students were less encouraged to insist on clarification.

4.3 SOLUTION FINDING

In a pilot study with industrial designers on a coffee creamer sachet, Bakker [24] proposes a five-level scale of analysis. Levels 1 to 3 are used to describe changes on packaging itself. Milk within sachet is questioned on levels 4 and 5. Our choice is to clarify propositions of students on three levels corresponding to 1-2, 3-4 and 5 by Bakker (see Table 3). Three irrelevant suggestions with Ecofaire are not taken into account.

Ideas on modification of logistics were attributed to the third category where a change in product environment is considered. Two main points should be mentioned to analyse suggestions on improvement.

- As foreseen the majority of propositions (54.1% (A); 61% (B)) relate to an optimization of the current packaging concept, composed of cup and cardboard. Same solutions are often quoted. First level is therefore the most simple to think of for students starting with eco-design. Besides it should be noted that neither secondary packaging (cardboard box protecting packs of yogurts which could be cut up for better refrigeration) nor tertiary packaging (pallet) were mentioned.

- On levels 2 and 3 an equivalent number of solutions were quoted, and more diversity and subtlety among answers were observed. Changing the shape of cup is often stressed on level 2. The idea of a flowering biodegradable cup was directly inspired by the "Sunflower mobile" concept of "Product Inspiration". On the last level two concepts are highlighted: removal of disposable packaging and reduction of the impact of logistical issues. With Ecofaire, sheets E1 and CE4 were probably helpful with regard to the latter issue.

Table 3. Solution finding to improve current "yogurt" product with Ecofaire and Information/Inspiration

Level 1, 2, 3	**Examples of frequently quoted solutions**		**Total number of relevant propositions by level (% total)**	
	ECOFAIRE (A)	**Information/Inspiration (B)**	**(A)**	**(B)**
1 Optimization of existing packaging (primary and secondary)	Removal of cardboard around cups Larger container (500g or 1kg) Change of material: biodegradable Tetrapak	Removal of cardboard around cups, use of recycled cardboard Larger container Change of material: biodegradable, biopolymer N on-toxic inks, mono-colour printing Communication on recyclability	20 54.1%	20 61%
2 Change of concept (packaging or milk product)	Cubic packaging Yogurt in powder Non-refrigerated yogurt	Cubic, triangular packaging Compaction of cup Biodegradable cup with embedded seed	8 21.6%	6 18%
3 Change in environment of product	Removal of disposable packaging: yogurt pump Closer siting of client and producer: Local distribution of product Alternative to road transportation (cycle, hybrid vehicle)	Removal of disposable packaging: yogurt-maker Local production Electric transportation Plant using renewable energy	9 24.3%	7 21%

As a conclusion participants had the opportunity to consider product and packaging in combination. It is a requirement to address sustainability according to Bhamra [4], and a great move should be made by companies in that direction.

4.4 DISCUSSION ON THE USE OF ECO-DESIGN GUIDES BY NOVICE DESIGNERS

Ecofaire is apparently well understood and appreciated by students since it is compliant with steps of the product development process with which they are familiar. Using a method shows one drawback with beginners: they tend to loose their global view on the problem with a step-by-step approach to the work. Nevertheless a good proportion of training designers were able, within two hours, to develop an accurate vision on the environmental issues of the product. This preliminary work seems a good starting point to understand or carry out a life cycle analysis. Our analysis could be enriched by testing all environmental assessment sheets, whose contents were specifically directed towards user-

friendliness. Besides, two drawbacks were mentioned: inconvenience to deal with non-printed sheets (on a numerical format), difficulty to make an adequate choice of sheets for autonomous use.
Students enjoyed using Information/Inspiration for its pleasant interface, and acknowledged its ability to enhance creativity. Alternatively, they experienced difficulty in finding strategic guidance on this specific study. Concepts found in Table 3 appear to be rather similar with both tools. It is fair to assume that novice designers tend to rely mostly on their personal experience for solution finding, and in a minor proportion on provided tools.

5 SECOND EXPERIMENT WITH EXPERT DESIGNERS

A second experiment was conducted with four eco-design tools, two of which were Ecofaire and Information/Inspiration. Four groups of six experts on design and/or eco-design were formed randomly, with a designated team leader and at least one expert female in each group. Every team was audio-recorded during this two-hour test. Experts are divided into two categories: engineers in industry/consultancy (25%), researchers (75%). In this paper, we will focus on the outcomes of the two groups we are interested in.
The subject to deal with is slightly more complex than in the first case. Participants are asked to improve a disposable razor for man or woman. A short introduction to historical and marketing aspects of the product is given by the experimenter. Presentation of the outcomes is left free: sketches, charts, tables…The aim of this section is to provide an insight into understanding how eco-design tools were actually used and judged by experts. We will examine the creative production of concepts of each group, and provide an evaluation of eco-design guides based on experts feedback.

5-1 SOLUTION FINDING

Various solutions or sub-solutions are presented by the two groups. Significant variants are observed (as opposed to the first experiment) and can be related to three criteria:

- number of concepts,
- level of detail of concepts,
- level of environmental improvement, on a scale from 1 to 3 (cf. 4-3).

A picture of different solutions can be found on Figure 3 and Table 4.

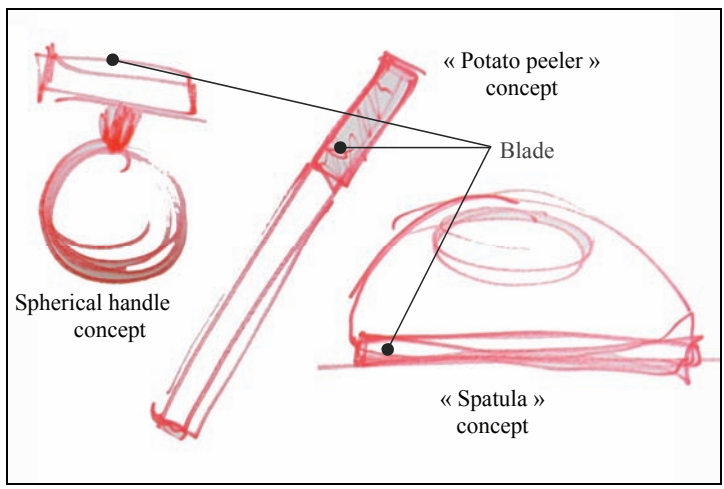

Figure 3. Examples of sketches of Information/Inspiration group

Table 4. Solution finding to improve current "razor" product with Ecofaire and Information/Inspiration

Tool	Ecofaire	Information/Inspiration
Product	Man razor	Woman razor
Presentation of solutions	Words-Phrases	Words-Phrases Sketches on paperboard
Number of concepts	8	16
Level of detail	Few details	Few details
Level of improvement 1,2,3	**Examples of solutions**	
1 Optimization of existing product (razor and packaging)	Mono material (polyethylene, terephtalate polyethylene) Separable head Biodegradable material Colours from vegetable pigments Communication to consumers: end of life, water consumption	Mono material Limit number of blades: 1 Interlocking heads One handle for 5 heads Packaging of heads only Soft protection of blade
2 Change in function	Multi-purpose handle (toothbrush/razor) Optimizing head to clean hair and save water	Blow out hair system Rotate blade: "potato peeler" Reduce material use: spherical handle, wire blade
3 Change in environment of product		Shave in the "Ecoshower" to save water Associate with bio cosmetic products

Both groups identified two major sources of environmental impacts on a disposable razor: material and hot water consumption. It can be noted that the second group produced more concepts related to environmental and functional aspects.
However the contribution of the tool itself is difficult to point out. What is attributed to dynamics of the group or to personal experience of each expert?

5-2 ELEMENTS OF COMPARISON OF ECO-DESIGN GUIDES

We choose four criteria to evaluate eco-design guides with a strong focus on usability, after Lindhal [6]:

- easy to use,
- time-efficient,
- compatible with few input data,
- multi-disciplinary.

Fargnoli et al. [25] also underline a set of six relevant criteria to help designers choosing a suitable tool:

- ability to correctly define the product's performances (a),
- usability (b),
- effectiveness of the method in assessing environmental performances (c),
- ability to provide new solutions (d),
- possibility to perform a correct design management (e),
- ability in fitting into a certain design process (f).

Criteria (b) and (d) are directly addressed in this paper, whereas criteria (a), (c), (e) and (f) seem more difficult to take into account. In our opinion concepts should be more detailed in order to define and assess performances (a), (c). Moreover this case should be integrated to a design process to evaluate (e) and (f).

At the end of the test participants were invited to evaluate the tool they used on a five-point rating scale and add any useful comments. A clarification of this rating system on the criterion "compatibility with few input data" is given below.
Score 1: the tool is not compatible with few input data
Score 2: the tool has a poor compatibility with few input data
Score 3: the tool has a sufficient compatibility with few input data
Score 4: the tool has a good compatibility with few input data
Score 5: the tool has a high compatibility with few input data
The average score of each tool can be seen on Figure 4.
Main differences are observed with regard to multi-disciplinary comprehension and compatibility with few input data. We suggest some explanations in next sub-section.

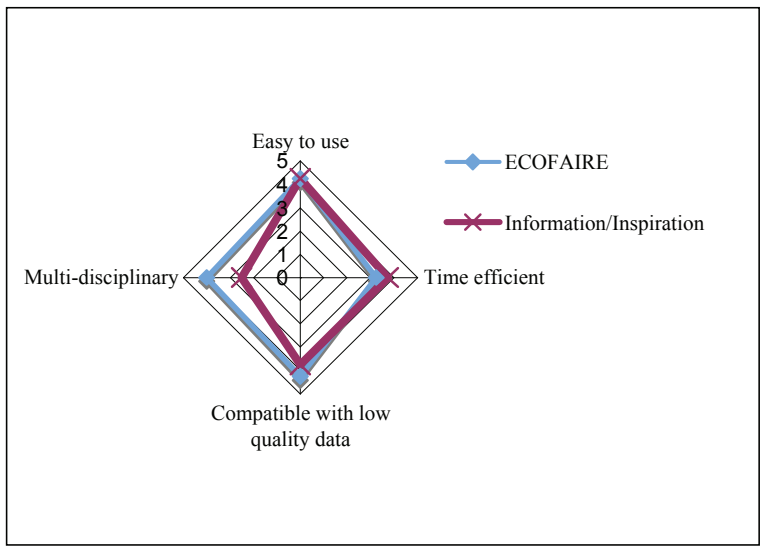

Figure 4. Comparative chart of Information/Inspiration and Ecofaire tools

5-3 DISCUSSION ON THE USE OF ECO-DESIGN GUIDES BY EXPERTS

As far as Ecofaire is concerned, one of the participants describes the tool as "structured, methodological, pragmatic and able to reassure actors in industry". Nevertheless the structure seems difficult to understand at first sight and more comprehensive instructions would be appreciated. Context of use of this guide would preferably be: non-expert groups (in SME for instance) with help of an expert to conduct and enrich discussions on environmental issues. It is added that a previous knowledge in eco-design is needed since many external pieces of information have to be gathered. Another participant notices that Ecofaire is aimed at supporting management of eco-design projects. The sheet summarizing strategies (R2) related to products categories is especially appreciated during solution finding activity.
Information/Inspiration is not considered as a proper tool, but rather as a source of focused information to enhance creativity in early phases of the product design process. The lack of specific method reinforces a random and spontaneous use. Hence there is a risk to ignore useful suggestions due to time constraints or to insufficient knowledge. It is also added that this tool is probably poorly adapted to less creative users such as buyers. From a pragmatic point of view, this tool was not easy to use in a collective context. It was suggested to resort to an interactive table for increased usability.
Thus analyzing points of views of students and experts enables us to build a more accurate vision on strengths and weaknesses of eco-design guides. An adaptation of Table 1 is eventually proposed (Table 5).

Table 4. Comparative framework of two eco-design guides: Ecofaire and Information/Inspiration

Tool / Criteria	Ecofaire	Information/Inspiration
Purpose	Enhance CREATIVITY on eco-design projects	Support MANAGEMENT of eco-design projects
Users	Creative profiles (e.g. industrial designers)	Design teams with an expert team-leader (e.g. eco-design consultant)
Expertise requirement in eco-design	LOW	HIGH (team-leader) LOW (team of non-experts)
Provides strategy	NO	YES
Provides assessment of solutions	NO	YES (simplified assessment)
Provides examples	YES (many examples)	YES (few examples)

6 CONCLUSIONS AND FURTHER WORK

Among the various actors involved in eco-design (inside and outside a company), designers have indeed a key-role to play. Through lack of time, they have to rely on tools which are simple, reliable and moreover compatible with every day work. As discussed in section 2.3, qualitative methods and tools fit within this constrained framework. Industrial designers experience the same time restrictions in their day to day work as engineering designers. The Information/Inspiration web tool was created specifically for industrial designers. Its ability to enhance creativity is underlined by novice and expert designers. The Ecofaire tool targets a wider range of users including industrial designers. Its strength lies in management of eco-design projects. Moreover, it is compliant with the product development process.

From now on these tools should be considered as part of a collective (instead of individual) learning strategy to ensure a durable practice of eco-design in companies. As an input of learning dynamics, qualitative tools can be considered and after that be transformed and combined to more accurate quantitative tools. This point of view is not shared by Reyes though [7]. She suggests that, on the contrary, quantitative outcomes are the most relevant inputs.

At this stage two directions of research can be foreseen. Firstly the contribution of industrial designers to eco-design tools can be more heavily emphasized during the solution finding phase. Creativity of industrial designers has the potential to transform environmental improvement into innovation. Secondly current views on methods and tools have to be challenged in a collective learning perspective. It is no longer useful to create more rigid eco-design tools with few chances of long term achievement. The real challenge lies in the creation of new multi-faceted customized eco-design tools able to support dialogue and to evolve within companies.

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