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ECODESIGN FUNCTION AND FORM. CLASSIFICATION OF ECODESIGN TOOLS ACCORDING TO THEIR FUNCTIONAL ASPECTS

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1. Introduction

This article presents the first general conclusions of a project developed with small and medium-sized enterprises (SMEs) of the Comunidad Valenciana (Valencia Region, Spain)[1]. In the research it was discovered that the few companies which developed projects of Ecodesign did not obtain the expected results (environmental, economical, social, or combinations of these). In some cases Ecodesign did not yield any new products, in other cases the new product was less competitive in other aspects, frequently the demand (for a fully competitive new product) was lower than expected, etc. Nevertheless, in all cases, Ecodesign activities seemed to be correct and the effort should have been enough.

An explanation for this could be as follows: maybe the Ecodesign tools employed were not adequate in function, in form, or in neither. That is to say, Ecodesign may be the proper tool for a problem, just as a screwdriver is adequate for unscrewing, but the applied Ecodesign toolset may not be appropriate for that particular problem, just as a Torx screwdriver is not suitable for a Slotted screw. Furthermore, another function and form should be analyzed: that of the agent that carries out the action, that is to say, the Ecodesign team. This collective function and form analysis of Ecodesign problems, the Ecodesign team and Ecodesign tools altogether has not been found in the consulted literature; most likely because it is an unnaturañ analysis, given that Ecodesign problems and tools do not necessarily have a function or a form. However, as will be shown later, the results provided by this analysis are useful for understanding Ecodesign and planning its development.

2. Function and form of the "Ecodesigner system"

2.1 The producer system of the product or service

A system can be defined as: *A set of two or more elements of whichever type or nature, related to one another and with the environment which contains them. Systems have functional characteristics (function): the activities of the elements, control and regulation elements and a time sequence for the activities. Systems also have structural characteristics (form): its elements, the flow channels between elements (matter, energy or information), the system's limits and the limits of its subsystems* [1].

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According to this definition, the organization which produces the product or service which is to be ecodesigned is a system. As such, it accomplishes a series of functions in a specific way. If “Ecodesigning” is one of those functions, it can be carried out by a particular department (subsystem of the company), be subcontracted (to an external system) or a combination of both. Of course, the system which ecodesigns is linked to the rest of the subsystems in the company and with other external systems (suppliers, clients, government, etc.). “How” this system accomplishes Ecodesign is the “form” with which the system undertakes this function.

2.2 Function and form of the Ecodesigner system

Explaining the function of an Ecodesigning system, i.e. Ecodesign, in a simplified manner is a difficult task. A great deal of bibliography is available about which activities these types of systems should perform, and also about the work sequence that should be followed [2][3][4][5]. According to this literature and for the purpose of this study, the activities of Ecodesign are:

1. *Preparing the Project*. Identification of objectives which are consistent with the company's policy. Project Team. Planning. Preliminary selection of Ecodesign tools. Search for internal and external support. Analysis of success factors, both internal and external.

2. *Identifying Environmental and Social Impacts*. Indicators and Assessment. Environmental Accounting. Definition of goals and environmental specification.

3. *Improvement Ideas*. Proposal of ideas which can resolve the problem. Evaluation and selection of the most feasible ideas, economically, technically and environmentally.

4. *Conceptual Design*. Development of the most feasible ideas into concepts (or embodiment designs). Analysis of Feasibility and selection of solution/s.

5. *Detail Design*. Final design. Production Project. Documentation. Production Support.

6. *Action Plan*. Support in the product's launch. Support in communication activities. Promotion and Sales. Environmental Reports.

7. *Evaluation of the Process*. Proposals for the improvement of the functions and the systems which have taken part. Preparing the next Ecodesign project.

Finally, the form of the Ecodesigner’s system, according to the definition given before, is determined by:

- Its elements (members of the team) and their knowledge and experience in matters of product development, production, environment and other disciplines.
- Its communication channels with the rest of the subsystems of the company and with external systems.
- Its available resources: software, hardware, finance, databases, etc.

It is important to remark that Ecodesign tools have to be adequate not only to function (Ecodesign activities) but also to the particular characteristics of the design team (the system's form).

3. Determination of the Ecodesign problem's form

3. 1 Does an Ecodesign problem have function and form?

In this article, the definition of the design (or Ecodesign) problem given in [1] will be used. This text states that a design problem is “an undesirable initial state, a desirable goal and a set of obstacles that prevent a transformation from the undesirable initial state to a desirable goal at a particular point in time”.

Therefore, according to this, and to the definition of “system” given, a problem is not a system in an orthodox sense. However, the problem is solved by an Ecodesign system that makes use of tools with systemic characteristics, as will be further explained. “What?” and “How?” are the most usual questions in order to analyze a system's function and form. Thus, asking the questions “What is the problem?” or “What is the nature of the problem (how)?” will lead to interesting selection criteria for tools.

3.2 Functional and formal aspects of an Ecodesign problem.

Consequently, for the diverse Ecodesign problems defined in the investigation, the question asked to the agents involved was: “What was the Ecodesign problem?” and “What was the nature of the Ecodesign problem (how)?”. As to the first question, diverse answers were obtained, which allow the definition of the following criteria in reference to the problem's function:

- Goal to achieve: product to improve, type of improvement to introduce, target of the improvement.
- Phase of the Life Cycle that will improve, if there is any of special importance.

The answers to the question “What was the nature of the Ecodesign problem (how)?” determined the definition of the following criteria about the problem's form:

- Estimated difficulty of the problem. Obstacles to the solution.
- Industrial sector in which the problem appears.
- Level of knowledge about the problem. Level of knowledge about the desirable state. Level of detail of the design’s initial specifications.
- Estimated resources necessary to solve the problem: economical, technical and of information.
- Deadlines. Available time to find a solution.

3.3 Levels of Improvement in an Ecodesign problem.

Measuring “how much” a product/service should improve has generally been found to be a difficult task. This can lead to the definition of many levels of improvement or “ambition” in the identification of the Ecodesign goal. From now on, this article will refer to “level of improvement” as a greater or smaller difference between an ideal situation and the one desired for the product or service. This ideal situation will be defined as “Ecoinnovation”, and will be explained further on. Therefore, the level of improvement is a functional attribute of the Ecodesign problem and should be compared to the functional attributes of the Ecodesign tools.

The bibliography reviewed and the analyzed Ecodesign experiences reveal that there has not been enough study about the relationship between the “level of improvement” of the Ecodesign problem and the usefulness of the Ecodesign tools for that problem. In fact, most publications consulted seem to assume an independence between the process of improvement and the level of improvement intended (ie the same activities are recommended with the same tools for different problems).

For an analysis of the level of improvement's influence in the selection of Ecodesign tools, 4 levels are proposed. Several factors are to be considered in order to determine the level of improvement in the objectives of an Ecodesign problem:

- Importance of the modification of the environmental characteristics of the product
- Consideration of the complete Life Cycle.
- Existence of goals related to Continuous Quality Improvement.
- Synergy with the objectives of other functions of the company.
- Existence of goals related to the establishment of cooperation with stakeholders.

Level 1: Adaptation. Design changes in order to make the product/service accomplish a specific requirement: environmental law, client specifications, etc.

The most elementary level of improvement is defined as one which intends only to adhere to specific external constraints. Therefore, it is a problem in which the environmental characteristics vary only in so far as they are obliged to, and only the required stages of the product's Life Cycle are analyzed. A substantial change in the product is generally not accepted. No additional goals related to continuous improvement are determined. No programmes of cooperation with stakeholders are intended. Mostly, the solution to these types of problems is limited to, for example, changing a particular production activity, or changing a particular raw material or component.

Level 2: Redesign. Design of a product with environmental specifications.

The next level corresponds to an Ecodesign action, whether introduced by the organization or not, which involves a change in the initial design specifications. Based on an environmental diagnosis, new goals, which are not especially ambitious, related to environmental impacts of the product or service, are introduced. This level seeks the product's feasibility in a safe way, at the expense of sacrificing possible economical or ecological benefits. Goals are usually limited to particular stages of the Life Cycle which have a greater environmental impact, or that are most problematic to the company. Normally, goals related to continuous improvement are established, although not precisely defined. It is not a well integrated or supported activity, thus it usually neither has synergies with the objectives of other functions of the company, nor vice versa. Nor are there any defined goals to establish programmes of cooperation with stakeholders.

Level 3: Ecodesign. Improvement of the product/service applying Ecodesign according to the most popular proposals found in consulted bibliography.

A company Ecodesigns if from the design approach, strict specifications are established in order to respect the environment in all stages of the Life Cycle. To carry out this new design, it is necessary to negotiate agreements among the stakeholders (suppliers, distributors, clients, etc.). It is also necessary to integrate this function with the rest of the company's functions, and also to introduce environmental management of the product's Life Cycle. Specific continuous improvement goals are also introduced, leading to a continuous revision of the design specifications and, consequently, to the product's redesign.

Level 4: Ecoinnovation. Ideal design improvement which allows the establishment of profound changes in the market.

Several authors defend the argument that "conventional" Ecodesign as a tool is not effective enough tool for the industry to contribute to Sustainable Development [4][5]. According to these authors, for the tool to accomplish its purpose, very ambitious objectives must be established: dematerialization of the product (transformation into a service), a technological revolution (such as the invention of the transistor, as an improvement of the vacuum tube), or the use of renewable sources of energy (like solar energy). These objectives can only be achieved by means of innovations which go much further than the mere optimization of existing products.

In practice, it is utopian to think that one company alone could solve the problems of Ecodesign as stated here, especially when the solution tends to require a change in the production system (and business concept) for the organization. However, these ecoinnovations can be carried out and be a resounding success if the company manages to change its traditional functions and forms. Thus, the company that poses its Ecodesign problems at this level must have its functions perfectly interlinked and have competitive, common environmental goals. Moreover, new links with stakeholders with the same environmental goals must be initiated. Ecoinnovation will not be the end of the road, but the beginning of a new business that will have to improve continuously in order to remain a leader in its sector.

4. Determining the function and form of Ecodesign tools.

4.1 Is an Ecodesign tool a system?

Various authors have already given thought to the systemic aspects of design tools (ie [6][1]). In these publications, qualities in design methods and techniques are identified which make them similar to systems, or at least, similar to their theoretical definition. In a strict sense, design methods and techniques are not orthodox "systems". Nevertheless, since the publication of Araujo and Duffy [6], engineering tools (and similarly Ecodesign tools) can be defined as the proposal of cognitive tasks structured in such a way as to help directly in the establishment of an engineering activity and/or its peformance, defining clearly who should carry it out, and with which instruments it should be done (PC, pencil and paper, data base, internet, etc.). Therefore, *LCA*, *Design for Recycling*, *Environmental Accountability*, *Green Marketing*, etc, are "structured knowledge activity proposals" that help to apply Ecodesign and can consequently be used as "Ecodesign tools".

It is interesting that naming a design method as a "tool" implies identifying the analogy with conventional tools, which are systems that have a function and a form. Hence, characteristics can be found in Ecodesign tools that are analogous to function and form in systems.

4.2 Function and form in Ecodesign tools

Bearing in mind what we have said before, function and form in an Ecodesign tool could be defined as:

- Function: the objective of a tool, what the tool does. In this case, it would be the temporal sequence of activities and the control and regulation activities.
- Form: the resources the tool uses to perform, how the tool performs. In this case it would be the required information, data process techniques (matrixes, equations, drawings and others), the way results are shown, the industrial sectors the tool is intended for, etc.

As we have done with the Ecodesign problem, many functional and formal aspects can be defined for Ecodesign tools. By these means, a proper set of tools can be selected in accordance with a particular Ecodesign problem and a specific Ecodesigner system. These functional and formal aspects are:

- Functional Criteria:
  - The objective of the tool. The type of problem it solves, or the stage in the Ecodesign process it helps attain.
  - The Life Cycle stages the tool mainly focuses on.
  - The problem improvement level the tool is intended to achieve.
  - The methodology, the activities for the appliance of the tool.
- Form Criteria:
  - Resources necessary to make use of the tool: Software, data, personnel skills, time, etc.
  - The difficulty of employing the tool. With this criterion, the intrinsic complexity of the tool's procedures, calculations and estimations are evaluated.
  - Techniques of the information process: graphics, mathematical equations, matrixes and others.
  - The typologies of industrial products or services for which the tool can be applied.

4.3 Classification of Ecodesign tools

The difference between Ecodesign and Design *as-usual* could be said to reside in the importance given to the environmental features of the product. Therefore, in recent years, a number of tools have been developed in order to define, process and fulfill environmental specifications throughout the product development process. These tools are named herein *Ecodesign tools*. Classifications of design tools have already been done both in the general *Design* field [9][10][6] and in the *Ecodesign* field [4][7][8]. All these classifications have been analyzed in the investigation carried out.

From the above mentioned publications and a new bibliographical search, more than 250 references have been analyzed to collect as many Ecodesign tools as possible. It was found that not all the references presented Ecodesign tools. In fact, a number of references present Ecodesign in practice (or examples of Ecodesign applications), LCA in practice, etc. From all the references, 65 Ecodesign tools were defined and assessed (for a complete discussion on the results see [11]). On Table 1, the tools analyzed are listed.

With the criteria put forward, the 65 Ecodesign tools were classified. Table 2 shows a summary of this sorting. The criterion "Design stage" has been regarded as the steps of the Ecodesign process that the tool helps to achieve. For the criterion "Life Cycle stages", five have been considered: "Raw Material and Components Elaboration", "Production", "Distribution", "Use and Maintenance" and "Disposal". Lastly, the levels of improvement of the problem to be solved have also been considered.

Table 1. List of Ecodesign tools analyzed

ANALYZED TOOLS	
1. Environmental Management System (EMS) [12]	33. Decision Aid Techniques based on multi-attribute

ANALYZED TOOLS

2. Environmental Market Prospective [13]
3. Forecast and Back-Cast [14]
4. Sustainability Indexes [64]
5. Ecoindicators [15]
6. Life Cycle Costing (LCC). Environmental Accounting [16]
7. Willingness To Pay Assessment (WTPA) [16]
8. MET Matrix (Matter, Energy y Toxicity) [17]
9. Design for Environment Matrix System (DfE-MS) [18]
10. Environmental Risk Evaluation ERE – Toolkit [19]
11. Environmental Auditing [20]
12. Checklists [21]
13. Sistema de Ayuda a la Evaluación de la Gestión Medioambiental (SAEGEMA) [22]
14. Ecodesign Product Investigation, Learning and Optimization Tool (ECOPILOT) [23]
15. Life Cycle Assessment (LCA). Series ISO 14040 [24]
16. Economic Input – Output Life Cycle Assessment (EIO–LCA) Model [25]
17. Environmental Policy Strategies (EPS) [26]
18. Life Cycle Data Acquisition (LCDA) [27]
19. Bibling [28]
20. Green Concurrent Engineering [29]
21. Environmental SWOT [30]
22. Good Practice Guide on Pollution Prevention (GPG-P2) [31]
23. Pollution Prevention Environmental Design Guide for Engineers (P2-EDGE)[32]
24. Cleaner Technology Substitutes Assessment (CTSA) [33]
25. Life Cycle Design manual [21]
26. Spider web Diagrams [34]
27. Quality and Environment Function Deployment (QEFD), Green Quality Function Deployment (Green QFD) [35]
28. Value and Environmental Impact Analysis [36]
29. Utility Functions (UF) [37]
30. Method – Mix Procedure [38]
31. On-line tutor-facilitated Ecodesign learning tools [39]
32. Life Cycle Planning (LCP)[40]

techniques [37]

34. Distributed Object-based Modelling and Evaluation (DOME) [41]
35. Common Object Request Broker Architecture (CORBA) [41]
36. Life Cycle Modeler [42]
37. CAD Modules that include environmental aspects [9]
38. ISO 14062 [43]
39. Design for Disassembly (DfD) [9]
40. Design for Modularity / Variety (DfMo) [44]
41. Design for Recycling (DfRc) [45]
42. Design for Remanufacturing (DfR) [46]
43. Design for Recovery (DfRe) [47]
44. Design for X (DfX) [9]
45. End-of-Life Design Advisor (ELDA) [48]
46. Environmental Value Chain Assessment (EVCA) [48]
47. Expert System for Engineering Sustainable Development in Product-Process Design (ESESPD) [49]
48. Ecodesign Tool for industrial designers [50]
49. Ecological Failures Modes and Effects Analysis (Eco-FMEA) [51]
50. Materials Ecoevaluator [52]
51. Petri nets evaluation methods [9]
52. ReStar [53]
53. Ecological Classification and Risk Analysis (ECRA) [19]
54. Technical Product Analysis (TPA) [54]
55. LINKER [55]
56. Product Ideas Tree (PIT) Diagram [56]
57. Selection of Strategic Environmental Challenges (STRETCH) Methodology from Phillips [57]
58. Product Lifecycle Extension Technique/Process Selection (PLETS) [58]
59. Product Business Model [59]
60. Environmental Evaluation Methods [60]
61. Eco-Portfolio [61]
62. Extension of Useful Life (EUL) [47]
63. Green Marketing [4]
64. ISO 14020 series [62]
65. ISO 14030 series [63]

Table 2. Ecodesign tools classification

FUNCTIONAL CRITERION	TOOL						
DESIGN STAGE	*Preparing the Project*	*Environmental Impacts*	*Improvement Ideas*	*Conceptual Design*	*Detail Design*	*Action Plan*	*Evaluation of the Process*
	1,2,3,4,5,6,7,25,30,31,63, 64	8,9,10,11,12,13,14,15,16, 17,18,19,20,21,22,23,24,27,28,29,45,46,54, 61	14,22,23,25,26,27,28,29,30,31,32,33,38,45,46,51,57	31,34,35,36,37,38,39,40,41,42,43,44,47,48,52,53,55	34,35,36,37,38,39,40,41,42,43,44,47,50,52,53,55,58	1,20,25,36,63,64,65	1,4,5,28,29,59,62,65

FUNCTIONAL CRITERION	TOOL					
LIFE CYCLE STAGE	*R.M and Components Elaboration*	*Production*	*Distribution*	*Use and Maintenance*	*Disposal*	*All*
	11,16,22,37,47,50	6,11,13,16,22,24,25,27,28,29,34,37,42,44,47,50,51,55		18,28,29,32,40,49,58,64,65	22,32,39,40,41,42,43,44,45,46,51,52,55,58,59,61,62	1,2,3,4,5,6,7,8,10,12,14,15,16,17,19,20,21,23,25,26,27,28,30,31,33,34,35,36,38,48,53,54,56,57,60,63,64,65

FUNCTIONAL CRITERION	TOOL			
PROBLEM LEVEL	*ECOINNOVATION*	*ECODESIGN*	*RE-DESIGN*	*ADAPTATION*
	2,3,4,6,7,20,32,36,57	5,6,7,14,15,17,18,19,26,27,28,29,34,35,37,38,39, 40,41,42,43,44,45,48,51,53,54,55,56,59,60,61,62	9,10,12,22,23,24,26,30, 31,33,47,49,50,52,58,63, 65	1,11,12,13,22,23,24

5. Discussion. Availability of tools according to functional aspects.

Hereafter, the availability of Ecodesign tools is analyzed, that is to say, for each type of Ecodesign problem, the available tools for each Ecodesign activity will be shown and, subsequently, the existing tools for the Life Cycle stages considered in the Ecodesign problem.

5.1 Discussion according to Ecodesign activities.

Figure 1 shows the result of this analysis for Ecodesign activities. In this figure, four web diagrams have been included. These contain 7 axes, one for each type of design activity – which summarizes section 0 – and each one of them divided into 5 categories that measure the availability of adequate tools for each activity. None of the categories in which the offer of satisfactory tools has been sorted must be understood as an absolute judgment: each is based on generic opinions based on research on other classifications already mentioned. Consequently, category 0, in the centre, means an "absence" of tools, category 1 indicates that "few" tools have been found, category 2 indicates "some", category 3 "enough", and category 4 implies "plenty" of tools.

Tools for Level 1 problems: "Adaptation".

For problems which seek only an adaptation to one or more environmental requirements, without the objective of continuous improvement, very few tools exist that are not specific to "Identification of Environmental Impacts" and "Detail Design" (see figure 1). This is mainly because:

- In these problems, a principle goal is to determine the environmental aspects in which improvement is needed only in order to fulfill the imposed requirements.
- The solutions to the problem are well known, tested and available in the market.
- Most authors who develop Ecodesign tools usually consider the company in an advanced state of commitment with the environment and, therefore, consider more ambitious Ecodesign goals.

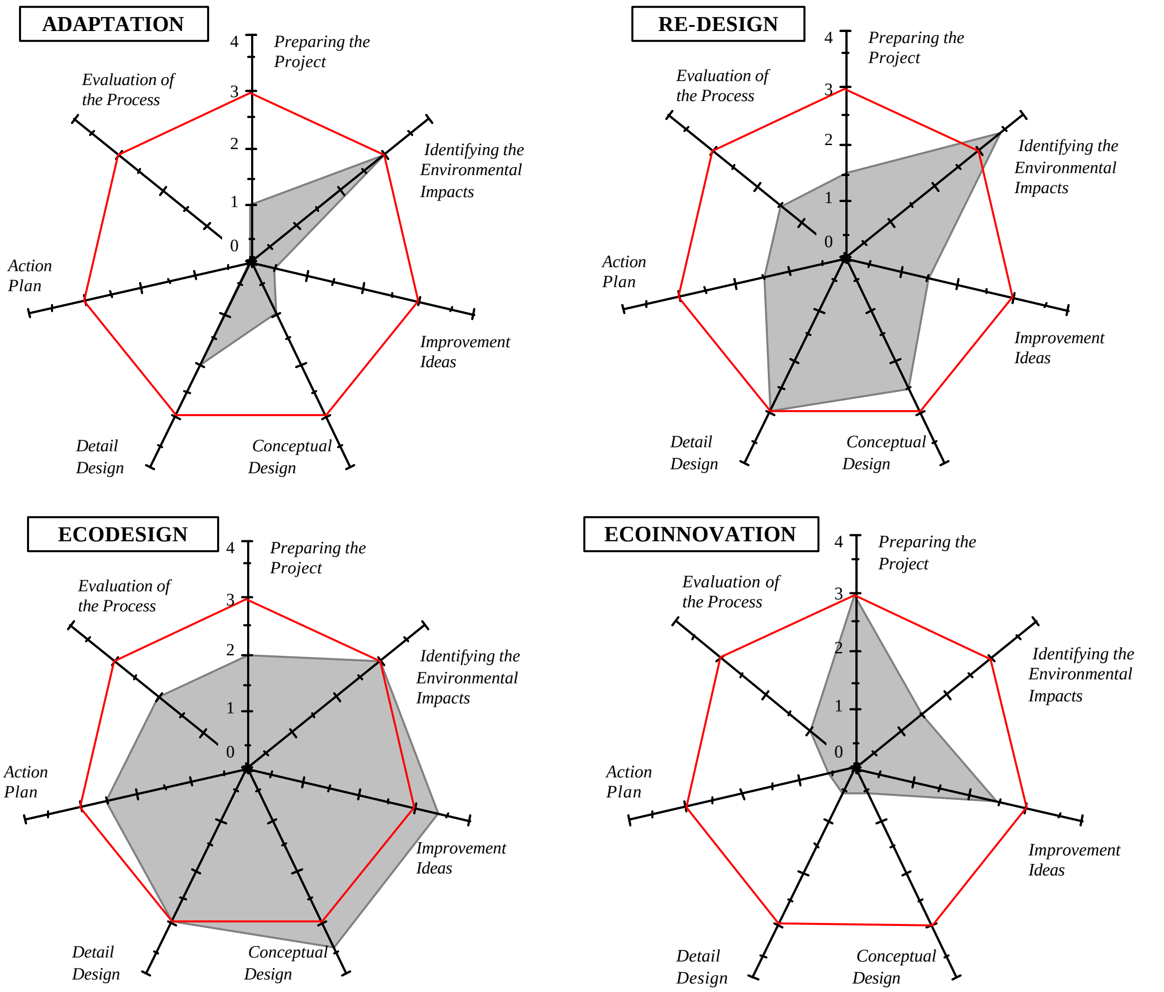

Figure 1. Availability of adequate Ecodesign tools for each of the levels of improvement: “Adaptation”, “Redesign”, “Ecodesign” and “Ecoinnovation”.

Tools for Level 2 problems: “Redesign with environmental specifications”.

When the product redesign is not only limited to the adaptation of environmental requirements, but also aspires to substantially improve, the design team will be able to find a larger number of tools. Other facts are also observed:

- The target number of tools in the proposal of “Improvement Ideas” and “Conceptual Design” increase.
- Simple tools have been found for the “Elaboration of the Action Plan” and “Evaluation of the Ecodesign Process”
- Several so-called Ecodesign tools, because of their scope and focus, could be denominated Eco-redesign

Tools for Level 3 problems: "Ecodesign".

To solve an Ecodesign problem, a great offer of tools has been found in all of the activities of the Ecodesign function. The reason of this is that most publications consulted were from authors and institutions who promote an Ecodesigner system which in fact defines and carries out Ecodesigns. Furthermore, in a summarized manner, the following conclusions can be drawn:

- For particular industrial sectors, there is an excess of tools intended for the proposal of "Improvement Ideas" and "Conceptual Design". This is the case of mechanical, electrical and electronic components, for example.
- It seems that not enough attention is drawn to those tools more directed towards Ecodesign management – activities of "Preparation of the Project", "Elaboration of an Action Plan" or "Evaluation of the Process". This is caused by the fact that, on the one hand, they are more conventional activities and well-known tools can be employed, on the other hand, Ecodesign is a young discipline, and hence, management problems emerged are only starting to be studied now. Because of this, tools developed for this purpose are not yet published

Tools for Level 4 problems: "Ecoinnovation".

Classifying the appropiate tools for Ecoinnovation is a complex task. On the one hand, innovation is not an easy activity to convert intro procedures, thus making it difficult to assign tools to innovation tasks. On the other hand, there are few examples of Ecoinnovation to study. In any case, for this ideal level many tools have been found for the tasks of "Preparation of the Project" and the proposal of "Improvement Ideas".

5.2 Discussion according to the product/service Life Cycle stages.

The functional aspects related to the Life Cycle stage in which the tool helps the product improve must also be evaluated. To illustrate the results, figure 2, analog to figure 1, was elaborated. In this figure, the diagrams have 5 axes, one for each stage of the product's Life Cycle. Each axis, as in figure 1, is divided into 5 categories which measure the availability of suitable tools for each Life Cycle stage.

A general conclusion can be drawn: the "Distribution" stage is the Life Cycle's least studied stage. This is consistent with the fact that most end-user industrial products (household appliances, furniture, etc.) do not show a serious environmental impact in their distribution stage, and these products are currently drawing most attention. Nevertheless, distribution causes a considerable environmental impact for products like components and parts of these end-user products, or for simple products with view to exportation such as flowers, some foods, some materials, etc.

Tools for Level 1 problems: "Adaptation".

Even nowadays most of the responsibility of the production system is limited to the Life Cycle stages of "Production" and "Raw Material and Component Elaboration" – since they select the raw materials and components. The reason for this is that the economic cycle is usually integrated in these stages of the physical Life Cycle. Therefore, it is not surprising that most tools are orientated towards a reduction of the environmental impact in the "Production" stage and, to a lesser extent, in the "Raw Material and Components Elaboration" (see figure 2). In some specific cases (i.e. electrical and electronic equipment) tools have been developed in order to specifically reduce the environmental impact in the "Disposal" stage.

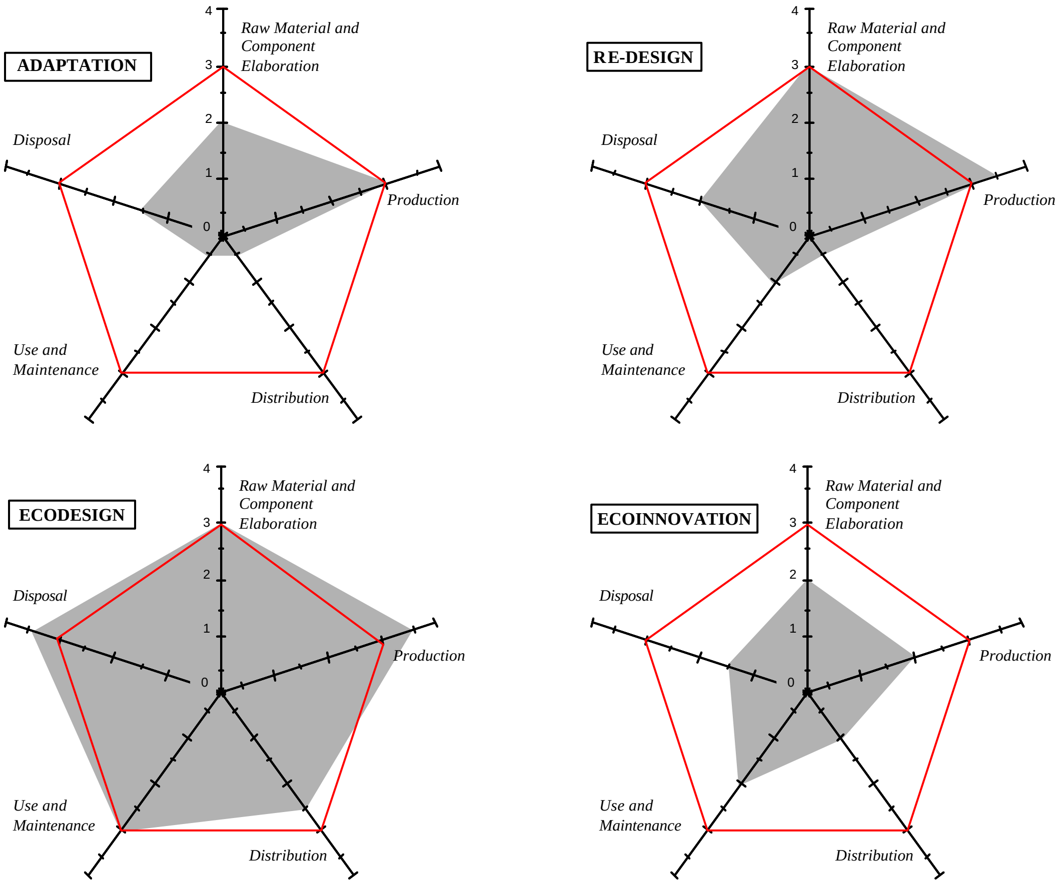

Figure 2. Availability of adequate Ecodesign tools for the reduction of environmental impact in different Life Cycle stages for each of the levels of improvement: “Adaptation”, “Redesign”, “Ecodesign” and “Ecoinnovation”.

Tools for Level 2 problems: “Redesign with environmental specificatons”.

It can be seen from figure 2 that the range of tools available for this level is quite similar to those on the previous one. Subsequently, the offer of tools for problems of this level will be more extended, but similar in its objectives. Moreover, it has been observed that, in most cases, problems at this level are not stated as an “improvement of the product”, but more likely as an “improvement of the company”. Thus, redesigns are focused on a reduction of the impacts on those stages which have a more direct influence in the company’s turnover, that is to say, the “Raw Material Elaboration” stage and, especially, the “Production” stage.

Tools for Level 3 problems: “Ecodesign”.

Once again, the range of tools is plentiful and complete for this level of problems. By definition, Ecodesign implies considering all stages in the physical Life Cycle. Besides, the abundance of tools for the stages of “Production”, “Disposal” and “Use” are logical, since these are generally – excluding some exceptions – the most environmentally harmful stages of the Life Cycle in end-user products.

Tools for Level 4 problems: “Ecoinnovation”.

As for the tools intended for Ecoinnovation, many have been found to be appropriate for the “Use and Maintenance” stages. It is of interest to note that Ecoinnovation takes into consideration the service that each product carries out, thus proposing a change in Ecodesign function from a more classical “reducing environmental impact of a product throughout its Life Cycle” to a new “provide with the satisfaction given by the service, without environmental harm”.

6. Conclusion

Throughout this paper, Ecodesign has been analyzed distinguishing formal and functional aspects of the Ecodesign problem, the Ecodesign team and the Ecodesign tools used. It has been observed that Ecodesign tools differ in functional aspects like the design stage in which they have relevance, the level of improvement they can achieve or the Life Cycle stage they can improve. Ecodesign tools must therefore be selected for these functional aspects to fit in with those of the Ecodesign problem or the Ecodesigner system.

From the analysis of the availability of tools for different Ecodesign problems, the conclusion drawn is that enough tools are available for problems of the “Ecodesign” level. Moreover, another conclusion would be the lack of tools for Ecoinnovation, for those Ecodesign problems that are more ambitious. From the Ecodesign activities study, the stages with most tools turned out to be: “Identification of Environmental Impacts”, proposal of “Improvement Ideas” and “Conceptual Design”. The stages about “Preparation of the Project”, “Elaboration of an Action Plan” and “Evaluation of the Process” have been found to have significantly fewer publications with proposals of tools.

As regards Life Cycle stages, the stage least taken into consideration was that of “Distribution”. This is certainly a result of the lack of awareness about the importance of the environmental impact of distribution for a certain range of products, as well as of the deficiency of external pressure from the administration, public opinion or clients.

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