RESEARCHING THE INFLUENCE OF ENVIRONMENTAL INFORMATION ON THE IDEATION PROCESS AND RESULTS

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Abstract

Most Design for Sustainability methodologies include an initial stage of environmental assessment. The purpose is to inform designers on what environmental problems to address, or which parts constitute a higher environmental burden. However, recent studies show that being exposed to a model of a product has a negative impact on creativity, both as to the variety and the number of ideas generated. This could limit ecodesign to mere incremental improvements and hinder radical design, requisite for sustainable development. This paper presents the foundations for the project “Effects of environmental information and models in the ideation and design process”. It includes the first results, and the overall approach in the project. The goal is to guide on the information and training of designers to ecodesign maximizing sustainability of their proposals. It includes the consideration of how the existence of different types of environmental information influences the ideation process, and how the results are affected as to the creativity and sustainability of the proposed concepts.

***Keywords**: Creativity, Design for Sustainability, Ecodesign, Radical Innovation, Ideation.*

Resumen

La mayoría de metodologías de diseño para la sostenibilidad se caracterizan por incluir una etapa previa de evaluación ambiental, para informar al diseñador sobre qué problemas ambientales resolver o qué partes son más dañinas para el medio ambiente. No obstante, estudios recientes muestran que la exposición a un modelo de un producto impacta negativamente la creatividad, tanto en referencia a la variedad de las respuestas como a su número. Esto puede limitar el ecodiseño a meros aportes incrementales, y dificultar la innovación radical necesaria para alcanzar el desarrollo sostenible. Esta comunicación presenta las bases del proyecto “Efectos de la información y los modelos ambientales en el proceso de ideación y diseño”, con los primeros resultados y el planteamiento global del proyecto. El objetivo del proyecto es generar directrices sobre cómo informar y capacitar a los diseñadores para realizar ecodiseño maximizando la sostenibilidad de sus propuestas. Incluye la consideración de cómo distintos tipos de información ambiental afectan al proceso de ideación; y a los resultados que de él se desprenden, la creatividad de las propuestas y los niveles de sostenibilidad alcanzados.

***Palabras clave:** Creatividad, Diseño para la Sostenibilidad, Ecodiseño, Innovación radical, Ideación*

1. Introduction

Sustainable development appears more and more in the public discourse, defining targets at a political level and finding its way into the media. Governments started acknowledging its relevance already decades ago, and in the last years markets have manifested an interest as well in purchasing products that claim to be more sustainable, and that are manufactured by companies that claim as well to be more sustainable. This has clearly raised an interest from industry as a whole. Today it is no longer a wise action to disregard aspects such as electric consumption, CO2 emissions or overpackaging. But it is no small challenge that we face: for a genuinely sustainable development in industry we require radical innovation, with resource efficiencies 10 to 20 times better that the current situation (von Weizäcker et al., 1997).

This context has made of sustainability a key factor in the design process (Baumann et al., 2002, Poole y Simon, 1997). This has received many names depending on the industry and countries where it has appeared: design for sustainability, design for the environment, ecodesign, etc. (Waage, 2007, Karlsson y Luttropp, 2006). The scientific community has developed a great number of design methodologies, methods and techniques that aim at developing more sustainable products. Gómez-Navarro et al. (2005) count up to 60 categories of methods, some of them with different implementations. However, this plethora of tools has found very little acceptance among professional designers (Baumann et al., 2002, Mathieux et al., 2001). Since the first robust proposals in the 90's, many of the new tools have been discarded for being costly, complex, or unnecessarily elaborate.

Albeit this variety, there seems to be some level of disappointment at practical level, when it comes to the application of these methodologies. Many of the results in applying such methodologies reach only small incremental improvements (Carillo-Hermosilla et al., 2010). Approaches that aim at improving ecoefficiency in products (Park y Tahara, 2008, Lehni, 2000) optimize the way in which products behave, but very rarely grant the team with ideas for radical innovation. On the other hand, to reach sustainability it is necessary to attain considerable changes in society, technology and institutions (Tukker y Butter, 2007, Pujari, 2006). It would seem that the current model for design is insufficient both for practice and for society.

There is hence an apparent conflict between the need for information and the need for independence, which could be stated and the ecodesign paradox. One possible cause of this is that literature on ecodesign majorly comes from the disciplines of mechanical and environmental engineering, rather than from design. Studying the design process from the perspective of industrial designers, or even that of psychologists, is bound to render a completely different result. Furthermore, it is in general terms complex to study how different variables affect the creative process, due to the inherent difficulty in defining such a process and its characteristics (Collado-Ruzi & Ostad-Ahmad-Ghorabi, 2010b). That is a possible explanation of why previous research has limited itself to analyzing the product and not how it is generated by the people involved. The research presented in this paper aims at developing these lines, with the purpose of generating scientifically grounded ecodesign proposals that will suit the creative problem-solving process that is designing.

2. State of the art

A common element of most methodologies – and the focus of most methods – is a preliminary environmental assessment of the product, during its development or even prior to it. Among the most widespread of those methodologies, the only difference with traditional systematic product design and development methodologies is a preliminary environmental assessment phase. In this phase, environmental impacts of the product, concept or reference product are studied, depending on availability. This assessment is commonly done through Life Cycle Assessment (LCA) or methods based in the same (Jeswiet y Hauschild,

2005, Nielsen y Wenzel, 2002, Erzner et al., 2001). In a lower number of cases, the assessment is done subjectively based on expert judgment, or on the previous experience of the design team (Brezet y van Hemel, 2002). However, LCA (ISO, 2006) or streamlined LCA are the most popular tools when performing this assessment (Millet et al., 2007). However, its suitability has been argued by a number of authors (Millet et al., 2007, Sousa y Wallace, 2006, Erzner y Birkhofer, 2003). The main reasons for this are:

- Uncertainty in the results.
- Complexity of the models used.
- Complexity of the task itself.
- Time requirements.
- Information requirements.

The latter strict requirements on information constitute one of LCA's greatest barriers, since by the time information is available, the potential for redesign are considerably limited. Cost for changes is high, and many decisions are compromised by the changes needed in other parts of the product, that may already be far in the development process. Lindahl (2005) calls this phenomenon the design paradox. Most authors agree in including environmental considerations as early as possible in the design process (Ostad-Ahmad-Ghorabi, 2010, Karlsson y Luttropp, 2006, Lagerstedt et al., 2003). Through this, designers have more potential for influencing the design, but a new problem appears: they are forced to select a reference model out of previous versions of the product, competitor's products or gross estimations of the technical characteristics – in some cases very specific and detailed – of the product.

Many new ecodesigned products, and especially those that are particularly innovative, constitute a change in the order of magnitude of the environmental impacts they make. Such sort of products tend to spawn not from structured systematic processes, but rather from more spontaneous, chaotic or unstructured processes than those described in ecodesign methodologies. Collado-Ruiz and Ostad-Ahmad-Ghorabi (2010a) proved that the existence of great amounts of environmental information (and most particularly those coming from an LCA) can provoke the effect known in cognitive psychology as fixation. In general, fixation happens when a person is pre-conditioned in a creative task by being shown an example of the solution, or information that guides them into particular subsets of solutions. The brain interprets those as constraints or success strategies, and has difficulties exploring more innovative concepts – let alone generating them. This phenomenon is not new, and it has been proven in other arenas that having an example of the solution to a problem negatively affects the variety and number of generated ideas (Tseng et al., 2008, Purcell y Gero, 1996) and there is a perceivable reduction in the number of what could be seen as "good ideas" (Rietzschel et al., 2007). In more general terms, the aforementioned studies show that the existence of a reference model – such as the one included in preliminary LCA studies – is a statistically limiting factor for innovation.

The case of ecodesign seems thus rather ironic: the methodological approach that literature proposes limits the potential of designers to be creative (Collado-Ruiz and Ostad-Ahmad-Ghorabi, 2010a and b). Encouraging creativity seems to be an accepted must in design in general, to ensure divergent thinking – and most particularly in some parts of the design process, such as the early stages. However, ecodesign approaches seems to recommend a practice that considerably limits it, and there seems to be a general agreement on bringing it earlier and earlier in the process… where such creativity is most critical! It is important to mention that this information is not there without a purpose: with the current knowledge levels and training in ecodesign, it seems like this approach is the only one that can point out the relevant questions and aspects to consider. Otherwise, it seems impossible to know what

aspects are most critical for the environment, what problematics need the focus of designers' creativity, and what problems need to be solved by the company to become more sustainable.

3. Methodological approach

The present paper presents the research approach and preliminary findings in resolving the ecodesign paradox. It should be possible to provide designers with information about environmental aspects and concerns when and where relevant, without fixating – limiting the innovation potential of – such solutions, and with as small a time investment as possible. The goal of the project is defined as the "generation of guidelines about how to inform and train designers in doing ecodesign maximizing sustainability of the outcomes". This is to be carried out with an understanding not only of the content, but on parameters of the information that is supplied. Information is here understood as any form of written or oral compilation of data that the designers gather or receive to complement lack of knowledge on a particular topic or circumstance, as well as results thereof.

For that matter it is critical at first to understand the effects of such environmental information, and the effects of different sorts of environmental information) in the ideation process.

The following secondary goals are defined as well:

- To understand the nature of environmental information, and the parameters that can affect the design process.
- To understand how information coming from an LCA can affect in the ideation process.
- To understand how information coming from an LCA evolves along the ideation and discussion processes in which a team is involved.
- To understand how the existence of a model (embedded in an LCA) affects the ideation process.
- To understand how information coming from an LCA affects the final results that is attained after the ideation process (as to its sustainability).
- To be capable of assessing different information alternative in regards to their influence in the ecodesign process.
- To test up to which point the models used in an LCA can be eliminated, leaving only the relevant information for design.
- To understand how designers react in front of information of different nature (fuzzy, unreliable, or with gaps).
- To generate a proposal of environmental information (be it in the form of a document, an informing process, or an educative proposal) so that designers maximize their effectiveness and minimize the negative effects on their creativity.
- To communicate the proposal on how design teams should be informed and prepared to the design community, the scientific community and the business field.

The way to do so is to study the ideation process and the products created by it. For that, it is important to observe this process and to define specific experiments for its understanding. The approach here proposed has two very differentiated stages: a first one that is completely descriptive, with different sorts of information, and a second one with an improved proposal based on the conclusions of this first study. In parallel, coordination, promotion, and

communication activities will be performed, with a stronger emphasis of the latter in the final stages of the proposed research.

The first stage, currently in development at the moment of writing this research paper, starts with the necessary study to build a competent experiment that shows what parameters of information are to be further developed. A model is to be generated, with such relevant parameters on environmental information. An environmental assessment of a reference product will be performed, and configured according to that model. Different alternatives – to measure the impact of information parameters – will be produced, to be given to different groups in the experiment. This experiment will be hereon called Experiment 1, and will consist of approximately 120 designers – mostly from companies or freelance – generating product concepts out of a description of the brief and the parametrized information. That would mean that each set of designers in the experiment receives environmental information on the product, but in very different ways. Examples of that modeling could be an LCA study directly, could be a set of recommendations, or could be a cropped out version of the LCA report in which only parts of the information are shown. The experiment includes at least a group with the complete set of information, and a control group that has no information, thus reacting freely to the brief. The latter is taken as representative of maximum freedom and creativity for the purpose of this study. The rest of the groups will depend on the parameters studied and the results of the state of the art and the panel discussions in the team and with experts.

The different sessions are to be recorded in video, sound and document forms, and each of the sessions is to be analyzed. Most particularly, the final results and the process that designers follow, as well as how information evolves, will be the focus of this study. They will be assessed as to their novelty, their technical and market feasibility, and their sustainability potential.

The second stage in the research project proposed here consists of elaborating, out of the previous descriptive study, a prescriptive proposal on how designers' performance can be improved, with the double purpose of avoiding creative limitations and maximizing sustainability of the outcome. A second round of experiments will be carried out, testing this approach. This second round will be called Experiment 2, with 50 participants taking part. Not only the amount and nature of information will be assessed, but also when and how it is delivered, and how easy or difficult it is to process it. Out of the results of Experiment 2, the proposed approach will be fine-tuned. If the fine-tuning is minor, this will be considered a scientific validation of the proposal in comparison to previously existing ecodesign methodologies.

Up to now, this project is in its most early stage, with Experiment 1 still being set up, and some preliminary assessments being carried out for testing purposes. The present paper presents the discussion points and the outcome that the team has currently dealt with, together with some potential key issues in the configuration of ecodesign methods and information management.

4. Preliminary results

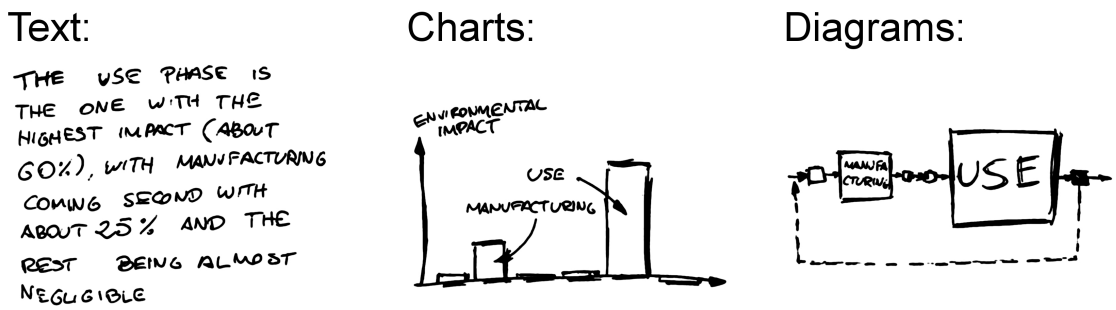
One of the clear phenomena that serves as a basis for this study is that, regardless of the details in the way of delivering the information, there is an effect. Even more, such an effect depends on traits in the information. Collado-Ruiz and Ostad-Ahmad-Ghorabi (2010a and b) showed that the level of detail of that information – measured in quite rough terms – was determining in the creativity of the final results. Even if results only came up as representatively different from a particular detail level onwards, it seems like the averages in each case have a descendent pattern. Therefore, such level of detail must be considered, be

it as part of the analysis, or keeping it constant when varying other parameters in the information delivered.

Some of the literature mentioned in literature pointed at the importance of having or not having a model of the product. For performing an LCA, such a model is necessary, but it is not necessary for showing the information. Some approaches try to avoid such a model by selecting the aggregated aspects as a source of information, but generally the different materials, parts and processes are shown together with the information. One element to consider will thus be the percentage of the model that is shown.

Apart from the model, the representation of the same may be of similar importance. How it's presented may have a strong effect on how it is perceived and used, both consciously and unconsciously. Visual thinking has been proven to guide people into thinking about problems in a different way, and is associated in popular culture with creative thinking (Goldschmidt, 2003). Additionally, there can be different ways of visualizing information, since the contents can be delivered as text, figures, graphs, diagrams, or even interactive versions of all the previous. Figure 1 presents some of these ways of presenting the information.

Figure 1: Examples of ways of presenting the information graphically



Another pattern that seems to rise in literature is the effect of different cues and inputs into the process. In a standard experiment, participants would receive the brief, and only information that comes from previous models of the product (even if coded differently). That may generate the expectation (or configure the way in a way to ensure) that previous models are what best suits the challenge. The existence of some random or unrelated information could constitute a source of ideas, or could lower the "rigidness" of the rest of the information, discarding this notion that all information put in the brief or provided in the experiment is to be used and optimized.

Another relevant element to consider is the time that participants are given to access the information and to generate ideas. In literature time for the whole ideation process has been brought down up to 2 minutes short. In other cases, to ensure that the participants get the chance of exploring more, periods of 5, 10 minutes are given. Other experiments try to ensure that the time to process the information is not as relevant, so times like 30 or 60 minutes are used. Even if not conclusions is brought up at this point, it can be seen that the time to access the information, the times the information is accessed and the time to process that information may have an influence in the way the brain deals with it. This should be included in the experiment, be it as a constant or as a parameter worth studying.

Another element worth controlling is the environment in which the experiment is carried out. It has been seen that people associate particular behaviors to particular environments, for the positive or the negative. People suffering from stage fright or sports stars associating behaviors to the field are part of the numerous examples. Different parameters in the environment need to be controlled.

One very important part of the environment, most particularly to the human environment surrounding the experiment, is the affective atmosphere that is generated. A very important trait is whether mistakes are encouraged or discouraged. In an environment in which "the best answer" is sought, and that mistakes are punished (be it actively, or verbally), participants are bound to be less creative. Spaces in which people receive a feeling of playfulness, open space and encouragement of crazy ideas, will help develop better ideas. This part can rarely be influenced directly by the brief or the environmental information put in front of designers, but they could reflect a much greater background. The fact of this activity being an experiment can have a strong effect on this, and the choice of wording (or whether there is an assessment after the experiment) can strongly influence the final outcome. These choices in the configuration of the brief should be considered in the development of the experiment. Another important point is whether the environmental aspects are included in the brief, or given as independent information, and in which way. This should take the form of another one of the variables, either to control or to assess.

Finally, not only environmental affective states can influence the final outcome. Human traits of the person have a strong influence. Disconsidering the persons inherent creativity, according to different tests (it seems like a safe assumption to consider that the results to such tests cannot be modified by applying one method or another, or showing different sorts of information), some other variables still remain. The persons affective state – prior to starting the experiment, and related to the person's personal life – or emotional state can strongly influence the final outcome. Surprisingly, some references in the literature pointed out the apparent contradiction that, support and the possibility of voicing concerns correlates positively with team creativity, but negative affective tones do so as well. It seems like generating an overall environment that encourages creativity, but a very demanding local environment, has positive effects in the final outputs. This somehow breaks the stereotype that happy playful environments are best soil for creative ideas: some level of harshness seems to keep the teams sharp in generating novel concepts. This should be tracked, potentially through the videos, to assess what influence information has on this, and how this affects the way information is assessed.

The last reflections come from the point of view of how to assess the final results and the process. Some strategies can be found in literature for this purpose:

- Expert assessment is one of the most widely used methods. Albeit time consuming, inter-expert correlations tend to be considerably high in literature, so measures tend to be robust.
- Self-assessment of the participant. This is generally one of the simplest ways, but also poses the risk of having very different standards to assess the creativity level of solutions. There also seems to be some level of systematic deviation on assessing the creativity of one's own ideas.
- Dual assessment. This approach would have both the participant and an expert assess the creativity of the object together, ensuring that there is at the same time a proper understanding of the idea and a good overview. It is more resource intensive, but seems to deliver good results.
- Follow-up on the ideas. In some cases, especially with small samples, the participant has kept developing the idea, and an expert has later sat down with the participant to assess how creative the idea documented back then was. This is considerably much more time consuming, but provides with a very clear picture considering both a conceptual and a temporal overview.

As can be seen, there is still room for different alternative scenarios when it comes to assessing the effects of different sorts of information in the ideation process, but the outlines

of the experiment and the parameters to be considered have been consistently extracted from extensive literature search and panel discussions.

5. Conclusions and further research

It has been seen that the effects of information on the outcome and process of ideation are an extensive field that holds much opportunity. There is abundant literature on the effects of small changes in the process, and psychology holds many potential effects that can make design methods more or less powerful. They could in some cases even be tagged as limiting, rather!

The experiment following this publication is to be conducted along 2012, with 100 people developing concepts when provided with a controlled amount and type of information, and in a controlled environment. A model will be generated from the outcomes of this study, leading to a validation of that model – or information, training or communication proposal – along the year 2013. After the whole project is finished, a clear strategy will be available for informing designers (most especially in the early stages) generating only positive outcomes and no negative effects.

The main further research spawning from this publication would therefore be the project itself, and the search for answers to many of the questions brought up in the results section of this paper.

Further understanding should point at further lines in the understanding of the design process. Some can be envisioned preliminarily, and are the focus of the authors for potential funding for future projects. One of them is the importance of team interaction, and how people exchange information. This paper presents a research line in which individual designers are faced with a problem, trying to understand how their brains will work. Putting several designers together is bound to create a much noisier picture, but once the behavior of individual designers is better understood, more complex environments will be possible to be analyzed.

Another important element to point out, which was seen as one of the less attainable items in information management, is the need for creating better innovation environments. How this could be created, and how this would reflect in the handling of information, is something that escapes the scope of this project, but that could be the scope of future studies, of a more organizational nature.

Another item that is intentionally left unexplored is the link between the information and the person. Every participant comes loaded with high quantities of information, be it in the form of facts, stereotypes, gut feelings, etc. Understanding how the person is reacting to that information, to the people delivering it, or to the fact of working alone or in groups, is a potential line to open up from this point in research.

All in all, it seems like the effect of information on creativity is a broad field that is just opening its hatch to reveal great potential for better design tools. We can hope that in the future, after this research project and many others, designers in the future will be enabled to deliver their best potential when trying to solve inventive problems, without considering them an obscure art.

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