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INCLUDING INTERDISCIPLINARITY TO INDUSTRIAL DESIGN

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Abstract

The product is a complex element. In addition to their material, formal and functional dimensions, products are based on many other dimensions, which are of a sensory, emotional, cultural, historic (and so on) nature. Product design unceasingly tries to design products by taking into account of their complexity and thus of a maximum of these dimensions. An enlargement designer's work necessarily goes through interdisciplinarity. That is all the more significant since interdisciplinary design leads the way for sustainable design, which will enable the design to progress again, and will also enable the designer to be finally able to respect its social responsibilities which he or she bears as a creator of industrial products. This paper intends to present how the education of designers could influence efficiently the profession to integrate interdisciplinarity into the industrial design process. Lastly, we present the research in progress at the Department of Industrial Design of Compiègne University of Technology, developing an assistance tool for interdisciplinary pedagogy in the education of industrial design. This tool not only aims at accompanying the student in his or her interdisciplinary pedagogic projects, but also the teaching team to set up interdisciplinary pedagogic teams.

Keywords: design, interdisciplinary, education, tool

1. Introduction

Why designers must be interested in interdisciplinarity? And thus, how to help them to be so? These two questions are essential today for industrial design. In a world which opens up more and more, as much from the cultural point of view as from the communicative one, Frederico Mayor, former Director-General of UNESCO [1] described well the movement in which industrial design should rush:

> *"One cannot limit the wind, one cannot partition the thought, one cannot simplify the complex without cutting the powerful wings of the creative capacity, which is the distinctive sign of the mankind, without mutilating the imagination, the invention, the capacity of innovation.[...] The future of the knowledge - as the future of the world - is mongrel, gradually mongrel. All the voices, all the musical ranges, all the cultures will intersect, take part, to control the extent and the complexity of reality. To follow rhythms of the life. To precede them - the key to success - and to make the most "human" choice for the possible futures. ".*

These lines remind with strength the need to share knowledge between the disciplines. It is industrial design's duty to learn from other disciplines in order to progress and then to make the product progress for a better "human" future.

The purpose of this paper is to introduce a method as well as a tool which allow education to lead the student-designer towards an interdisciplinary professional behaviour.

2. Purpose

2.1. Dimensions of products

When a product is described, whatever it is, it is of use to evoke its functional, formal, structural or material aspects. They are immediate aspects of the product. Recently (relative to the history of industrial design), the influence of the product on the five senses has been considerate [2]. To this are often added either more specific or more general aspects. Thus, one speaks about the ergonomics aspect and the emotional aspect of products [3].

But beyond these immediate aspects of the product, there is a great quantity of other factors, which give meaning and identity to the product. A product can be separated neither from its design, nor from its manufacture, even from its use or from its disuse. It is thus inherently related on history, on the society and on the mankind (represented by its users, its designers and its producers). The object has also many dimensions of cultural nature (dimensions related on the religion, the practice, the mood, the culture and the human knowledge), historical nature (the product is inherently binds to the historical and temporal context in which it is conceived) and technological nature (related to the state of the art of technologies).

The connection between the human being and the object is fundamental for both. The history of one of them was permanently related to the one of the other one [4]. This is all the more significant since the users ascribe to certain objects a sentimental value, a value of regard and characters similar to those which they can ascribe to their counterparts [5]. Actually, a strong emotional connection between the user and the product can exist. With the object are associated an identity and a meaning on the social standard. It is thus possible to consider factors of value, identity and symbol. These are the stakes and the consequences of the connection between the object and the society (or context), which emphasize the symbolic, social, anthropological, and even ethologic aspects of the product.

Therefore, the product appears as an entity whose great complexity is due to its integration in the human society. That is what the designer has to face. He or she must take this variety of dimensions of the product into account and collect them together in order to design the product. But this point of view is theoretical. Whatever the designer is alone or within a design team, it is not realistic to expect that he or she would be able to take all these factors into account during its work. These factors can be gathered in three different factorial categories:

- The elementary factors are currently regarded as fundamental for the industrial design. These factors are consciously taken into account for each design. For instance, the functional, formal, anthropometric aspects of the product can be regarded as elementary factors.
- The complementary factors are recognized by the designer as significant concerns to the design work. However, these factors are placed on a second level compared to the elementary factors. The environmental and emotional aspects of the product are included in this category.
- The induced factors are not consciously studied by the designer. Because of his or her human nature, the designer chooses intuitively solutions. The suggested solutions ensue

primarily (not to say completely) from his or her own experience (cultural, historical or identical experience…). These solutions are exceptionally validated. Moreover, their relevance and their evolution are often hazardous. Theological or ethologic dimensions of the product are induced factors in the majority of the designs of products, since even if the designer does not take them into account consciously, the product cannot get free from them.

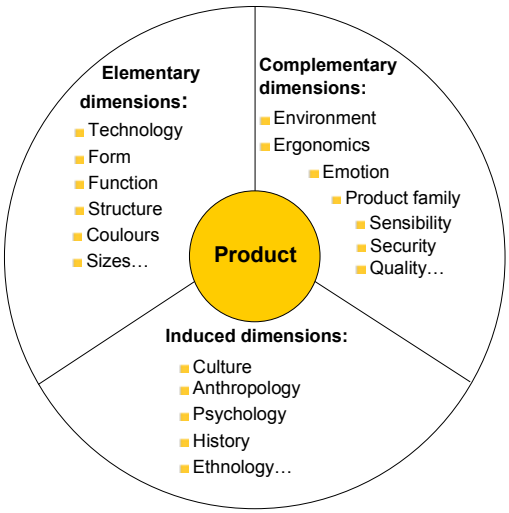

Figure 1. Product components (based on a proposition from Quarante [6]).

2.2. Interdisciplinarity and design

The development of knowledge was conducted with the profit of disciplinary specialisation, and vice versa. During the last century, the rate of knowledge advancement had declined due to the limits of each individual, as the knowledge of each individual was restricted to only his or her own specialisation. This dam was to be overcome was to be overcome by the application of interdisciplinary research as an extension of each specialisation, instead of a substitution [7].

The main concern encountered by interdisciplinary is the communication between the disciplines (their vocabulary and their visions). Whereas an "interdisciplinary translation" is necessary, it can be in the meantime the reason of a failure of the interdisciplinary project. A translation provokes mandatory a loss of information, which can be fatal. However, as it remains inevitable, the interdisciplinary team has to assume this limit and cannot be released from it. The success of these translations will appear in the relevance of the results and in the consensus inside the interdisciplinary team does not define this consensus as '*the result of a synthesis, but of a new meaning which emerged from the collective work, which was "co-produced", which derives from the new system of knowledge founded by the interdisciplinary practice'* [7]).

This approach allows taking all the measurements of the interest of interdisciplinary in design. The designer does not acquire a too much quantity of knowledge, which he or she cannot fully comprehend. A design-centred interdisciplinary structure can be created to permit to choose judiciously new solutions for the design of industrial products. The "interdisciplinary" solutions create (or emphasize) one (or several) solution for one of the factorial categories of the product. These dimensions are complementary from the product elementary dimensions. This complementarity is not distinctive: all these dimensions interact of course between themselves. The principal mission of the designer is to coordinate them in order to extract some new products, which improve in their social and human dimensions without disturbing formal, functional and emotional qualities of the product [1].

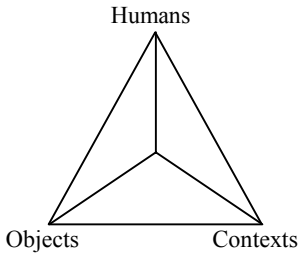

Figure 2. The three key elements of designing.

One of the first issues that comes to interdisciplinary design is the identification of the disciplines to be integrated. Love [8] proposes a framework to identify the relationship between design and other disciplines. It can be used to determine the disciplines that could be relevant in an interdisciplinary design process. This framework is based on three *key elements of designing: 'humans', 'objects' and 'contexts'*, and is extended by their relationships (materialized in the triangle by the sides and the inside lines (cf. Figure 2)). This framework is then composed of nine areas that are *identifying the relationships between theories about designing and designs and theories of other disciplines*. Thus, Love proposes a list of disciplines that can be in close relationship with the design process, and therefore that are a priori relevant to interdisciplinary design.

2.3. Interdisciplinarity, a solution for sustainable design

Since the publication of the Brundtland report [9], the industrial world evolved somehow. The end of the Eighties saw the development of the ' green consumerism', and the Nineties its disappearance. *Agenda 21* launched the sustainable consumerism that Cooper [10] defines as follows: " *Patterns of consumption through which the purchase and use of goods and services meet people's basic needs while minimising any environmental degradation* ".

The concept of durability takes the entire environmental impact of the design, the manufacture and the consumption of products into account. Some tools are used to evaluate and compare the impact of various products and of their mode of consumption on the environment, in particular by counting the whole of the raw materials used during the life cycle of these products. Moreover, sustainability is also interested in the social and human aspects whatever they are concerning space, intergeneration or intrageneration. Even if these aspects are currently much less developed than the environmental aspect, it is one of the two major orientations of the sustainable development.

Within the framework of sustainable development, the role of design is immediate. Papanek [11] suggests (even before *Agenda 21*) to designers to look further into the social and environmental aspects of their designs. Since then, some progresses have been made with the development of eco-design and sustainable design [12]. To challenge it, the designer must understand the current consumerism's socio-cultural and psychological dimensions in order to understand better how he or she can act. The human and social meaning of the product must reach the same level of comprehension as that one concerning functional or anthropometric dimensions of the product [13]. Therefore, sustainable design sets itself the task of reconsidering its process and adopting a more responsible behaviour (and thus more

reasonable objectives). Within the framework of a sustainable design management, the product design team will put at the core of its reflection, and at the same level, the whole of cultural, sociological, historical, technological, harmonic and functional dimensions. Thus, there is a double challenge (identical to the sustainable development's one): to obtain viable products from an economic and marketing standpoint, without decreasing the importance of their socio-cultural and environmental viability. This defines the responsibility for the designer towards the company and towards Gaia (as defined by Lovelock [14]).

The previous section points out that interdisciplinary design can find an answer for the problems of setting up sustainable design and sustainable consumerism. The difficulty, which moves us away from the sustainable design, can be found in the factorial complexity of the product. As we figured out that interdisciplinary will help the designer to apprehend more correctly a greater number of dimensions, we can affirm that the more the designer will develop interdisciplinary in his or her work, the more he or she will be able to approach sustainable design activity. It is a fundamental acknowledgement to explain the importance of such a process. It will make industrial design and societies advance positively.

This undertaking of designers in the way of interdisciplinary, and thus of the sustainable design will enable them to respect their social responsibility which they are carrying each time they are designing a product [15]. It is a significant factor and it will make design progress intrinsically.

3. Methodology: How integrating interdisciplinarity to education

Considering the extent of the fields of knowledge which can be concerned with interdisciplinary design (cf. section 2.2), it is better for the designer to be able to complete the work of abstraction in order to apprehend the connection of these fields. The designer will need to rely on strong methodological bases and on a significant cognitive behaviour in order to achieve this primarily theoretical work. Thus, it is a priori better for the designer responsible for setting up interdisciplinary design, to be a m-designer (*"designer who had education in design methodology at a university and gained design experience from projects in co-operation with industry"*) [16]. Therefore, the education of designers appears as essential for the setting up of interdisciplinary design.

3.1. Proposal for an interdisciplinary design pedagogic method

Interdisciplinarity can be introduced to the student like a whole of methods and knowledge bases, in the same way that it is done for ergonomics or mass production technologies. The singularity of interdisciplinary is that it is basically related to a vast whole of other methods and knowledge bases. Knowledge brought by interdisciplinary is mainly the sensitization to the other disciplines, to their vision of product design and to the type of solutions they can potentially bring to industrial design. Moreover, interdisciplinarity must include in its teaching a conscience of the social and human problems, of the technical and scientific achievement consequences and of the limits of the standards. The student should be able to have a retreat concerning his or her activity and concerning what the other disciplines will bring to him or her [17].

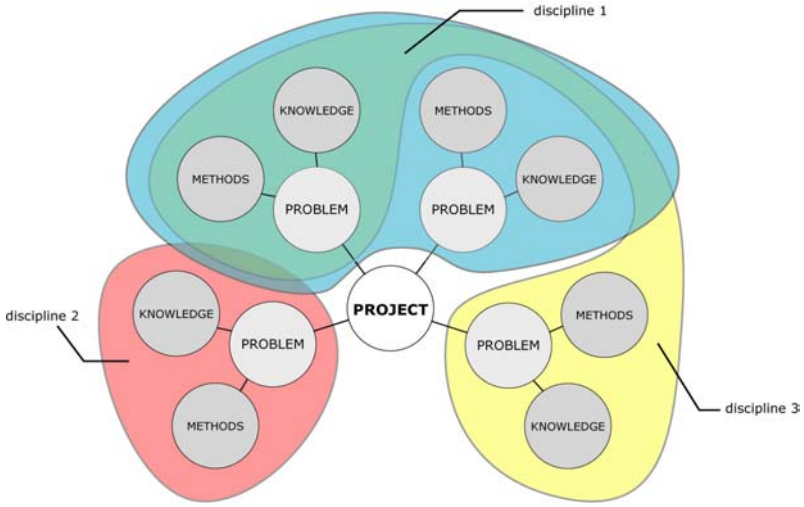

Figure 3. Sketch of the relations between the project, the methods/knowledge, and the disciplines.

As for the method, it will relate rather to the way to resort to these other disciplines, and also to their knowledge and methods, in order to integrate them into the design process. The interdisciplinary-trained designer will then be able to associate some design problems with one or more disciplines (cf. Figure 3).

The student-designer will be brought to create an interdisciplinary associative network based not only on the methods and the knowledge which he or she has acquired during his or her education, but also on the orientations he or she will privilege for the design process (for instance, technical or conceptual orientation). This network will be formed according to the issues the student will encounter in the project. The Figure 4 proposes a general and dynamic view of this network.

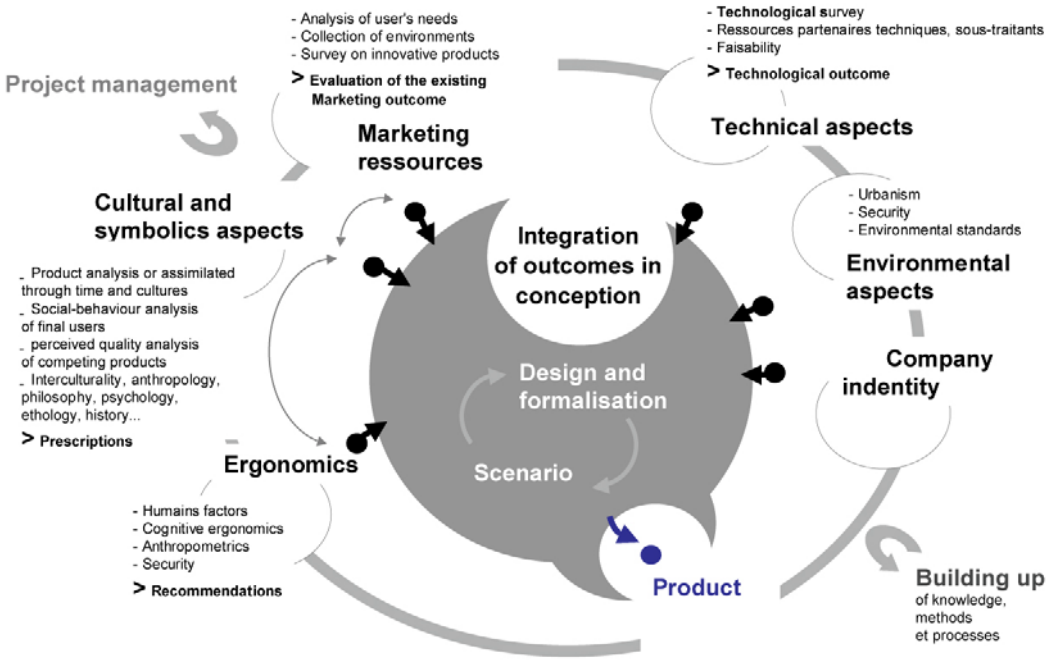

Figure 4. Diagram of the representation of the integrated design: the result of a global approach [18].

3.2. Experiment

Currently, a study is undertaken to evaluate what the related disciplines can bring to interdisciplinary design (firstly in order to constitute an interdisciplinary teaching team). This study began within the research team ODIC at Compiègne University of Technology. Several criteria were worked out in order to build a vision of the relations and potential actions of the various disciplines (whatever they are already integrated or not into the design process) and of industrial design. The list of the criteria is as follow:

- Relation between the discipline and the concept of product – the view on the concept of product of each discipline is influencing its sensibility about the product, the relevance of its participation during a specific step of the design process, and the complementarity (or on the contrary, the foreseeable tensions) between various disciplines.
- Vision of product design for each discipline - Within the framework of interdisciplinarity, the various disciplines must have a common objective, which means a common vision of the design process.
- Questions for which the associate of specific discipline (and by extent, the discipline itself) wishes to invest himself into it - These questions, given by the discipline itself, strongly help the student-designer to organize the problems he or she will have to face, to know which associate(s) will be able to help him or her, and finally to carry out a single and relevant schedule of conditions for the whole of the interdisciplinary team.
- Motivation to take part in one of the design steps - the methods and knowledge that each discipline can bring are significant criteria for the creation of an interdisciplinary design team. However, that cannot work well if the associates are not motivated. This factor is at least as significant as the others in order to success interdisciplinary design.

Through these criteria, we pointed out the various factors on which not only an interdisciplinary pedagogy could be built for industrial design, but also a tool to assist the student-designer to manage his or her project.

In order to lead this study, a tool was created. It makes us able to build a database likely to help the achievement of the two objectives quoted in the previous paragraph. In order to fill this database, interviews, based on semi-directed interviews, are necessary (and currently in process). Each interview is structured in three parts, aims at obtaining the information previously told. These dialogues are systematically recorded for a future processing.

- In a first time the interviewee is asked about products and product design. It discourse is free and is recorded by the interviewer.
- In a second time, pictures of products are used (same size and the same background), and are presented to the interviewee on a horizontal plane in a completely random way (no kind of organisation which could influence the interviewee). Products had been previously selected according to the following outline: product are part of a few categories defined as types of necessary products to the mankind (for the first series of interviews, we concentrate on three categories: liquid containers, urban transportations and care and hygiene related products); In each category, products cover a large range of passed, current and emerging technologies and forms. We propose a great number of varied products so that the interviewee can find at least a product on which he or she will want to react. The interviewee is asked to select a product and speak freely on it. The speech of the interviewee is open, even if the interviewer must lead him or her on several subjects: global criticism of the product (qualities and defects from the point of view of the

discipline); imagination of a product of same nature, but ideally nearer to the perfection; possible contributions of the discipline; and so on. Then, the interviewer exposes again the list of the questions, which were issued in the first phase, and proposes to the interviewee to supplement it if he or she wishes to do so. This stage is done again for another product as many time as the interviewee wishes to do so. Considering the length of this experiment, it is necessary to let the choice to the interviewee. Fatigue or wear can be considerable damaging factors for the experiment results.

- Lastly, in the third time, an interface, "eis" (cf. back-right picture of Figure 5), is used. This interface allowed quantifying the motivation of the interviewee to take part of one step of the design process [19]. This interface records the user's identity and discipline. Then, the products which were selected during the second phase are shown again. The interviewee gives his or her opinion concerning his or her possible participation in one of the stage of the design process for each product. The 5 grades are as follows: "not at all", "not really", "equal for me", "pretty much" and "a lot".

4. Results

From this study, several results are obtained.

A first analysis is to be intradisciplinary. The vision of each discipline concerning the product and design permit us to know the nature of the potential contributions of each discipline for industrial design. A close attention is paid to the heterogeneities and the homogeneities expressed by each interviewee inside each discipline. That is not only give us the opportunity to evaluate the relevance of an argument within the framework of the discipline, but also to point out the fact that the choice of the people is quite as important as the choice of the disciplines in the constitution of an interdisciplinary team.

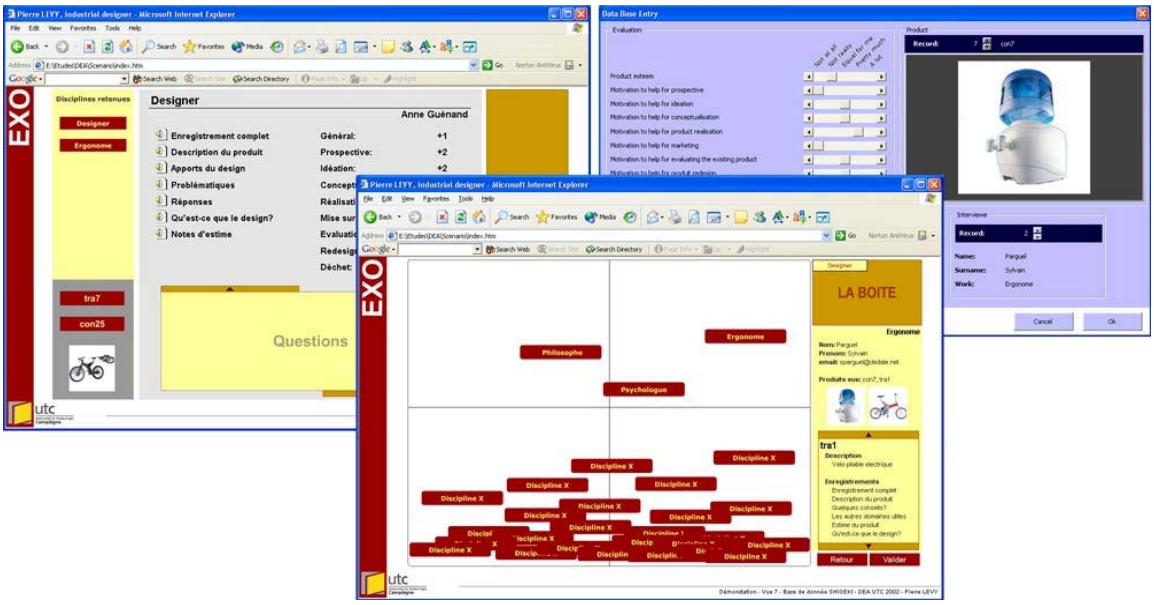

Figure 5. exo and eis, output and input interfaces.

A second analysis is to be interdisciplinary. We are able to reflect about the connections between the various disciplines. For a specific phase of the design process, some disciplines are complementary, or on the contrary can be opposite one to the other. That creates conflicts, which can be constructive and not destructive. This concept is very significant, not only for an

intelligent construction of a pedagogic method, but also for the success of a project of design. Thus it is important to be prepared to it as much as possible.

A third analysis allows the student to get prepared to the exchanges with his or her associates. By paying attention to each associate's visions concerning the product and product design, while listing the questions suggested by each associate, the student is able to present the problems in a way adapted to each associate. Moreover, it will be able to write a single schedule of conditions, common to all the associates of the project, and in which each associate seeks the questions he or she is able to answer to. This last point is fundamental for the success of the interdisciplinary project, which must be carried out with a minimum of additional difficulties compared to a traditional project.

Thereafter, the type of input introduced previously is one of the inputs for an assistance database for interdisciplinary pedagogy. On one side, two types of requests are possible using "exo", the output interface:

- Students can be helped by the database in order to create an interdisciplinary team. This database indeed provides them the information collected during the interviews. According to the request formulated by the student, the database provides the student with the cards of the possible associates. These cards contain all interesting information. They enable the student to organize an interdisciplinary design team and to create a single schedule of conditions common to all the team. Moreover, each student is able to input the database with information collected during the interview of new future potential associates.
- Teachers are also able to use this database in order to set up an interdisciplinary pedagogic team. Following the example of the students, they are also able to input the database.

Recently, the first step of the development of the database has been reached. Although only a few interviews have been conducted, it was adequate in order to precisely validate some specifications for the interface and also enabled the creation of simulations (cf. back-left picture and the front picture of Figure 5) in order to progress in the design of the interface. The interface introduced here is made with Macromedia Flash, using php and mysql technologies, allowing us to make various kinds of dynamic and intuitive interfaces (the user may be able to choose one of them, according to his or her profile). After the identification (or the creation of the profile, based the user's preference, and an personality test to be defined), the user will be able to define requests (based on the kind of design project and the issues currently not solved). Then the database proposes some disciplines or some persons able to help him or her according to the request (cf. the front picture of Figure 5). The relevant disciplines are at the top of the table and a separated in order to be highlighted, whereas the less relevant disciplines are "quizzed" together at the bottom of the table. The user will then be able to click on each red rectangle to obtain (on the right side of the screen) all the information required to select (or not) the disciplines (identity of the potential associate, selected products, recorded interviews, comments, quantification of the motivation for each step of the design process). The selection is done by sliding the rectangles in the top right orange rectangle titled "La Boîte". After the selection is over, the user will be able to see some additional information (according by his or her profile) about the disciplines. Among them is the list of questions given by the potential associates. The user will then be able to select the questions he or she wants to work on. In a last step, "exo", the output interface, will provide the user, a file with the identity of the selected associates, and the list of questions. This file will be useful not only for the user to created an interdisciplinary team, but also for teaching purpose or for industrial design purpose.

5. Conclusion and perspectives

We figured out the importance of the role of education in the setting up of interdisciplinary product design and we have introduced a tool and a method of assistance at the creation of an interdisciplinary pedagogy.

We initially pointed out why it is significant that design has to be interested in interdisciplinarity and that it can strongly help to apply sustainable design. This point is regarded as crucial because it explains the importance of this problematic and justifies the research introduced into this paper. The main difficulty in interdisciplinary design is not the operation of this team, but rather the creation of this team. In order to create skilfully this team, the person(s) in charge of this creation has to be sensitized with interdisciplinarity. Consequently, the education of the students-designers to interdisciplinarity appears to be a way to reach interdisciplinary products. Through methods and knowledge applied during his or her pedagogic projects, the student will be able to set up an interdisciplinary project.

One of the researches currently led at the Compiègne University of Technology concerns interdisciplinary in industrial design pedagogy. The objective is to propose a way (i.e. methods and tools) to introduce sustainable interdisciplinarity into the industrial design activity and pedagogy. In other words, we propose a tool which will permit not only the students to be guided in their interdisciplinary pedagogic projects, but also the teachers to assemble with relevance an interdisciplinary team adapted to the projects and the pedagogic objectives. The objective is now to look further, until the effective application of these ways to set up interdisciplinary pedagogy by project. Progress of our research will be the purpose of future papers.

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