THE VALUE OF DESIGN RESEARCH

A DESIGN-BASED APPROACH RESEARCH ON INNOVATION: FROM MULTIDISCIPLINARITY TO TRANSDISCIPLINARITY

Fabien MIEYEVILLE [1,2]

Renaud GAULTIER [1,2,3]

Jean-Patrick PECHE [1,3]

Philippe Silberzahn [1,3]

(1) Programme I.D.E.A.

(2) Ecole Centrale Lyon

(3) EMLYON Business School

fabien.mieyeville@ec-lyon.fr

renaud.gaultier@orange.fr

jpp@anonymate.fr

silberzahn@em-lyon.com

ABSTRACT

Innovation nowadays is increasingly based on the triple helix model of industry-university-government interactions (Etzkowitz and Leydesdorff, 2000). If institutions' interactions are vital for innovation, such practices have demonstrated that driving innovation requires not only crossover practices but also innovation in research. As a consequence, researchers must renew their epistemology, including the design of their research.

In this paper, we present the research approach developed in a triple helix model-based initiative named I.D.E.A. (Innovation, Design, Entrepreneurship and Arts), a national sponsored project (IDEFI grant in 2012) that uses Design Thinking as a methodology for project management (Péché et al., 2013), Effectuation as a philosophy for Action (S. Sarasvathy 2004) and Art as an experience.

We explore how the cross-over, pragmatic and pervasive approach of design thinking is especially adapted to building a research that has to be abducted from lived experiment with a constructivist way of thinking (Le Moigne, 1995). Research-Action in both teaching field and consulting field could be a good vehicle for such a research based on a pluridisciplinary research group tending to transdisciplinary practices. This paper tries to define the model and discusses the limits of research aimed at innovation by and on design.

Keywords: innovation, transdisciplinarity, design thinking, helix model

1   INTRODUCTION

While innovation regularly appears at the top of CEOs agenda, it is still a challenging task for organizations. While silos are nowadays clearly identified as the number one innovation killer factor, some researchers have proposed that the creative industries (CI) could be a source of innovative management practices because the dilemmas experienced by managers in cultural industries are also to be found in a growing number of other industries where knowledge and creativity are key to sustaining competitive advantage (Lampel et al., 2000). According to Howkins (Howkins, 2001), the success of creative industries reflects the growing power of ideas – and how people make money from ideas. Landry et al (Landry and Bianchini, 1995), assert that twenty-first century industries will depend increasingly on the generation of knowledge through creativity and innovation.

We can talk of breaking silos as well as introducing creative industries in industrial processes, the underlying bottleneck in both case is the fact that

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transcending the well-established and familiar boundaries of disciplinary silos poses challenges for firms, organization and institutions.

Design Thinking is one way to overcome this bottleneck. Design can be understood as material and conceptual innovation, realized through the integration of arts, culture, business and technology, and experienced as beauty, value and meaning. In its practice, design integrates culture and the arts, and one of the reasons why previous attempts to teach design in business schools failed is that such attempts did not integrate this art and culture background. Design Thinking, then, refers to the methods and processes for investigating ill-defined problems, acquiring information in a large scope, analysing knowledge, and positing solutions in the design and planning fields (Brown, 2009). As a style of thinking, Design Thinking combines empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyse, fit and test solutions to the context. Design Thinking has become part of the popular lexicon in contemporary design and engineering practice, and also in business and management (Dunne and Martin, 2006). Beyond the style of thinking, Design Thinking can be considered as a powerful tool for innovation project management (Péché et al., 2013) and can be used to integrate transdisciplinarity in academic curricula as well as to train effective trandisciplinary innovation managers.

Design thinking implies among many aspects to mix up ethnology methods of insights (investigation) in users communities, design with try and fail steps supported by visualization and mock ups, production management and retail. Art as an experience (Dewey, 2005) is a pragmatic approach of teaching and sharing knowledge that implies an arrangement of dedicated and unique devices (Agamben and Rueff, 2007; Deleuze and Parnet, 1987). Effectuation, a logic of entrepreneurial thinking, develops the idea that action is often a root cause of novelty in the world (Sarasvathy, 2004). From this point of view, the authors build a two-years degree where Design Thinking, Effectuation and Art are combined in the curriculum of a post-bachelor program named I.D.E.A. (Innovation Design Entrepreneurship and Arts). This Program was founded in 2011 by Centrale Lyon, an engineering school and the EMLyon Business School. The main idea lies in the integration of Design Thinking and Arts into management to develop innovation while providing basics technology education. This model takes its roots in design thinking both as organizational resource (Brown, 2009) and as cognitive style (Cross, 2006). As part of this master degree program, a research group has been constituted around with the intention to emphasize a trandisciplinary approach. In this project, the training (university aspect) and the consulting for innovation (industry aspect) are fields to study the transformation of multidisciplinarity to transdisciplinarity.

In this paper, we explore how the cross-over, pragmatic and pervasive approach of design thinking is especially adapted to build a research that has to be abducted from real experiment in a constructivist way of thinking (Le Moigne, 1995). Action Research in both teaching field and consulting field is a good vehicle for such research based on a pluridisciplinary research group tending to trandisciplinary practices.

The paper has 6 parts: first, the notion of transdisciplinarity is explicated, then we develop the practice of design thinking as project management. The third and fourth parts of this paper introduce the research gaps and the method used

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to address them followed by the presentation of preliminary results and perspectives.

2 TRANSDISCIPLINARITY : DEFINITION OF THE TERMS AND RELATED RESEARCH FIELDS

Transdisciplinarity is a keyword that has taken more and more importance since the beginning of the 21st century. The complexity of the systems that humans have to design is reaching its climax since expanding from technology to biology while integrating business aspects, societal expectations and worldwide stakes without mentioning the fact that interconnectivity introduces virtual spaces as well as distributed paradigms. Moreover, such systems must now be adaptive and dynamic. If multidisciplinarity practices are nowadays a commonly established necessity, overlaps between all those design spaces requires transdisciplinarity to be fully effective.

From research studies and experimentation in the field of the transdisciplinarity as well as research field as education stake, some good practices have begun to emerge: emphasis on teamwork, bringing together investigators from diverse disciplines, developing and sharing of concepts, methodologies, processes, as well as development of tools to assist in the creation and promotion of stimulating ideas that expand the boundaries of possibilities.

Yet, depending on the researchers, the three terms of multidisciplinarity, interdisciplinarity and transdisciplinarity are different. Furthermore, transdisciplinarity is often confused with interdisciplinarity or multidisciplinarity while interdisciplinarity is often confused with pluridisciplinarity.

As a first step, we can refer to transdisciplinarity as the term "used for integrative forms of research. Trandisciplinary education and research programs take collaboration across discipline boundaries a step further than do multidisciplinary and interdisciplinary programs. The trandisciplinary concept is a process by which researchers representing diverse disciplines work jointly to develop and use a shared conceptual framework to solve common problem." (Ertas, 2010).

For more extended definition, we will, following Ertas (Ertas, 2010), refer ourselves to the work of Julie T. Klein (Klein, 2004) :

"Multidisciplinary approaches juxtapose disciplinary/professional perspectives, adding breadth and available knowledge, information, and methods. They speak as separate voices, in encyclopedic alignment. The status quo is not interrogated, and disciplinary elements retain their original identity."

"Interdisciplinary approaches integrate separate disciplinary data, methods, tools, concepts, and theories in order to create a holistic view or common understanding of a complex issue, question, or problem."

"Transdisciplinary approaches are comprehensive frameworks that transcend the narrow scope of disciplinary world views through an overarching synthesis, such as general systems, policy sciences, feminism, ecology, and socio-biology. More recently, the term also connotes a new structure of unity informed by the world view of complexity in science, a new mode of knowledge production that draws on expertise from a wider range of organisations, and collaborative

partnerships for sustainability that integrate research from different disciplines with the knowledge of stakeholders in society."

Multidisciplinarity and transdisciplinarity deal with the transfer of methods, tools, theories, practices from one discipline to another: it may allow research to spread over disciplinary boundaries but staying within the framework of disciplinary research. Transdisciplinarity aims at developing true synergy between the different disciplinary perspectives. Yet, tools and methods to perform such an approach are not defined. According to Ertas (Ertas, 2010), the trandisciplinary research "involves not only crossing engineering disciplinary boundaries but also requires crossing families of disciplinary boundaries (engineering, social science, natural science, and humanities). Social Sciences and the Humanities bring an abundance of knowledge on cultural, economic and social growth and advancement as well as on social system. Therefore, they provide an important input to decisions being made relative to current problems and challenges. The Humanities play an important role putting to beneficial use new findings in engineering and the natural sciences".

As it will be shown later, the research process proposed by Ertas et al can be extended with the merging of arts, culture, social sciences and humanities with the engineering discipline through the project management. Design Thinking naturally integrates such an approach adding the dimensions of Arts and Business, not mentioned by Ertas, In the next section, we develop our approach of Design Thinking so as to be able to introduce the research gaps.

3   DESIGN THINKING : BEYOND THE HYPE, A REAL METHODOLOGY OF INNOVATIVE PROJECT MANAGEMENT

Design Thinking as developed by Tim Brown (Brown, 2009) aims at obtaining convergence of feasibility, viability and desirability from an approach focused on desirability and usages. Yet, the approach developed by Tim Brown lacks methodologies and fails to establish operational processes. Design thinking can be perceived in a more complete manner and operational settings. We do consider Design Thinking as an inheritance of industrial design and by integration of Tim Brown approach we have developed design thinking as an operational project management tool, specifically well suited for innovation (Péché et al., 2013). The method is summarized in the Figure 1.

A project driven by design thinking goes through 5 phases: Exploration of the design space, Evaluation of the bottlenecks, Solution search, Experimentation of the solution and Economical and industrial deployment.

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The first two phases are devoted to the questioning of the initial problem, considered by nature as a wicked problem (Buchanan, 1992). By extended exploration of disciplinary field such as arts, culture, history, social and human sciences, economics and business field, engineering fields, the wicked problem can be redefined according to the global context that these two phases build. The emergence of the redefined problem comes from a wide pluridisciplinary research that leads to a *de facto* transdisciplinary synthesis. Phases 3 and 4 aim at finding a solution to the problem previously defined. If engineering sciences are important during this field, solutions that are created must take into account the previously explored dimension. These two phases can then be considered as interdisciplinary. The solutions will be sketched, their formal and conceptual universes will be built, usage scenario will be defined and experimented, and the solution will be prototyped and experimented in real cases. The last phase consists in transforming the prototype into a real final product, ready to be produced and deployed in an economical manner.
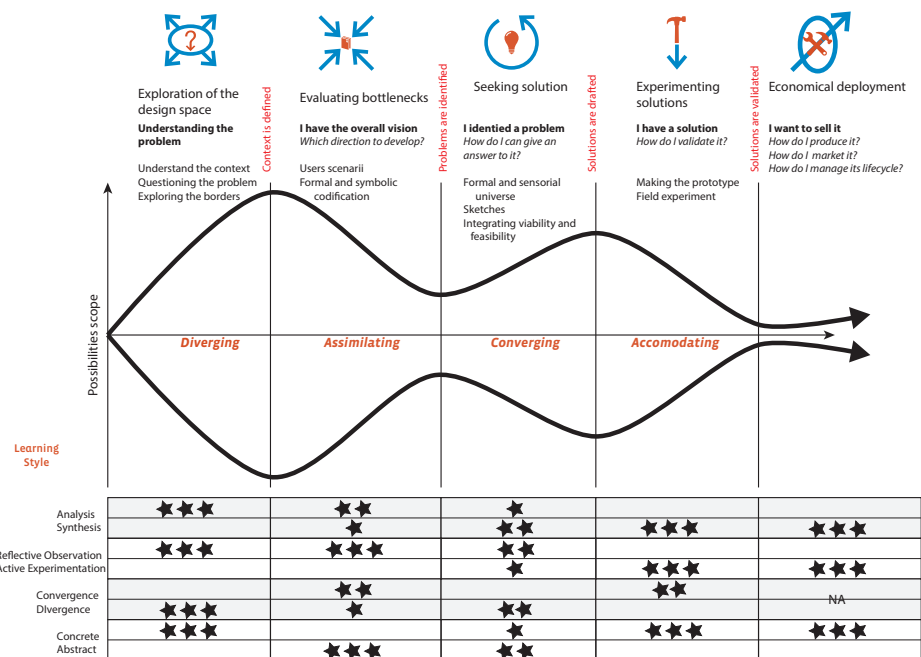

Figure 1 – Design Thinking : a methodology and a process to manage projects.

Inspired from the works of Sarah Beckman (Beckman and Barry, 2007), we have studied the evolution of the learning abilities involved in the whole process. Learning abilities or learning style, as defined by David Kolb (Kolb, 1976), can be considered as the process of constructing knowledge : people perceive and process information differently to build knowledge. David Kolb proposes that learners, through their choice of experience and their manner of perceiving it and assimilating it, program themselves to grasp reality through varying degrees. David Kolb defines four style of learning process: accommodating, assimilating, converging and diverging. Hence, the stances that users are led to adopt during the whole project process can be evaluated on four axis: analysis-synthesis, reflective observation – active experimentation, convergence-divergence and concrete-abstract. The combination of these 4 metrics permits to define the learning style. We evaluate the predominance of each dimension

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during the five phases of our project management framework as it can be seen on Figure 1. Depending on skills and methodologies used in each phase, we have determined what main dimensions are used and then what is the best learning style appropriated to each phase. Thus, beyond the multidisciplinarity at stake in the process, the dynamic introduced by the learning styles reinforce the interdisciplinarity by putting people in learning styles that are not commonly invoked by their traditional disciplinary field. This merging of both providing a multidisciplinary context and this dynamic of learning styles that are moving along the process are two main factors that can explain the reason why we are obtaining a real shift from multidisciplinarity to transdisciplinarity (see the section of results for more details).

In conclusion of this introduction to our perception and practice of Design Thinking, we can now attempt to define the research gap under scrutiny in this paper.

4   RESEARCH GAPS

As developed in the previous section, Design Thinking is a natural way of practicing multidisciplinarity and by combining several specialists from different fields, it can allow interdisciplinarity in those groups whose results can show transdisciplinarity.

In our research, we try to address several interrogations about transdisciplinarity: the first one is about teaching and training. How can we effectively train transdisciplinary project managers? This research gap has been explored through two experimental fields:

- ✓ the field of initial teaching through a two years post-bachelor degree experiment (Programme I.D.E.A.)
- ✓ in partnership with Ivy Group in the management of innovation. Ivy Group is a large company involved in providing industries with high tech devices for engines, transport and mobility, including manufactured licensed materials and electronics. We take it as a case for studying the organizational design of a community of innovators in a new arrangement of knowledge in a large multiskilled group.

The second research gap that is currently in its preliminary stage of exploration is how to conduct a transdisciplinary research activity? The IDEA research group leads experimentation and research study on the innovation management through design thinking and effectuation. From a multidisciplinary team, methods and theories are being developed on the field of innovation process but could also be qualified as research on transdisciplinarity.

So as to address those gaps, the IDEA research group extensively uses its formalization of Design Thinking as a process but has developed a method to evaluate the effectiveness of its practices.

5   METHOD

For Schumpeter (1934) innovations are novel combinations of resources carried out in practice, i.e. subject to attempts at commercialization. Behind this definition lies the idea of newness, and the idea that this newness is socialized through the process of diffusion and/or adoption (Rogers, 2003). Building on this and based on Sarasvahty (Sarasvathy, 2001), we define innovation as *the*

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successful transformation of ideas into social artifacts such as products, firms or markets.

5.1   MEASUREMENT: ARTIFACTS AND SOCIAL INTERACTIONS

Hence measuring the production of social artifacts is a good proxy to evaluate the innovativeness of a process. This suggests two important dimensions of output to measure: the degree of complexity of the artifact created, and their social dimension (in the sense of commitment).
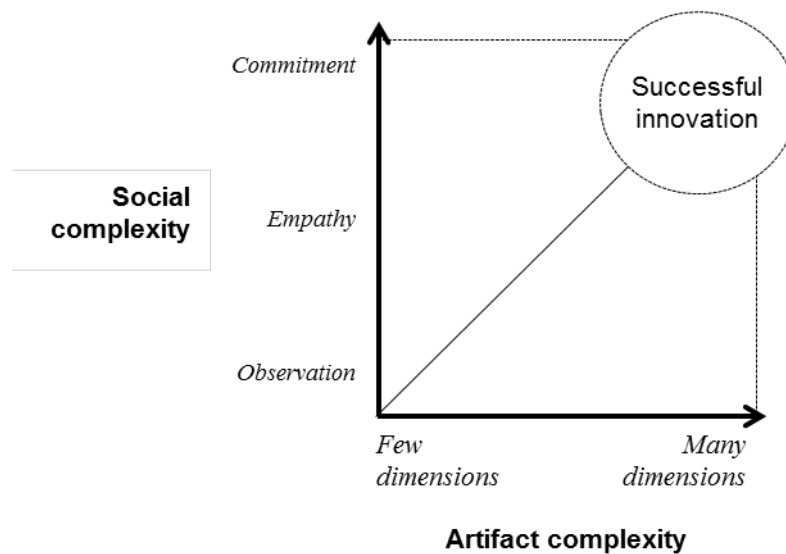

Figure 2 – Evaluating effectiveness of innovation.

The degree of complexity of an artifact, in the context of design thinking, is the number of dimensions introduced into it. It can range from a simple product that is redesigned, such as an eyeglass frame, to a software application and to a firm. Hence the success of the resulting artifact, particularly for complex ones, can be directly linked to the ability of people committed in its building to interact through silos and to mix from multidisciplinarity to transdisciplinarity.

The social dimension ranges from simple, passive interaction (e.g. market research) to getting user insights (design thinking and empathy) to social commitments. By social commitment, we mean the active involvement of a stakeholder in the project evidenced by the supply of resources (tangible or intangible). Examples of commitments include a acceptance into an incubator, a pre-order by a customer, etc.

Only when a project has become a fully developed social artifact can it be considered a successful innovation. In this article, we focus on the artifact complexity since multidisciplinarity and then inter- and transdisciplinarity are to be found in this dimension but we must keep in mind that ability of the artifact to go through disciplinary boundaries to establish more global paradigms can be a key factor in sparking social commitments.

Hence we have two axes: 1) The complexity of the project as it evolves over time, by inclusion of a growing number of dimensions; and 2) The social complexity, ranging from user observation (brainstorming) to interaction and empathy (market study, ethnography) to actual third-party commitments such as investment, incubation or a first sale.

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Based on this framework, we try to evaluate, through the effectiveness of an innovation, the ability of its participants to to switch from a multidisciplinarity paradigm to a trandisciplinary paradigm. This process of creation that we have formalized through the Design Thinking as project management methods takes also it roots in the concept of "chaîne opératoire" (operational sequence) (Lemonnier, 2004). Indeed, particularly with the IDEA case, transdisciplinarity is under scrutiny through the process and less through the results of the process. Thus we use the notion of "chaîne opératoire" to analyze the practice of design thinking as a mean to break, at least temporarily, the boundaries between disciplines and professions. Furthermore, we have established that the permeability of those boundaries fluctuates in the dynamic of the project.

5.2   EMPIRICAL SETTINGS

IDEA research group has been experimenting its theories on the transdisciplinarity in teaching and training for 2 years.

5.2.1   *I.D.E.A. Programme*

The first field of experiment is the teaching process where IDEA Program is considered as a pedagogic living-lab. To date, this is the experimentation that presents most results and then will be developed in this section.

The objective of the program is to train future managers by breaking the existing silos between design, the arts, technology and business as per Dunne and Martin (2006). The program aims at educating students able to create new firms or to manage innovation departments in existing firms.

This model takes its roots in the triad developed by Brown (2009). Feasibility is covered by courses delivered by the engineering school. Viability is covered by courses given by the business school. Desirability, includes design, and creative and cultural aspects, and is covered by a diverse, ad-hoc faculty from both schools and external lecturers. The program is not aimed at teaching Design Thinking as a discipline to existing students of the two institutions, but at educating management students on the basis of Design Thinking from the ground up, in conformity with the objective of renewing management practice. Accordingly, the program has its own recruitment process and criteria.

As such, IDEA is representative of the new generation innovation programs based on design thinking aimed at future managers and entrepreneurs, and can be considered an exemplary case of the stakes in teaching transdisciplinarity. An important difference with existing programs, however, is the emphasis that the program places on the actual production of artifacts early in the process.

In line with the principles of Design Thinking, real life projects form the cornerstone of the curriculum. Design Thinking seen as project management integrates both with Problem-Based Learning and Project Based Learning. Problem-Based Learning is an instructional learner-centered approach that gives students responsibility for problem definition, research conduct and theory and practice integration. Each phase of the Design Thinking as project management offers by itself a natural problem-based learning situation. Problem-Based Learning uses design and project experiences to transfer and integrate learning, thus amplifying the experiential learning as described by Kolb (Kolb, 1976).

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Students must create work directions since no defined outcome is set: hence, these learning approaches offer room for creativity and arts sourcing by the liberty they offer with regards to the open outcome expected.

Furthermore, using these two nested approaches enables to profit from their complementarity as described by Perrenet et al (Perrenet et al., 2000). First project tasks are closer to professional context and cover longer time periods, and project work is more dedicated to the application of the knowledge when problem-based learning is more directed to the acquisition of the knowledge. In Project-Based Learning, the management of time, resources and task allocation is very important. Hence the approach can be described as small "project-oriented studies" gradually switching to "project-oriented curriculum" to implement the principles of Design Thinking.

Lastly, project-based learning is a natural way of "learning-by-doing" transdisciplinarity in a group focused on the realization of a global project.

5.2.1 *Ivy Group*

The second field of experiment is based on the works that are led in partnership with Ivy Group in the management of innovation. Ivy Group is a large company involved in providing industries with high tech devices for engines, transport and mobility, including manufactured licensed materials and electronics. We take it as a case for studying the organizational design of a community of innovators in a new arrangement of knowledge in a large multiskilled group.

6 RESULTS

In this section, we review the results obtained, primarily on the first field of experimentation.

6.1 I.D.E.A. PROGRAMME EXPERIMENTATION RESULTS

Transdisciplinarity is achieved through the realization of projects. If the academic curriculum provides students for multidisciplinarity through the several disciplinary fields that are taught, projects are the context in which multidisciplinarity can blend into interdisciplinarity and sometimes transdisciplinarity. It is achieved at two levels : at the level of the student itself and at the group level. The student, by the project, learns to make the link between the different knowledge he has acquired on several disciplines. At the level of the group, each student is an expert in his field and must interact with others, must share his knowledge and has to integrate different point of view and methodologies.

The first year of the program is articulated around four projects, P0 to P3. Most interesting in regards of transdisciplinarity acquisition are projects P1 and P2.

Project P0 is the first step of the project-based learning methodology based on the realization of a "simple" object starting from typography bases. This project is an introduction to pluridisciplinarity. Each student works on his own glasses and begins to learn to invoke several disciplines at once. During this project students are confronted to pluridisciplinarity and the necessity to make bridges between silos.

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Project P1 is the first project where multidisciplinary groups are composed by the IDEA Programme. Starting from given objects, students have to develop an interactive exhibition[1] around a given theme for the annual Festival of Lights in Lyon, France[2] (which has millions of visitors). With this project students have two objectives: 1) integrate arts and creativity to create aesthetic and interactive artifacts telling a story to the public; and 2) create, prototype and manufacture the artifacts they have imagined. Compared to P0, the artifact gets more complex as new dimensions are added (aesthetics, storification, etc.) The solidification of the design thinking approach is focused on this project on establishing a meaningful product through a broad (arts, culture, literature and technology) state of the art exploration. The artifact produced is real complex since students go beyond the prototyping stage to the product stage with full meaning. Interaction with the public visiting the exhibition is introduced, providing an increased social dimension. In this project student learns to work together and to share their expertise with the other students of their group. Beyond multidisciplinarity, first experiences are conducted by students about interdisciplinarity. They have to create form several disciplinary fields a holistic common view of the concept that will be the backbone of their interactive installation.

Project P2 is a proposition that could be issued to any design agency. Students experiment the whole Design Thinking process (including problem definition). Design thinking is fully apprehended since it is the first time that students will manipulate all the dimension of the methodology and experiment all of its freedom dimension aspects. In 2013, the brief was to *"Imagine a product or service that takes inspiration from bees as a society and as dissemination vectors in the context of Big Data and Urban Mobility"* and the event concluding the project was held in conjunction with Biennale Internationale Design Saint-Étienne and received 15,000 visitors. Six out of seven projects were viable enough to eventually be exposed, and two of them moved to startup phase. For this project, multidisciplinary groups of 5-6 students are composed. This project is the most complex : interdisciplinarity is clearly at the heart of the project since the blending of discipline will directly result in an improved quality of the produced artifact. By the practice of this project, students begin to build their mindset and behavior toward transdisciplinarity practices. The experience gained in this project give then the basis of the methodological framework that they begin to build for the management of innovative project.

Project P3 has a different nature. It is an internship abroad in an NGO designed to develop students' intercultural awareness.

The second year of the program focuses on the viability of the Design Thinking triad with a strong emphasis of entrepreneurship. The project called "Grand IDEA" begins in Project-Based Learning mode from September to January before becoming either an internship within an existing company or a startup within the associated incubator of IDEA for the following six months. The aim is to significantly increase the ambition of the project along the two dimensions of social and artifact complexity. The ability of students to operate in constrained organizational environments is directly linked to their capacity to go beyond silos and then to deploy a trandisciplinary comprehensive methodological set.

The first promotion of this two-year post-bachelor program that opened in September 2012 has just graduated. It is too early to determine whether the

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[1] http://programme-idea-lumieres2013.tumblr.com/

[2] http://www.fetedeslumieres.lyon.fr/EN_2013

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Programme succeeded in training truly transdisciplinary project managers. Yet, some preliminary conclusions can be asserted. Every student is able to apprehend the notion of form as the visible expression of the artifact of any complex project. This expression consists of semantic components, functional components, and emotional components that act as mediators of intrinsic values. This mediation uses little but measurable components, determinants in the success of a project: it is what people often refer to as the perceived values. Students are able to build project that integrates these notions even though they are not designers. They also have assimilated the necessity of building on the social and human sciences, the notion of meaning, sense-making, and semantics and through design thinking, they are able to deliver a conscious and controlled form, in relation to the project's objectives (value creation). Students are able to push their project until the final prototype by using creation places such as fablabs but also by using the support of specialists and skilled people in specific fields. Beyond integrating feasibility and viability, they are able to discuss with specialists of different fields and discipline to express their needs and to follow the development of their project on several different disciplines. This ability of managing project through multiple dimensions and discipline can be perceived as transdisciplinarity skills. Further works are needed to explore more in details "la chaîne opératoire" and to follow the professional career of this first promotion to see in which extent this transdisciplinarity is a key factor of their job.

6.2 IVY GROUP EXPERIMENTATION RESULTS

This work is currently under investigation and shows some interesting preliminaries results, particularly in the shift from multidisciplinarity to interdisciplinarity and the way that both mentalities of actors as well as structuration of organization are heavily impacting the design process we tried to implement. We do not have yet processed all the materials to our disposal and this work in progress will not be developed further in this article.

7 CONCLUSIONS AND PERSPECTIVES

In this paper, we have presented a formalization and use of design thinking as an operational management project framework particularly well suited to innovation. Through the use of our framework, we tried to address the issue of transdisciplinarity and the processes that can be used to switch from multidisciplinarity to at least interdisciplinarity or even transdisciplinarity. We showed that design thinking can be effectively used to train transdisciplinary project managers.

Yet further exploration has to be performed, based on the concept of "chaîne exploratoire" to be able to precisely characterize the process that can enable transdisciplinarity. Current activities of the interdisciplinary IDEA research group have shown promising results in transdisciplinarity, particularly in the actor network theory.

8 ACKNOWLEDGEMENTS

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