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PEOPLE, PLACE, PROCESS: LESSONS LEARNT ON THE PATH TO A D.SCHOOL

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ABSTRACT
Since 2006, Design Thinking education programs for master-level students have been developed at Ponts ParisTech, a leading French engineering school. This paper presents a longitudinal study of the creation and dissemination of Design Thinking (DT) as a discipline to educate top-level French students for innovation. From 2006 to 2012, 53 projects were carried out by a total of 224 students. A review is made of the instructional design of those DT projects, from local experiments through the creation of a d.school supported by the French Ministry of Education and Research to the dissemination of DT nationally. From this, key lessons are drawn for faculty members wanting to set up and disseminate DT in their own university. The paper advocates that a DT professor becomes a staging director who should consider three elements - people, place, and process - in order to create "the right conditions for students to innovate" (Leifer, Stanford). A faculty member's task thus defines itself as the art of creating the best conditions for driving students' journeys of exploration within a specific context, and represents a transformative and learning adventure.

Keywords: design thinking, education, innovation

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1 INTRODUCTION

In companies and universities, Design Thinking (Brown, 2008) is currently a growing and global movement. Initially fostered by IDEO, a Silicon Valley design company, design thinking (DT) has been largely disseminated in worldwide companies. Indeed, DT offers promising perspectives of value creation (Cross, 2011; Martin, 2008; Verganti, 2009; Frazer, 2011), including the design of competitive products and services. Approaching management problems as designers approach design problems may have important implications for management and education (Dunne and Martin, 2006). In 2005, the creation of the d.school at Stanford University (actually Hasso Platner Institute) represents a shift from practice to academia. In a 2009 interview, David Kelley, founder of IDEO and the d.school at Stanford confessed that he did not expect that it would be such a challenge with faculty. Integrating the culture of design in other disciplines' education is a paradigm shift (Cross, 2007). One of the reasons is that DT uses both analytical (induction and deduction) and intuitive logic, with abduction (Peirce, 1934) and pragmatism (Peirce, 1878; James, 1907; Dewey, 1925). DT looks promising for companies, but difficult to implement in academia. The purpose of this paper is to provide guidelines to faculty interested by developing DT pedagogy.

The paper presents a longitudinal study of developing DT courses at Ponts ParisTech, a leading French engineering school, in cooperation with other leading schools. It covers three different eras (2006/2008, 2008/2012, 2012/2020) with the creation of three different courses and programs: Innnovacteurs, a project with multidisciplinary teams between leading French engineering and design schools; ME310 Design Innovation, a year-long international capstone project with multidisciplinary teams and Stanford network; a d.school with many different courses and programs, in order to achieve the mission to transform French innovation education. Each era has distinctive ecosystems (including students, faculty and partners), syllabus (including process and tools taught), objectives (including the level of project ambition) and class settings. It is the opportunity to draw lessons on how to develop DT pedagogy. DT requires a new way of teaching, in order "to create the right conditions for students to innovate" (L. Leifer, interviewed at Stanford in 2009) based on specific values, forms of thinking and epistemologies (pragmatism, constructivism, phenomenology). Which elements should a DT faculty consider? The paper recommends to "stage" people, place and process.

2 HISTORICAL DEVELOPMENT AT PONTS PARISTECH

2.1 Data collection

From McKernan's (1996) handbook of methods and resources for curriculum action research, two research methods were selected for our pedagogical action research (PAR): on the one hand, observational and narrative research methods (including case studies from students' projects and journeys); on the other, survey techniques and face-to-face interviews, especially for coaching and evaluation (cf. Table 1). Firstly, our observational data include narrative data through ethnographic data collection via field notes, a personal diary, audio and video film footage. "The aim is description and interpretations from the inside rather than strict measurement and prediction of variables using a quantitative approach" (Mc Kernan, 1996, p 59). Teams' dynamics (especially in terms of the capacity to work together and learn from each other) and project results (especially in terms of capacities to define a problem, to generate many alternative solutions and develop concepts through final presentation and reports) were the two foci of observation. Secondly, evaluations were carried out in accordance with the school standards via a survey completed by students and a discussion between a student who carried out a synthesis, a representative from the school, and teachers. In order to gain further qualitative insights, the teaching team identified proactive and self-reflective students to carry out face-to-face interviews.

Becoming professionals requires faculty members to become reflective practitioners (Schön, 1983). PAR has been carried out each academic year to improve the quality of teaching and further to develop the curriculum. In order to capitalize on one's experience, it is of paramount importance to track down each step of student projects and faculty actions within a structured framework: a session, either at a broad level for the program or at the very specific level of a project review is recorded with the following items: context (problem situation and need assessment), plan (suggestion and learning contract), act (development and implementation of action plan), observation (what is said and done by students) and reflection (understand what has happened and newly define problems). Context, pan and

act are described in introduction and section 2.2., 2.3.1., 2.4.1., 2.5.1. Observation and reflection are described in sections 2.3.2., 2.4.2. and 2.5.2. Recommendations are described in section 3.

Table 1. Data sources and collection techniques used

Data collection techniques	**Data sources**
Obtrusive and interactive observation	53 teams of students in their first or second year of master, during project reviews and creativity workshops
Oral presentations	53 student presentations in front of "guests"
Evaluation process	Student / Teaching team / Partner evaluation
Face-to-face interviews after class	Students, partners, teaching team, school administration

2.2 Context

How to educate future French industry leaders? That is the mission of the Industrial Engineering Dept. ("IE"), one of the six departments at Ponts ParisTech, a leading French engineering school. Given the need of French companies to rejuvenate their mature businesses (Stopford and Baden Fuller, 1984), the question is how to educate future leaders who are able to combine exploitation and exploration (March, 1991; Martin, 2009), i.e. the administration of existing businesses and the creation of new ones. Upon the appointment of a new President and Academic Director in 2006, IE repositioned its focus from national manufacturing to international intrapreneurship, which means the combination of product innovation and supply chain management. The ambition to integrate the dimension of sustainability is still in process.

Since 2006, IE innovation curriculum has been developed from scratch. Following a stay of half a year at Stanford University in 2008/2009, and regular collaboration since then, IE academic director has developed DT programs in order to integrate abductive logic within the framework of matching people's needs, technological feasibility and business viability (Brown, 2008). As a result, IE curriculum in innovation now includes - for first-year students: two compulsory courses including a bootcamp (3 European Credit Transfer System, "ECTS") and a capstone project called "Innovacteurs" (6 ECTS), in cooperation with ENSCI/Les Ateliers, a top French design school and elective courses (3 ECTS each) in project management, innovation protection, new product marketing, and - for second-year students: an elective full-time one-year program (28 ECTS including courses, bootcamp, workshops and a capstone projects ME310 Design Innovation + 30 ECTS in master thesis), in collaboration with Stanford and its academic network.

2.3 French cooperation / Innovacteurs: 2006/2008

2.3.1 Course description

Since 2006, IE has developed a joint project course "Innovacteurs" (see Table 2) with a major French design school, Ecole Nationale de Création Industrielle / Les Ateliers (ENSCI). It is 13-week project during the 2nd semester. Estimated personal hours from students are from 30 up to 100 hours. The instructor team includes three faculty members from three disciplines (two from IE specialized in strategy and in either mechanical engineering or languages/debating[1], one from ENSCI specialized in product design) until 2011. Experts are invited at project reviews or interviewed by students through the project. Pedagogical objectives can be defined as: giving a real experience of product design and experience of projects with at least 4 students from two different backgrounds; confronting students with different ways of thinking and acting; challenging industrialized products through the lens of sustainability; reconciling heart, mind and hands; learning by doing; engaging students in creativity and development; engaging students in self reflection (in terms of project management, product design, multidisciplinary team, sustainability). 2008 briefs are the following ones: reinvent rainwater for houses; reinvent packaging of a luxurious brand for sustainability; reinvent a luxurious bag for sustainability; reinvent the bottle of water for sustainability.

In addition to Innovacteurs, other possibilities of multidisciplinary courses in innovation were inquired from 2006 to 2008, such as courses offered by consultancy companies (for example "Chaîne de l'Innovation" organized by Accenture with 5 schools from three disciplines). After a year of experiment, a stay at Stanford and the setting of ME310 (see section 2.4.), the pedagogical elements of the course in terms of people, place and process have been refined through PAR over the years.

[1] The professor in mechanical engineering retired in 2011 and was replaced by a professor in debating. .

Table 2. "Act" for Innovacteurs

Attributes	2008	2009	2010	2011
Total class size	24	36	55	28
Students in engineering	16	31	39	28
Students in design	9	5	16	0
Coach	1	none	8	2
Number of teams	4	6	8	7
Multidisciplinary teams	3	3	3	0
Teaching process	3 miletones = 3 project reviews	3 milestones	3 milestones	Kick off, 2 project reviews
Space	No space at Ponts, a machine shop at Strate, individual space and machine shops at ENSCI	An empty dedicated room at Ponts; idem at ENSCI	Project space and a light machine shop at Ponts; idem at ENSCI	Idem at Ponts and ENSCI
Duration of exposure to design thinking before the class	A couple of sessions in a class on the 1st semester	A trip in the Silicon Valley, a few hours, 1 full week class	A couple of 3h sessions included in an innovation class	13 week bootcamp in S1
Specific tools taught	None	Forecast DT process	Design fiction for 3 teams; materials from Stanford	DT methodology and tools reviewed
Expected deliverables	Presentation	Presentation and report	Presentation, Report, Brochure, Paper prototype, Booth	Presentation, Report, Paper prototype, Video

2.3.2. Observation and reflection

In both programs (Innovacteurs and *Chaîne de l'Innovation*) from 2006 to 2008, one could observe that multidisciplinary teams generated more conflict and tension than collaboration and efficiency. Student evaluation forms showed it. The so-called "dream team" became rapidly a "hell team": it was an exception when a team worked efficiently in the same direction (even if possible, see Hillen and Banerjee, 2009), with a good atmosphere and interesting outcomes. Instead of building on complementary perspectives and competences, they usually did not understand each other. They started fighting to defend one's ideas (which leads to poor compromise) or they gave up (which leads to no result). No deep context understanding was carried out. Solution generation was poor or inappropriate. Before assignments, one student took the lead and some others contributed by splitting tasks and working remotely and individually. It was more a communication exercise than a collaborative project. Among many pitfalls observed, we can mention no deep context understanding, no in-the-field work, no prototyping, "paper" presentations with no impact in reality, poor teams' dynamics between engineering and design students. The only milestone, which was appreciated by students, was a one day brainstorming session organized with a consultant in creativity.

Courses organized by consultancy companies were dropped after two experiments with 2nd-year master-level students for the following reasons: limited control of the faculty on briefs and pedagogical activities; low commitment of students from other schools; a process influenced by consultants' analytical thinking; focus on market studies, business plans and salespitch; students too tight to consultants' spirit; poor knowledge and practice of consultants in innovation. The lesson is that traditional consultancy companies' initiatives do not match our pedagogical objectives. Staging an appropriate eco system is of paramount importance to meet them.

Although it is a lot of work to create multidisciplinary teams from different disciplines and schools, it is not enough to create efficient collaboration among students. There is a need to disseminate a common language, in order to create the "glue" within multidisciplinary teams. That is the reason why the culture of the Silicon Valley was inquired the following years (2008/2012). As defined in section 2.1., pedagogical action research on Innovacteur and ME310 (see section 2.4.) has considerably increased the quality of pedagogy, with an impact on teams' dynamics and projects.

2.4 International cooperation / ME310 Design Innovation: 2008/2012

2.4.1. Course description

In order to set up ME310 in Paris, a faculty member from Ponts ParisTech stayed half a year at Stanford University in 2008/2009. It was of paramount importance to gain personal experience in terms of knowledge, know-how and *savoir-être*. ME310 course (Leifer and Cutkosky, 2013) is a radical course that has been taught at Stanford University since 1967. The two professors are from the mechanical engineering school. The year-long course is a graduate level sequence in which student teams work on complex engineering projects sponsored by industry partners. Student teams complete the design process from defining design requirements to constructing functional prototypes that are ready for consumer testing and technical evaluation. The course has functioned as a dynamic combination of problem-based learning (PBL), immersion and simulation (Carleton and Leifer, 2009). The course has evolved through time with the industry's trends. Nowadays, all student projects are paired with global academic partners. The total class size at Stanford and its academic partners is around 80/100 students each year. Teaching team includes around 40 faculty members, alumni coaches and teaching assistants.

ME310 Paris has become one of the 9 academic partners of ME310 network since 2009. Academic partners include three d.schools at Stanford, Potsdam (Germany) and Aalto (Finland). Students are from different disciplines (engineering, business, design), French schools (Ponts, Polytechnique, ESSEC, Centrale Paris, Strate, Dauphine, Science Po, EFREI) and countries (up to 7 nationalities). Corporate partners are mostly international French companies (see Table. 3). All briefs concern the reinvention of companies' businesses and cover a large spectrum of issues: reinvent screens for social media network; reinvent helicopter cockpits; reinvent drones; reinvent airports; reinvent eco-efficiency in buildings; reinvent image capturing for cinema; reinvent water services; reinvent Local Situation Awareness for civil applications; reinvent TV experience, reinvent protontherapy systems. Place includes half a floor, so around 100m^2 in four main spaces.

Table 3. "Act" for ME310 Paris

Attributes	2009/2010	2010/2011	2011/2012
Corporate partners	Pioneer, Thales Underwater Systems Thales Avionics	EADS, Amplitudes Thales Optronics Suez Environment	GDF SUEZ Angénieux Panasonic
Academic partners for Ponts ParisTech	Stanford Aalto University	Stanford, Aalto, Hasso Platner Institute	Stanford HPI

ME310 course is structured around three quarters: "making it up", "making it real", making it happen", with assignments given every two weeks. During the first quarter, students run for an international competition with paper bikes and discover the brief given by corporate partners. During the second quarter, a major event is the travelling of Stanford students to academic partners. The last quarter ends with a presentation and a booth at Stanford and at Pont ParisTech. Reports are written each quarter to trace back the exploration journey. Every week, students have lectures and coaching.

2.4.2. Observation and reflection

The first observation while at Stanford in 2008 was to notice a gap between ME310 and the d.school. ME310 is "a course where students from Stanford University and leading global universities tackle design innovation challenges posed by global corporations". Since 2005, the d.school has paved the way to define pedagogical principles of DT: *"hands-on real world projects", "radical collaboration between faculty, students and industry", "a methodology of innovation that combines creative and analytical approaches", "learning by doing", "bias toward action", "to learn the process together and then personalize it, internalize it and apply it to their own challenges", "we don't just ask our students to solve a problem, but to define what the problem is*". The process is described as followed: *"Students start in the field, where they develop empathy for people they design for, uncovering real human needs they want to address. They then iterate to develop an unexpected range of possible solutions, and create rough prototypes to take back out into the field and test with real people. Our bias is toward action, followed by reflection on personal discoveries about process. Experience is measured by iteration: Students run through as many cycles as they possibly can on any project. Each*

cycle brings stronger insights and more unexpected solutions." (Kembel, 2013). From our observation and analysis[2], a DT course (cf. Table 4) represents a shift from problem solving and function analysis, to the concept of affordance and a relational theory for design (Maier and Fadel, 2009).

Table 4. Characteristics of a course in DT

Purpose	Innovation to better people's lives (products, services, systems)
Tools	Ethnographic research methods, idea generation, hypothesis development and testing, prototyping and experimentation, rapid concept development, concept visualization, storytelling
Work format	Interdisciplinary teams
Project nature	A corporate project with real issues and stakes
Location	A collaborative, hands-on environment allowing visual interplay

Over the years, more and more students in ME310 also take classes at the d.school. As students at ME310 Paris did not have this opportunity so far more curriculum development was needed, such as a bootcamp before official start, a series of a dozen of lectures explaining the "what", "why" and "how" (the history of the discipline, description of tools and methods, case studies), a bootcamp in ethnographic research, selected materials (articles, papers, books), space contest, a series of exercises (see section 3.3)… More explanation also fits the French culture where people need to understand and think before action. "I think, therefore I am". It is very different from an action-based culture such as in the Silicon Valley where people value action first and foremost. "I do, therefore I am".

PAR between 2010 and 2011 shows the importance of reflection for student's dynamics and project. That is the reason why reflection assignments have been designed for each quarter, both orally and in written. The purpose is creating connections between discoveries, making, thinking and vision. At the final presentation in Paris, students are required to tell their learning story (instead of a salespitch). The implementation of a reflective transformative design process (Hummels and Frens, 2008) is currently researched as a promising exploration tool for teams. Evaluation criteria for DT projects (see Table 5) have also been developed. It helps students to self reflect.

My observation in the Silicon Valley confirms how important space is when staging for creative collaborative in design teams (Lerdhal, 2001). 9 types of space have defined (zen room, material and book library, kitchen, living room, brainstorming, prototyping, project space, fun). A dedicated empty space is not enough to create teams' dynamics. When a dedicated place was at their disposal in 2008, it was not enough to attract students: The space was a traditional remote classroom with no personalization or customization. The organization of events and activities is necessary to make the space lively. Space should be inspiring and invite students for specific activities.

Concerning the teaching team, it has taken a few years for the multidisciplinary faculty team to speak with the same voice but from different perspectives: identifying the weaknesses of the team and driving it in the same direction while offering different ways of tackling the brief. One must pay attention to the fact that experts have a negative influence on teams' dynamic (if too focused, restrictive in embracing possibilities, or authoritative).

Real issues given by companies represent a strong source of motivation for students: "We know that what we have done is useful for someone in a company". It represents a lot of coordination work for teaching team, especially to educate corporate liaisons. Reality checks may indeed become censorship when executives or experts want to demonstrate that "it is not that easy". For Innovacteurs from 2008 to 2011, there was no corporate partner, in order to free students from business constraints and foster breakthrough innovation. The consequence was less commitment from some students. In 2012, half the teams have corporate partners.

In terms of team results, the hardest is to find a balance between concrete outcomes for a given situation, which usually limits to incremental innovation, and paper presentations, which can envision breakthrough innovation. Experience shows that a combination of both is optimal for student competence development. When students fail at one step (problem statement with ethnographic research for instance), it is of paramount importance to maintain the team's dynamic and move on to the next step: Interesting outcomes can happen, even with poor inspiration and ideation!

[2] A worldwide review of DT courses is under preparation (cf. www.dschool.fr).

2.5 Demonstrator of future pedagogy/ Paris Est d.school: 2012/2020

2.5.1. Description

Following a bid in 2012, Ponts ParisTech will receive a 4,1M€ grant from the French Ministry of Research and Education to create a d.school. The project has two periods: 2012/2016 is focused on the dissemination within 5 academic partners; 2016/2020 to any faculty members that wish to set up a DT course, in France or abroad. The budget is mainly split into human resources, pedagogical resources and space equipment. A team can be hired to develop such pedagogy (partnership, pedagogical support, PAR). Ponts ParisTech provides dedicated space, with a minimum of $300m^2$ in a new eco efficiency building, which will be open in September 2013. Reporting is regular to academic partners and the French Ministry in addition to an international audit after 3 years.

Paris Est d.school's mission is to become a demonstrator in innovation education by the discipline of DT. It represents two main activities: educating faculty members and creating a range of adapted courses in DT for nearly 300 students a year. The principle is to transform existing courses in each partner into DT courses by combining faculty members, subjects and students. Sustainability is a transversal topic for all courses. Three types of courses will be offered: part time courses (a course that already exists in a given curriculum); a full academic year (which will replace the second year of a given master) in the framework of ME310 program; 6-month full project in the framework of European masters. Topics and courses will be defined in cooperation with volunteer faculty members. They reflect their sensitivity and institutional orientation.

Table 5. Evaluation criteria for Paris Est dschool's projects adapted from Lilley (2007)

Design stage	**Criteria**
Inspiration	Evidence of context understanding including user understanding Process of scoping the research task / Evidence of reframing the original brief Evidence of identifying relevant issues/problems/constraints/expectations Depth, quality and method of analysis Use of both quantitative and qualitative analysis
Ideation	Quantity and quality / Innovativeness/ Appropriateness
Implementation	Relative success in overcoming issues identified Realism and coherence: sense making Use of prototypes Storytelling and visualization capacity
Design process	Design process spirit (e.g. reflective, iterative and/or solution-focused) Evidence of evaluation and reflection on outcome(s) generated: If, how often and how techniques have been used
Others	Aesthetics (of the presentation of the report) Team dynamics (proactivity, effort, enthusiasm, conviction)

2.5.2. Future reflection

The creation of a start up inside a French administration with a national mission represents many challenges. In terms of space, the negotiation with the administration and internal communication are high on the agenda. In terms of people, challenges include the management of a big project with many different partners and internal issues, the management and education of a project team, the attractiveness for professors, their commitment, recognition and training, as well as for students and partners, the development of new European academic partnerships. In terms of curriculum development, challenges include pedagogical resources, schedules and competence framework.

The adaptation of DT is the main challenge in terms of pedagogical development: how to tackle issues linked with sustainability and objects such as systems (instead of industrialized objects)? It will be a key area of research in the coming years. PAR and research symposium will play an important role. Evaluation criteria used for Innovacteurs (see Table 5) should also be tested for all projects.

3 KEY LESSONS AND RECOMMENDATIONS

3.1 The shift from professorship to staging director

DT pedagogy is a shift from knowledge dissemination in one discipline to action based on the synthesis of many disciplines. Describing DT along line traditional characteristics of a discipline is important for faculty. Table 6 offers a dozen categories under which DT can be compare to other

disciplines (science, design, humanities, business…).

Table 6. DT characteristics as a discipline

Purpose	Improving quality of life
Objective	Value creation for people
Focus	Solution and action oriented
Stance	Proactive, affordance
Competence focus	Know-how and "savoir être"
Pedagogical format	Real issue projects with partners, field work, coaching, activities in staging space
Epistemology	Pragmatism and constructivism
Student's origins	Many disciplines including engineering, design and business
Faculty	Multidisciplinary teams
Project definition	Context based brief discussed between partners and faculty
Problem nature	Ill defined / wicked / messy
Mode of thinking	Collective and constructive
Outcome	Appropriate solutions to a given situation
Pedagogical activities	Inspiration / ideation / implementation
Process type	Cycle and iterative process
Pedagogical tools	Ethnographic research, inspiration, brainstorming, prototypes, user feedback, storytelling, real outcomes
Evaluation	Self reflection, outcomes in the real world
Location	In the field and project space with rooms staged for activities

3.3 PPP framework as a guideline for DT pedagogy development

DT courses imply a lot of work from faculty in order to create the "right conditions for our students to innovate" (Leifer, Stanford, 2008). Setting up DT courses and programs imply to tackle three areas of concern: **people**, **place**, **process (PPP)**. PPP framework may be an efficient tool to guide DT faculty. Depending on the context (resources, project nature, students, faculty's experience…), we recommend three steps of development for each category. Step 1 aims at getting started with a course. Step 2 aims at developing a dedicated program with a full curriculum. Step 3 aims at gaining recognition at an institutional level (national, European, international level for instance). For each step, faculty staff should find the right balance in terms of people involved (students, faculty, partners), place (size, materials, dedicated space for design activities) and project process (motivation, pedagogical tools, access to real world issues, partnership). For each step, one should adapt one's ambitions to credits and resources available, which defines the level of possible commitment and refinement (see Table 7).

Table 7. PPP framework for teaching DT

Step 1: create	**Step 2: develop**	**Step 3: scale up**
One course	One program	A d.school
1 to 3 professors	5 to 15 professors	Up to 70 so far
Up to 70 students	Up to 70 students	Up to 650 so far
None to 5 partners	Up to a dozen financial partners and sponsors	Governmental and private financing with up to a dozen partnerships
A dedicated room	A dedicated floor with a machine shop	Up to a dedicated building with many activity rooms
Use of existing tools and teaching materials	Development of one's teaching tools adapted to one's students	Research and development of new teaching tools adapted to a broad range of topics and contexts

Concerning people, step 1 includes identifying interested faculty members from different disciplines, creating multidisciplinary teams, and identifying outside partners (if needed). Step 2 includes building a consortium with different schools from different disciplines and attracting students from different horizons in a single curriculum, and finding sponsors and creating long term partnerships. Step 3 includes getting official accreditation and recognition and creating and maintaining an ecosystem.

Concerning place, step 1 includes obtaining 50 m^2 space with a full time access and a DT atmosphere (such as "corners" that symbolize 9 activities in section 2.4.2.). Step 2 includes scaling up (to around 150 m^2) and to add a machine shop for light prototyping. Step 3 includes creating a "whole dedicated space" (such as a building) adapted to multiple classes at different time schedule.
Concerning project management, step 1 includes creating a team of faculty members and teaching all together (identifying for whom faculty members want to innovate, which problems motivate them an individuals and why, how to get access to real local contexts). Step 2 includes business development ability, political negotiation with the administration and small team management. Step 3 includes fund raising ability, big project management with different partners and big team management.
Concerning pedagogical tools, step 1 includes identifying assignments for students, simple ethnographic research tools adapted to students and projects, and relevant types of prototyping given the level of resources. Step 2 includes developing a whole range of topics/briefs, transversal tools and adapted ones, according to levels and projects, a clear integration in different education steps. Step 3 includes training and pedagogical resources for faculty staff, a clear adaptation to students.

3.3 Future: Competence framework and teaching tools

A global research direction (Tardif, 2006) is the definition of a competence framework: which competences are developed? How to evaluate them? A handbook would contribute to disseminate DT education according to level of competence (Level 1: basic level / Level 2: intermediate / Level 3: advanced). Based on existing ones (Frazer, 2012), ME310 network and Paris Est d.school's practice, exercises have been developed to respect the philosophy of teaching DT, with approximately 20% of theory/concept and 80% practice. Each exercise is described with the learning objectives, the level of difficulty, teaching method and tricks. The level of difficulty depends on the setting: level 1 concerns classroom exercises, level 2 exercises on ill-defined problems in "controlled" settings, level 3 exercises on wicked projects in open fields. They are broken into 4 categories (inspiration, ideation, implementation, team's dynamics), 8 subcategories (benchmarking, needfinding, brainstorming, creativity, imagination, test with prototyping / modeling / simulation / reality check, storytelling, operations).

4 CONCLUSION

For a professor, taking the decision to transform one's course into a DT course is the beginning of a personal learning and transformative experience: it changes everything in terms of stance and teaching, from professorship to staging director, from knowledge to know-how, from defined to real world problems, from class room to the fieldwork... Such a journey is full of pitfalls and hurdles. It is a very long and difficult journey. Academic recognition based on research and publications may be hard to obtain. Belonging to a community, both locally and globally, is key to learn and exchange best practices, to maintain the momentum, the spirit and the motivation, and to scale up in terms of students, projects and partners. Last but not least, a DT professor continuously learns. Staging DT courses is a constant challenge. It needs continuous refinement, which requires reflection upon one's practice. The reward is in students' words: "It has changed my life".

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