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MULTIDISCIPLINE TEAMS FOR INTELLIGENT INNOVATION: EDUCATING AND TRAINING ENGINEERING AND DESIGN STUDENTS TO CO-CREATION

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Abstract

Holistic approach for industrial innovation is obtained in integrated design teams by mixing up backgrounds and skills into multidiscipline teams. However, is mixing enough? To go further than a simple addition of skills and create a synergy, the key ingredient is to favour communication and understanding between individuals in the team. Our contribution as a graduate school of engineering is to impulse the establishment of common languages and favour constructive interactions between future engineers and future designers. A specific educational program has been tailored for French engineering students to favour mind opening through variety of lectures and hand-on activities. The focus point is a multidiscipline international workshop in design and engineering, gathering students from both areas. The workshop process has been studied and it was demonstrated that significant knowledge transfer and efficient complementarities of skills and methods were occurring and led to a global and user-centred response to the Design brief.

Keywords: Collaborative design, Design education, Design methods

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1 INTRODUCTION

Modern innovation in products or services requires more than successfully implementing advanced functionalities made possible by technology. Empathy with the user, experiences rooted in personal history and memories, consistency across aesthetics and function, seamless integration in connected environments, are among the expected qualities offered by well-designed products and services. Technology itself is being pulled by untold expectations brought to the surface by perceptive designers. Bringing together all these qualities at once under tight "time-to-market" constrains might require more direct and intuitive ways of concept generation and development than the methodical iterative exploration the conceptual and functional spaces (Dorst and Cross, 2001; Hatchuel and Weil, 2004). Cross (2007) explains that the last decades witnessed a shift from a "Design Science" to a "Design Practice". "Desing thinking" is arguably the most visible manifestation of the widespread adoption of designer's work methods outside the Design community. This often ill-defined concept has triggered much enthusiasm both in academia and industry and experienced a widespread attention, as it provides practical ways and means to embrace a holistic approach to product and service development. Pointing out its strong trans-discipline character, Buchanan (1992) qualifies Design Thinking as a *new liberal art of technological culture*. Brown (2008, 2011) defines it as a human- centred approach to innovation that brings together what is desirable from a human point of view with what is technologically feasible and economically viable. Design Thinking differs from traditional problem solving in that is does not rely on value optimisation within a pre-set value framework, but redefines the value proposition itself at the same time as it attempts to maximize its outcome (Dorst, 2011). Intensive experiential creative sessions in multidiscipline teams are among the most favoured settings to implement this process (Clark and Smith, 2008).

In France, the history of Engineering Schools anchors the educational contents to industrial needs, first in Civil Engineering and then in variety of industrial domains. On the other hand, Design Schools in France are deeply rooted in the tradition of Schools of Applied Arts. Thus, due to their educational environment, students from both disciplines accumulate two different knowledge and communication skills. Differences in communication toolsets is recognized as one of the major barrier to efficient multi-discipline teamwork (Kim et al., 2015). Meanwhile, the evolution of industry pushes Design and Engineering closer together in multidiscipline, multicultural product development teams. Our contribution as a graduate school of engineering science is to train our engineering students to work efficiently in multicultural, multidiscipline environments and impulse Design thinking to trigger innovation.

This paper describes a specific workshop setup that was introduced at Ecole des Mines de Saint- Etienne in 2009 in collaboration with Brunel University of London, and developed further until 2012, the year it reached most of its current features. This setup was developed to trigger innovation in a very short time. It was set right from the start in an international context. The process was tested and implemented during workshops gathering engineering and Design students, but also during a workshop gathering worldwide young executives from a global leader in the energy market (herein referred to as "World Company") and young professional designers working in design or design strategy consultancies in the London area. The interactions between the Design and non-Design populations have been observed and analysed over the workshops and demonstrate the efficiency of multidiscipline teams working on a Design brief.

2 MIXING UP BACKGROUNDS: MULTIDISCIPLINE WORKSHOP

2.1 Workshop Setup

Since 2009, Ecole des Mines de Saint-Etienne organises yearly an international workshop in design and engineering that gathers students from both disciplines. While workshops are a common activity in Design schools (Johnson, 2007), such events were rarely held in schools of engineering at that time. One workshop hosts 40 to 60 participants, a third being our engineering students (EMSE), and the rest coming from various international Design related backgrounds, ie: MA students in Design Brand and Design Strategy from Brunel University (BRUNEL), undergraduate students from Saint-Etienne School of Art and Design (ESADSE) and MSc students from various MSc Design degrees from Politecnico di

Milano (PoliMi). The setup was developed empirically, based on various existing methodologies and workshop setups. Early sources of inspiration came from the Synectics innovation method (Gordon, 1961), a problem-solving framework developed for corporate environments, and a workshop in service Design held in 2005 in UIAH Helsinki (UIAH 2006), which rationalized the formal separation between the first creative (divergent) sequence in large groups and the subsequent (convergent) project development phase in smaller teams. The workshop thus comprises two distinct sequences: a creative sequence and a project development sequence. In our setup, one staff per 10 to 12 participants is needed to manage the creativity sequence. The smaller (ideally, 4 participants) project teams are made-up from the large creativity groups at the end of day one by the workshop facilitators, based on their observations of group dynamics and interactions during the idea generation sequence. Opening is on Monday noon and final concept presentations are on Friday afternoon. Thus the workshop duration is 4 full days spread over 5 calendar days. In recent editions, the duration was reduced to 4 calendar days, without significantly altering the structure and outcome.

2.2 Workshop subject

The workshop subject is sent to the participants one month before the workshop. It is usually based on a new technology that has not yet found its application area (personal fabrication systems in 2011), or on existing ones that raise issues with user experience or social behaviour (energy for mobile devices in 2009, numerical identities in 2010). These difficulties are briefly reviewed in the workshop description and the challenge of overcoming these with non-conventional solutions is set.

2.3 Workshop process

A description of the workshop is detailed hereafter and an analysis of the innovation process is proposed based on observations made over the first four workshops. On day one, all students are gathered in a main room for an opening lecture, which is the first collective highlight of the week. A lecture is given as a state-of-the-art or illustration lecture for the upcoming design brief. The content of the lecture has to be carefully selected in order to prevent unwanted self-censorship, obtained for instance when the content is so detailed that no room for innovation seems available at first sight. From our experience, design and engineering students have a different attitude towards introductory speeches. While the former, used to change subject often, are keen on gathering as much information as possible before starting to generate ideas, the later do not see much interest at that stage and usually have a more positive attitude towards focus lectures later in the week, when they are well into the subject and need fresh material to feed their projects. We opted for the quick-and-broad option. While the one-page subject highlighted difficulties, the opening lecture is aimed at opening new horizons by pointing at various unexpected directions, sometimes loosely related to the initial subject.

2.3.1 Production of ideas, textual and visual stimuli

Creative sequence: semi-collective idea generation. After the welcome lecture, the students group is divided into 4-5 groups of 10-12 students comprising all schools and universities. Each group goes in a separate room with one facilitator from the staff. This first sequence is devoted to idea generation. Most of the tools implemented in this sequence are derived or adapted from the Synectics methodology, which is a creative problem-solving method for corporate contexts. The students are facing the facilitator in a U-shape arrangement and are asked to interact with him/her and not with each other. This setup is aimed at preventing sterile and time-consuming discussion or arguing between students during the idea generation sequence. Discussions are deferred to a second sequence, clearly distinct from the idea generation phase. The animator does not interact as a creative input: his role should be limited to note-taker and "atmosphere-minder". The aim of this sequence is to produce as much raw material as possible, which will serve as textual stimuli for the concept development in the next project development sequence. After breaking the ice by introducing everyone, the animator begins with a series of warm-up exercises. These exercises are mind challenges of increasing difficulty, aimed at levelling the ground across design students, who may have had different experiences with creativity exercises. They also help overcoming a possible apprehension towards working in English, which is not the native language of a majority of students, as it would result in production blocking (Nijstad et al., 2003).
The idea generation sequence starts by delivering the design brief for the first time. The brief is a one-sentence incentive summarizing the subject, expressed in a way as to challenge students to be open-minded and creative (e.g., for 2011, "Imagine what personal fabrication will make possible"). The

facilitator asks the students to provide one-sentence ideas that come to their mind. Students are asked to provide ideas without elaborating on relevance or feasibility. They may begin their sentences with “I wish ...” or “It would be cool if ...” as if to quickly describe a vision. The animator writes each idea on a flipchart or large post-it note without censorship. Although the production bits (ideas) are slightly more elaborated than in conventional word-based brainstorming, the same rules apply: no censorship, no arguments, bouncing rather than elaborating on other's ideas, quantity prevails over quality. The result of the idea-generation sequence is 100+ ideas in each group generated in 90 minutes and posted on the walls. This material remains on display during the whole week and can be used as the first step toward a concept or as rebound material later on. At the end of first day the walls of each room are covered with the ideas provided by each group (Figure 1). Students are encouraged to wander in other groups rooms and steal ideas if necessary, in order to defuse a possible early sense of property and an excessive investment in ideas that may turn out to be weak later on.

Figure 1. left: textual stimuli: ideas generated collectively after the creative sequence. Right : Visual stimuli brought by each student (Day Two morning)

Before calling the day off, each student randomly picks the picture of a persona (the exactitudes website (exactitudes, 2011) is a rich source of material) and is asked to gather four other pictures related to the persona they were given. This simple assignment materializes the end of the idea generation sequence. Secondly, the hundreds of gathered images will be used as visual cues (Figure 1 (right)) in addition to the text stimuli produced earlier (Figure 1 (left)). This assignment is in line with the afore mentioned effort to have students anchoring their proposals in a given user group and social context.

2.3.2 Idea grows into starting concept (Starter)

Based on textual and visual stimuli generated the first day, the students are asked to gather ideas that can be linked together through a social context, a user experience, a geographical location or any explicit common point. Elaborating on and challenging ideas is now encouraged, as the main objective is that such clusters of ideas go through a “natural selection” process, in which only the strongest will survive. By mid-day two, the large idea generation groups are split into smaller groups by the group facilitator. The smalls groups composition was set by the facilitators team during debriefing at the end of day 1, based on observed group dynamics and some balance of skills and backgrounds. These groups will be the project teams for the remainder of the week. Each team chooses two clusters of ideas and turns them into starting concepts or "Starters". They are asked to prepare manually a poster on a flipchart paper with visuals and one unique sentence (as long as they want) that defines the Starter (Figure 2). The sentence has to address the “What”, “Who”, “Where” and “When”, but leave aside the “How”, which will be dealt with during the project development phase. This stage is a more involved and linear one than the idea generation. A presentation session is then organised in the main room: each team has five minutes to present both Starter with the posters. All the posters are displayed in the main room so that every participant (students and staff) can vote for the most promising Starter (Figure 2). At the end of the day, only one starter per team remains and they will work on that one for the rest of the week. The challenge now is to go from these Starters to viable and mature concepts in the remaining two days of project development.

2.3.3 Starter develop into projects

During the development and implementation sequence the teaching staff is in charge of challenging the concepts in order to make them mature and viable. The students are asked to implement a global

approach by developing five aspects of their concepts: scenario, user, context, technology, and business model. One of the main pitfall during this 2.5-days phase was seen to be 'over-facilitation : each facilitator randomly checking with each group in turn. From the group's point of view, this resuts in a parade of facilitators who ask repeatedly the same questions and might provide contradicting comments or advice. Frequent facilitators meetings and groups / task assignments overcomes this, targeting in priority the groups whose starter ideas are weakest or who are seen to experience problems in converging to a common vision of their project. Compared to the idea generation phase, in which everything is made to level the ground and blur the differences among participants, the groups dynamics change significantly during this phase and the students seem to come back to some 'roles' prescribed by their backgrounds and skills, as illustrated in the following section. On Day 4, a collective brief is delivered by the head facilitator on what is expected for the final presentations (format, contents, tips for preparation …). On several occasions, "problem owner" or "expert" presentations related to the workshop subject were given during in the middle of the project development phase, with an observed increase of interest from the students (measured by general attention and questions being asked to the speaker), especially from the non-design ones, who had appeared to be less involved in the introductory lectures.

Figure 2. Starter's poster in progress (left), Starter's vote (right)

2.4 Analysis of the workshop process

2.4.1 Isolated team working and collective highlights

Managing the process between participants that do not know each others before is a challenge. Favouring exchanges and mixture of cultures by managing a creative environment mood is a key ingredient in multidiscipline workshops. Organising people, rooms, equipment and other resources has to be carried out in detail. Lunches are organised in the same building to favour informal exchanges across teams and foreign students are accommodated in the local students' residence. The creative part is semi-collective, with project teams not yet formed. It was felt that it favoured the early mixing of skills and contributions from the students groups. Short collective highlights are organised every day in the main room, even after the team formation. These activities (lectures, votes, concept presentation…) help the students to remain connected to the whole group and prevent the isolation of a team during the project development process, which can be intense. For instance, the vote session creates a very emulative atmosphere:the teams defend and rephrase their Starters to the others and also re-interpret others' Starters based on their own interests and views. It can be noticed that this sequence is very exciting for the students because all of them were highly involved in the idea generation, Starters definition and defence processes.

2.4.2 How the process was perceived

On Day Four, during the project development sequence, the students are gathered into the main room and are asked to represent the process they have been through on an A4 piece of paper. They have a few minutes so that their response has to be very spontaneous. Some chose text-based representations in flowchart form, while others chose visual representation with schemes and figurative drawings such as light bulbs or smiling faces to represent ideas.

Independently of their text or image-based form, these representations could be classified into two categories. In the first category, the focus is on the idea generation followed by the selection of a good

idea that would then grow into a valid concept (Figure 3). In the second category, focus is on a process based on clustering and gathering pieces together to create a valid concept (Figure 3).

Figure 3. Student representation of the workshop process (left) focused on idea selection, (right) focused on idea clustering

Actually, the whole workshop process contains both ingredients at different stages. The creative sequence is devoted to idea generation, leading to a very large amount of thoughts than can be either valuable or not as pictured in Figure 3 (left). A selection does occur first when the teams have to build up Starters based on the ideas generated and after when one starter has to be chosen. As highlighted on the left picture (Figure 3), some good ideas might be lost in the process. To limit those risks, all thoughts are displayed permanently during the workshop and opportunities to re-phrase, re- formulate and re-interpret ideas are provided, for instance during the starters presentations and the vote. When project teams encounter difficulties during the development phase, a member of the teaching staff may help them re-run a miniature session of idea generation and clustering on a sub- problem. Being too involved in their project, students do not usually have the capacity during the week to step back and formalize such a process. Finally, the building up of the starters is performed through a clustering of ideas as pictured in Figure 3 (right). While the process was not perceived identically across students, their interpretation of the process showed that for all of them, the process should point towards a viable and valuable concept.

2.4.3 Evolution of students perceptions during the workshop process

This workshop was held in the Ecole des Mines de Saint-Etienne since 2009. Besides the educational interest in terms of student experience, we were interested in analysing the knowledge exchanges and the perception of the students groups in the process (by themselves and by other's). To do so, the students' views have been collected at different times during the workshop. Three specific times were selected: first at the beginning of the workshop (Day 1), before any interactions between student groups, second, after the creative part, i.e. right after the concept selection (Day 3) and finally at the end of the workshop (Day 5).

The first year, a questionnaire with six questions was given to be filled-in by the participants. The questions were:

1. What do you see as the main or most important reasons for using multidisciplinary teams in the innovation or product development process? List three only, starting with the most important.
2. What barriers, obstacles or difficulties do you think will occur in the St Etienne workshop? List three only, starting with the most important.
3. What do you think the 'groups' will contribute to the workshop, in terms of tools, skills, attributes – positives and negatives?
4. What personality traits do you think the other groups will exhibit…which are directly associated to there 'discipline' or training?
5. Circle or Underline the words that best describe the process you imagine being pursued for the project: linear, structured, unstructured, directed, iterative, activity based, cerebral, creative, consensus driven, authoritarian, practical, abstract, chaotic, other…
6. Circle or Underline the words that best describe the tools that you imagine will be used within the workshop / project: brain storming, Synectics, personas, QFD (Quality Functional Deployment), scenario building, Six Hats (De Bono), SCAMPER, body storming, Soft Systems Methodology, mapping, customer journey, blue sky, intuitive thinking, critical thinking, other…

Some obvious conclusions popped out from the analysis of the questionnaires. For instance, the reason for using multidisciplinary teams in the innovation or product development process is the access to complementary views and skills. "Brain Storming" is often cited as a tool, but is probably used as a generic reference to describe "unstructured creative thinking" type of activities. Finally, English language is consistently cited as difficulty by the students, although it has not been seen as an issue by the tutors (note that English is not the native language for most participants). Indeed, in another multidiscipline workshop held in French and gathering engineering, design, architecture and social science students (mostly native French speakers), language and communication were even more strongly pointed out as difficulties by the students. Our analysis is that communication issues more probably stem from differences in cultural backgrounds and approaches/priorities than language (Kim et al., 2015). On the contrary, it seems that the constraint of working in one's non-native language helps the students accepting the obligation to constantly rephrase their ideas, which is a cornerstone of such multidiscipline team working, and which may appear as a burden when working in one's native language.

Other answers illustrate the knowledge transfer that is occurring during the workshop. We noticed the appearance on Day 3 of a positive vision of the multicultural aspect, which was seen as a possible obstacle on Day 1. The increase of the number of cited tools, some of them having been used, but not formally named and identified is an illustration of learning by practice. Personality traits of design students seen by engineering students significantly shift from imaginative and creative towards methodological. Engineering students discovered that design students had strong methodology and market analysis skills. Some engineering students realised that designers focused on a user-centred approach, as opposed to solution-driven approach. Concerning the viewpoint of design students on their engineering counterparts, the most impressive evolution between Day 1 and Day 3-5 is that all preconceptions - which portrait engineering students almost as engineer archetype (methodical, rational and solution driven) - vanish in the course of the week (apart from the focus on technology, which remains strong along the week).

While these questionnaires produced interesting data on the workshop process, filling them seemed to impair the momentum of the workshop, by forcing the students to adopt a critical view on their own contribution. During the 2011 workshop, we opted for a more spontaneous and visual way of collecting students insights. Large charts (2 metres tall and 1.5 metre wide) headed with a question and 2-perpendicular axes hosting one proposition at each end (four in total) were displayed in the main room. The students were given stickers with their different institutions' names or logos and were asked to position these on the charts. Like with the questionnaires, charts were displayed on days 1, 3 and 5. Some of the resulting charts are plotted in Figures 4, 5 and 6. The first question was related to the personality and the educational discipline (Figure 4). On Day 1, engineering students (EMSE on the charts) were mostly perceived as rational and not specifically narrow nor open-minded. At the other end, undergraduate students from the School of Art and Design (ESADSE) were clearly seen as non- rational and open-minded, while graduate Design Branding students (BRUNEL) were perceived as open-minded but not specifically rational or irrational. On Day 3, the collective work that they have all been through during the creative sequence has levelled the differences in personality that was previously imagined. All three groups of students are described as open-minded and not specifically rational nor irrational.

A second interesting chart (Figure 5) describes the evolution of the perceived inputs of each group. While both design students groups are similarly perceived on Day 1 and Day 3, i. e. they provide ideas and are creative. The engineering students' group moves from providing solution and being methodical to a more balanced description in the middle of the chart meaning that they also provide ideas and are creative. These two series of charts (Figures 4, 5) illustrate what was qualitatively observed during the Starters' presentation. As mentioned above, the Starters presentation is a very exciting moment for the students because all of them, designers and engineers, were highly involved in the idea generation process and the Starters preparation. After the fuzzy impression left by the idea generation sequence with unstructured methods and an overwhelming amount of data generated, students feel efficiently creative in that they manage to propose two Starters they believe in. Over the years however, we consistently observed that an overwhelming sense of satisfaction at this intermediate stage was detrimental to the development sequence. Indeed it has been observed that some teams that had very promising Starters did not manage to develop them into a mature concept: Their concept just went round in circles during the two days of project development. We interpreted it as a paradoxical and somewhat

exacerbated occurrence of Design fixation (Jansson and Smith, 1991, Purcell and Gero, 1996, Linsey et al., 2010). The excessive sense of achievement derived from a powerful Starter idea would prevent the reframing of the initial idea in terms of user, contexct and usage scenario during the development phase

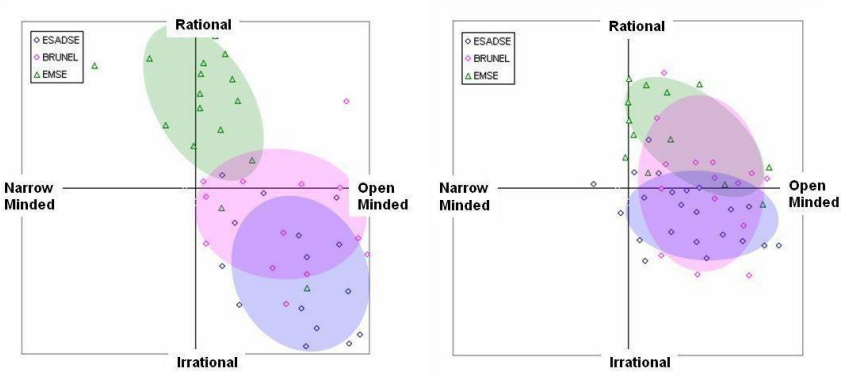

Figure 4. Answer chart to the question: "What personality traits did the other groups exhibit which are directly related to their discipline?". Day 1 (left), Day 3 (right). Colour areas are guides to the eye. The chart excludes self-evaluations from each group

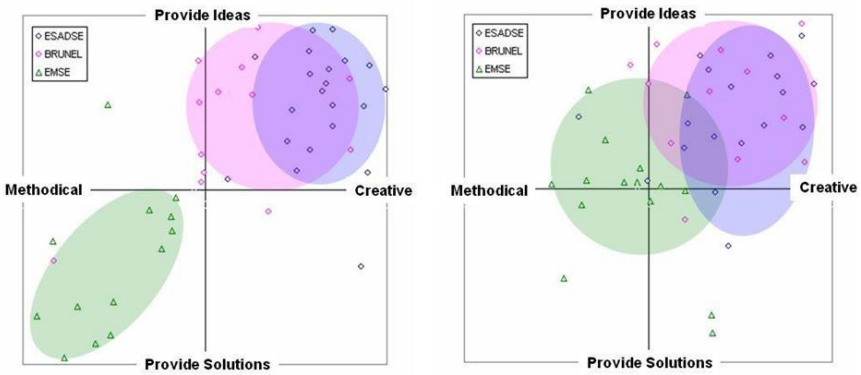

Figure 5. Answer chart to the question: "How would you assess each group's input in the workshop process?". Day 1 (left), Day 3 (right). by others. Colour areas are guides to the eye. The chart excludes self-evaluations from each group

To prevent this "Day 3 Bug", the two sequences of the workshop could be separated in time. A few days or weeks could be left in-between both phases to reduce the premature feeling of achievement associated to these presentations. Youmans (2011) suggests that physical prototyping is also an effective workaround To evaluate the effects of such a time break in the project development process, the 2011 engineering students took part in a prototyping workshop based on the concepts that were proposed at the end of the multidiscipline workshop. They were asked to choose one concept and to make a functional prototype using cardboard. The target of that second workshop was to have students identifying the "critical function" and/or "critical experience" associated to a concept and to turn the concept into a physical prototype. They become Tom Kelley's Experimenters that "prototype new ideas, learning by a process of enlightened trial and error" and Hurdlers that "develop knacks to overcome obstacles" (Kelley, 2005). This second workshop occurred one month after the first one. Students had resumed activities unrelated to design in between, even though, the students' involvement, interest and memories of the concepts were acute and the prototyping workshop positively enriched the concepts in terms of ergonomics, user experience and product-user interface.

Finally, the chart on Figure 6 displays the evolution of how engineering students perceive themselves in the process. A trend is observed going from the engineer archetype that provides solutions and is methodical to a more versatile engineer that can also provide ideas. This means that an evolution has successfully occurred in the self-consciousness of the engineering students.

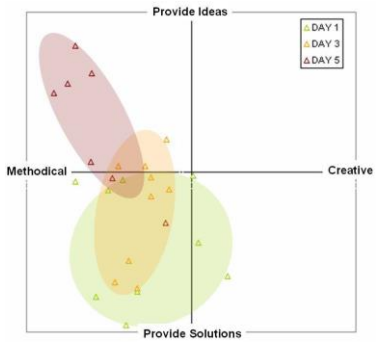

Figure 6. Answer chart answer to the question : "How would you assess each group's input in the workshop process?". Day 1 (left), Day 3 (right). Colour areas are guides to the eye. Self-evaluation of the engineering students

Managing a balanced contribution from each group is probably easier when working with students during their initial training. In addition to a technical and cognitive task, design is a social process (Cross, 1995) and prescribed social roles may play an important part when involving professionals (Austin 2001). Our students groups are not immune to archetypes and social conventions, as exemplified by their replies to the surveys on Day 1, but it was seen that these perceived differences may vanish after two days of an intense collective creative effort. In 2012, a workshop gathering young professionals from a world company and young professional designers working in consultancies was held, based on the same setup. Similar charts were displayed in order to record the participants' insights. These charts demonstrates that a similar process is perceived by young executives from a global company: they first come thinking they will provide solutions and understand that they can also be creative and provide ideas (Figure 7 left). On the other hand, these young executives were perceived as solution- driven archetypes by the young designers before being revealed as idea providers (Figure 7 right).

Figure 7. Left: How would you qualify your own group's input in the workshop process?Young executives from World Company, by themselves. Right: How would you qualify the other group's input in the workshop process? Young executives from World Company, seen by the young professional designers

3 CONCLUSIONS

This specific teaching and training program was tailored for engineering students with interests for innovation and industrial design. The keywords of this program are co-creation, multidiscipline, synergistic communication. It aims at preparing future engineers for team-working with people with various backgrounds, methodologies and skills. The chosen strategy is to favour mind opening through complementary lectures (sociology, materials, perception, drawing, design cultures) and hands-on activities. The focus point is a multidiscipline international innovation and design workshop gathering engineering and design students from different European institutions. The analysis of the workshop process demonstrates that a transfer of knowledge and methods is operating during the week. In this setup, design and engineering are forced to work together since the very beginning during the first creative sequence of the workshop. An appropriation of the design brief is achieved simultaneously by both engineering and design students. A positive interaction between those two disciplines leads to co-

creativity and enriches the innovation process. A holistic approach of the design brief is implemented during the project development sequence leading to balanced concepts.
Working in one's non-native language was observed to be beneficial to the involvement of all, irrespective of their initial background, by levelling the ground during the initial intensive idea generation phase. Monitoring the students perception of their roles in the process showed that their initial 'prescribed' roles vanish after the idea and concept generation phase, but tends to come back by the end of the week, when the pressure of the final presentation deadline calls for an efficient attribution of tasks A “Day-3 bug”, which was interpreted as an exacerbated form of design fixation caused by an early feeling of achievement was consistently observed among groups who had a strong starter concept to work on during the development phase. Moving on to an activity of physical prototyping on the same concept a few weeks after the workshop was seen to overcome this design fixation efficiently.

REFERENCES

Austin S. et al. (2001), Mapping the conceptual design activity of interdisciplinary teams, Design Studies, Vol. 22, pp. 211-232.

Brown, T. & Katz, B., (2011), Change by Design. Journal of Product Innovation Management, 28(3), pp.381–383.

Clark, K. & Smith, R., (2008), Unleashing the Power of Design Thinking. Design Management Review, 19(3), pp.8–15.

Cross N. and Cross A. C. (1995), Observations of teamwork and social processes in design, Design Studies, Vol. 16, pp. 147-170.

Cross, N., (2007), From a Design Science to a Design Discipline: Understanding Designerly Ways of Knowing and Thinking. In Design Research Now. Basel: Birkhäuser Basel, pp. 41–54.

Dorst, K., (2011), The core of “design thinking” and its application. Design Studies, 32(6), pp.521–532.

Dorst, K. & Cross, N., (2001), Creativity in the design process: co-evolution of problem–solution. Design Studies, 22(5), pp.425–437.

Exactitudes (2011), photography website, http://www.exactitudes.com

Gordon W. J. (1961), SYNECTICS. The Development of Creative Capacity. Harper & Row, 180 p.

Johnson P., Griffiths, R., Gill, S. (2007), ‘The 24 hr product: from concept to interactive model in less than a day’, ,Int. J. Design Engineering, Vol. 1, No. 1, pp. 56-70.

Hatchuel, A. & Weil, B., (2009), C-K design theory: An advanced formulation. Research in Engineering Design, 19(4), pp.181–192.

Jansson, D.G. & Smith, S.M., (1991), Design fixation. Design Studies, 12(1), pp.3–11.

Kelley, T. (2005), Ten faces of innovation, New York, Random House.

Kim, Y. et al., (2015), Barriers to hinder collaboration within product development teams from a designer's perspective and the development of a method to . In Proceedings of the 20th International Conference on Engineering Design (ICED15). Milan, pp. 193–202.

Linsey, J.S. et al., (2010), A Study of Design Fixation, Its Mitigation and Perception in Engineering Design Faculty. Journal of Mechanical Design, 132(4), p.41003.

Nijstad, B.A., Stroebe, W. & Lodewijkx, H.F., (2003), Production blocking and idea generation: Does blocking interfere with cognitive processes? Journal of Experimental Social Psychology, 39(6), pp.531–548.

UIAH (2006), Repent! Service Design Workshop / UIAH Helsinki 26-30.09.2005, ISBN: 951-558- 207-5

Purcell, A.T. & Gero, J.S., (1996), Design and other types of fixation. Design Studies, 17(4), pp.363–383.

Youmans, R.J., (2011), The effects of physical prototyping and group work on the reduction of design fixation. Design Studies, 32(2), pp.115–138.