

CREATIVITY AND INNOVATION: DEVELOPING DESIGN THINKING AND VISUAL COMMUNICATION SKILLS

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Abstract: A common feature of today's societal challenges lies in their complexity. Society's ability to address these problems depends on education programmes developing in their graduates competencies and capabilities needed to drive innovation in unanticipated situations. Key challenges lie in developing creativity and innovation skills in students and in supporting them learning to apply these skills to real-world problems that are typically complex and unpredictable. This paper builds on experiences from a week long workshop, "Innovation Week", that is delivered as a core and distinctive part of a multi-disciplinary undergraduate programme in Product Design. Through a condensed, one hour, version of Innovation Week, we also explore ways in which design and visual thinking might be integrated into educational curricula with a view to identifying requirements for future developments in both educational and professional practices.

Keywords: *design thinking, visual thinking, creativity, innovation, education*

1. Introduction

Finding responses to today's major societal challenges, such as sustainability, energy, water and food security, will require innovative solutions that span social, technical and politico-economic dimensions. The people who lead the development of these responses are likely to be members of multi-disciplinary teams working with diverse groups of stakeholders. This creates a need for education programmes that produce graduates with competencies and capabilities needed to drive innovation in unanticipated situations and from the perspectives of multiple disciplines. Creativity and innovation are recognised as important factors in business success and are regarded as important aspects of employability (CBI, 2009). For the purposes of this paper, and in line with the Oxford English Dictionary definition, creativity is the unconstrained use of imagination or original ideas to create something new. In the context of design and development, the results of creativity are typically design concepts and solution principles. Innovation, on the other hand, is constrained; in this paper we regard innovation as creativity with constraints. For example, innovation skills are needed to develop design concepts into design definitions that can be manufactured using specific resources and delivered to market on time and to cost. Design and visual thinking are essential skills that underpin creativity and innovation. Curano (2012) cites a number of authors who assert that design thinking encourages the generation of new concepts during the front-end of innovation. For the purposes of this paper, design thinking (Platner, 2012) is regarded as a holistic ideation process that produces new ideas or thinking on a given topic; this complements Martin's description of design thinking being a

balance of analytical and intuitive thinking. In contrast, visual thinking is a tool used to explore and further elaborate new ideas (such as those generated through design thinking) using visualization much like an author uses words. Drawing, for communication as opposed to art, is an important tool for doing visual thinking. There are many examples of powerful ideas have been communicated with simple sketches (see examples in Figure 1) and (Kettles Yard, 2006) provides evidence that visual thinking, realised through drawing, is used to good effect across a wide range of disciplines as a means of exploring and developing ideas.

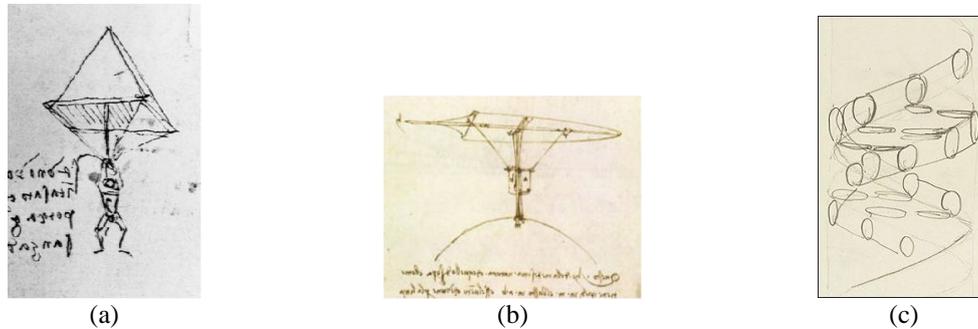


Figure 1. Simple sketches communicating powerful ideas (Images reproduced from www.leonardo-da-vinci-biography.com/images/ (a&b) and (c) the DNA helix by Francis Crick from www.wellcome.ac.uk)

2. Structure of the paper

Design and visual thinking are key competencies needed for creativity and innovation. A review of literature (in Section 3) considers creativity and roles visual representations play in design practice. The idea and composition of Innovation Week is introduced in Section 4. It has been delivered in two forms: a week long workshop for Level 2 Product Design students and a condensed one hour workshop to introduce these ideas to academic staff (Section 5). Results produced by participants in a workshop based on the condensed version are presented and discussed in Sections 6 & 7. Finally, in Section 8, conclusions and relevance to other disciplines are considered.

3. Background

The importance of graphical images and drawing in building mental models of complex problems is widely recognised (Latour, 1986). The value and use of sketches to designers is discussed by Schon & Wiggins (1992) based on observations of architectural design students using sketches within a design process. They describe the sketching process observed as a sort of experimentation consisting of “a reflective ‘conversation’ with the materials of a design situation”. Each ‘snippet’ of designing, is described as a kind experiment they call a ‘move’ experiment. Their observations describe the ‘conversation’ as a seeing-move-seeing process. Seeing in this scheme has two meanings, actually seeing what is there [the sketch] and seeing in terms of being able to make new interpretations. The ‘move’ aspect is the creation of a sketch which may provide a new or developed idea for further interpretation. At the point of second seeing, an appreciative decision or judgment is made to affirm or negate the work which is portrayed in the sketch. Such conversations can produce both intended and unintended consequences with both significant and insignificant outcomes. Working stage by stage, rather than on an entire problem at once, allows a designer to manage complexity and discover consequences move by move. More recently, Hasirci and Demirkan (2007) report on studies with architectural design students exploring factors that enhanced their creativity. Key findings of relevance to this paper were that (i) 3D representations of designs correlated with more creativity than 2D representations and (ii) the highest correlation was between process and creativity where the process was O’Neill and Shallcross’s 5Rs model of creative processes: readiness, reception, reflection, revelation and recreation. Ewenstein and Whyte (2009) report research on how visual representations support knowledge development activities in the context of organisational learning in multi-disciplinary teams, again using architectural design as a case study. One of the challenges in developing design creativity skills lies in avoiding fixation on any specific solution. Walker et al

(2009) report a study of relationships between design fixation and the use of design prototypes early in students' design processes. Their findings were inconclusive when they compared resulting designs using three criteria: how innovative individual designs were, how feasible they were and how diverse the ranges of designs were.

4. Innovation week

Innovation Week is a five-day workshop on creativity and innovation in design meant for Level 2 Product Design students. Normally it has an enrolment of 50 students. It has been offered annually since 2005. Innovation Week exposes students to a variety of creativity and innovation experiences by way of different exercises, each one underpinned by design thinking and visual communication skills. Furthermore, each exercise has been designed and selected to familiarise the student with various aspects of the creative process. All exercises emphasise learning by doing. Table 1 provides a description of the exercises most closely associated with design thinking and visual communication skills. Since 2005 these exercises have been offered to well over 400 students. In the context of design thinking and visual communication skills our observations have led to the following conclusions.

Variety of challenges: As a set and over a period of five days the exercises must provide a variety of challenges and experiences in design thinking and skills in visual communication. Some exercises are more realistic while others are quite abstract. Some exercises challenge spatial thinking while others focus more on logical thinking. In our experience, variety reduces predictability.

Length of exercises: The time allowed for exercises appears to be important. Some exercises should be short with immediate results because there appears to be positive reinforcement with more immediate gratification. That said, there are also benefits to be gained from longer exercises where more time is given to explore multiple solutions and ponder alternative directions. Once again, there is a need to be unpredictable in the types of exercises offered.

Individual vs. team: There is merit in working in teams when considering exercises in creativity and innovation. Teams can be effective when team dynamics are at their best. In these cases, team members can support and reinforce each other. That said, there is also a need for exercises geared to the individual in order to build self-confidence.

Co-operation vs. competition: From our observations, it appears that exercises that are based on co-operation can be effective in the development of design thinking and skills in visual communication. Design is not always self-referential. That said, there is also a need for competition when applied judiciously and in ways that teams or individuals are encouraged to go beyond their initial expectations. These two approaches – co-operation and competition – need to be intertwined in the various exercises, most often by encouraging co-operation within a team in an exercise that is undertaken in a competitive setting.

Table 1: Description of Exercises in Design Thinking and Visual Communication

Exercise 1: One Size Fits All		
Description	Objective	Results
Individually, participants are asked to find one solution to a specific problem for which there is only one known solution. The challenge is situated in a person's capacity to visually imagine a solution. Total time for the exercise: execution: 20-25 minutes; discussion 30-45 minutes.	Visually imagining solutions is an invaluable yet atypical creative skill. By the time we reach the age of twenty our perception of the material world has been conditioned by many factors some of which place real limitations on visual thinking as an important skill.	The very nature of the problem makes it almost mandatory to visualise a solution; moreover, the challenge is too complex for most people to solve in their heads, so to speak. To be successful, the participant must combine logical thinking (mental capacity) with visual exploration (visual thinking).

Exercise 2: View from the Top		
Description	Objective	Results
<p>This exercise is an individual exercise and continues the potential implicit in visual imaging introduced in Exercise 1. It is based on the logic of the orthographic view, on the one hand, and the numerous possibilities for interpretation if only the top view is provided, on the other. Total time for the exercise: execution: 3-4 hours; discussion 1 hour.</p>	<p>The exercise raises and addresses the issue of predictability, which often comes from expectations based on stereotypes. Known expectations are challenged, resulting in images never imagined to be possible. In great part, such images are made possible because of visual thinking skills.</p>	<p>When first presented with the exercise the participants are more often than not inclined to develop predictable ideas. Soon thereafter comes the inevitable creative leap. From observation it appears that this leap is in great part fostered by strong visual thinking skills.</p>
Exercise 3: Mix 'n' Match		
Description	Objective	Results
<p>Predictability is the bane of creativity. To break the predictability pattern teams of participants are asked to design a known product but for a totally unfamiliar user. Total time for the exercise: execution: 12 hours; discussion 2 hours.</p>	<p>The exercise deals with innovation because specific constraints are introduced. Teams select a familiar everyday object from a list. This heightens their expectations about the design exercise. However, their expectations are immediately shattered because the user of the everyday object is totally unexpected. This combination of familiar object and unexpected user places the teams in a design conundrum. Our observations show that design thinking and visual communication skills clearly enhance the exploration of ideas.</p>	<p>Participants realize that innovative solutions are more likely if criteria are challenged in their entirety. The unexpected user achieves this end because it does not allow for stereotypical design solutions. Innovative solutions and strong presentations are usually those that incorporate visual communication skills to both explore their design solutions and to explicate them.</p>
Exercise 4: Dropping an Egg		
Description	Objective	Results
<p>There are many sources for creative and innovative solutions. In this egg-dropping exercise, a classic one in design education, teams of participants are asked to look at how nature can be a source for creative and innovative thinking.</p> <p>Total time for the exercise: execution: 2 days; testing and discussion: 3 hours.</p>	<p>There is nothing new with the egg-drop exercise. It has been offered in many guises over many decades. What makes this version of the exercise different is that the solution must originate with nature in a way that is more commonly known as biomimicry. Biomimicry provides a kind of design-thinking model, one that provides a direction for solutions.</p>	<p>Our observations have shown that design thinking is invaluable in reconciling the many facets of the design problem and that visual thinking skills greatly assists in the development of innovative solutions.</p>

5. Condensed innovation week

A condensed one-hour workshop to introduce similar ideas to academic staff (see Table 2) was first delivered in January 2012 (SEC1, 2012). The results presented below relate to the Mix 'n' Match exercise, as shown in Table 1 (Exercise 3). It was offered as part of a university-wide Student Education Conference (SEC) to approximately 30 staff from a number of disciplines. The questions we were exploring surrounded the applicability of Innovation Week, which is highly effective and well-received for undergraduate design students, to non-designers in a number of disciplines. The

Table 3: Delegates' reflections

TRIANGLE	SQUARE	CIRCLE
Balance between image and language	Context is critical; i.e. meaning of word only works if one knows the context.	Likely to be most suited to (unreadable) types of learning? What can you do with it?
Difference between creativity and innovation; use of drawings to communicate How teams work to develop ideas.	How impossible tasks were accomplished.	How to use this?
Opened up possibility; encouragement to use creativity; everyone can be involved.	Good fun; quickly able to work in a team.	How might this work in the humanities?
Encourages working in fun way; ease of doing.	Extent of learning in a single exercise.	Outline ???
That you can design anything for any situation; don't need to confine to expectations; consider user needs before moving on to device.	Using images to work through design direction; actually finding a 'product' with a function appropriate to animal.	Consider use of this method for drawing in my work.
Evolution of products; egg-problem solving exercise.	Constraints leading to more directed problem-solving/creative thinking.	
Apologising for ideas; use of fun/ridiculous to break barriers; combining words and pictures (not all written down)	The freedom of thinking – like unconstrained creativity.	How could I use this in my teaching; lines of enquiry; thinking through drawing.
Good fun exercises; fun; interactive; challenging.	Importance of image; the biomimicry made me think of lessons from nature.	How can I use this in my practice? How can I use this with staff development? (decision making maybe)
Challenge; project in two days; begin end; impossible; achieved; success.		How to assess?
Being in a team; other protocol difficult; no good/difficult; get a lot done in a short time (3)	Bring back the pencil!	How inventiveness could be assessed/ integrated into course?

7. Discussion of results

The focus of this section is on the participants' reflections. The language used in the reflection sheet comments (given in Table 3) was analysed to identify patterns. The format of the response form (Triangle/Square/Circle) is not a scientific instrument in any true sense of the words. However, the format does provide insights that are both spontaneous and quick. Consequently, there is value in analysing these impromptu, almost visceral, statements made by the participants. The focus of the analysis was on recurring use of specific words. In the following, the number in brackets indicate the frequency with which the words occurred.

- **Triangle:** this question asked the participants to note three things that stood out for them in the design exercises offered. There was a pattern of specific keywords in many of the responses. The most common keywords and their possible indications are as follows.
 - Fun/challenging (5): the importance placed upon personal satisfaction in doing a design exercise, i.e. participants welcomed the challenge of the design exercise but even more so if there was pleasure derived from doing it.
 - Team/collaboration (4): the interpersonal connections and relationships that were experienced in the design exercises and that were considered notable.
 - Image/drawing (3): the importance of the visual language when undertaking exercises in creativity and innovation as well as an essential aid in the communication process.

- Creativity/innovation (3): the use of such words can be interpreted as a confirmation of the goals of the design workshop and its meaningfulness to the participants.
- **Square:** this question asked the participants to note the one thing that squared with them in the design exercises offered. In other words, what was one thing that resonated with the participant as the result of the design exercise. Consequently, the words used would most likely indicate an important feature in the creative process. Two participants provided more than one response. There was a pattern of specific keywords in many of the responses, some of which were similar to the Triangle question. The most common keywords and possible interpretations are as follows.
 - Goal/success (3): could be interpreted as a confirmation of the underpinning psychological goal of an exercise in design creativity, i.e. the reinforcement of the creative activity by way of achieving success. These two words that were never mentioned in in the Triangle question.
 - Creativity/innovation (2): can be interpreted as a confirmation of the goals of the design workshop and its meaningfulness to the participants.
 - Image/drawing (2): two participants mentioned image and drawing as features that squared with them. Combined with the inclusion of the same words in the Triangle question image and drawing appear to be important features in creativity and visual thinking.
 - Team/collaboration (1): the use of such words in the Square question appears to confirm what had already been discovered by the use of the same terms in the Triangle question, i.e. there is benefit to be gained by way of collaboration.
 - **Circle:** this question asked the participants to note the one thing that was circling in their minds once the design exercise was behind them. In other words, what were issues left unresolved as the result of the design exercise. Clearly, the question provides two possible types of answers: a narrow reflection of the design exercise itself but, more importantly, the broader implication for future application of the creativity process. Several participants provided more than one response. There was a pattern of specific keywords in most of the responses but almost all focused on two interconnected keywords: application and assessment.
 - Application/assessment (6): there were no comments on the quality of design exercise itself. There were, however, comments on the application of creative exercises in areas outside of design as well as the process or method for assessment. Such reflection provides the researchers with feedback on further exploration of creative design exercises in areas that are perhaps non-traditional such as education and the humanities.

8. Conclusions

Skills in innovative thinking are sought after by business. Following extensive collaboration with business, the CBI defined a set of eight employability factors they believe are essential for graduates to enter the work of work. One of these is problem solving (defined as “analyzing facts and situations and applying creative thinking to develop appropriate solutions”) and another is entrepreneurship/enterprise (defined as “an ability to demonstrate an innovative approach, creativity, collaboration and risk taking.”) According to the CBI these two skills, based on innovation and collaborative creative problem solving, make up a quarter of the prerequisite attributes a graduate requires to make a “huge difference” to any business (CBI, 2009).

Design thinking can be used as a means of taking different routes to a goal; the starting point may be very unclear with ill defined problems and solutions. Figure 2 illustrates that the starting point may well be from ill defined problems or ill defined solutions with the ultimate goal as a well defined problem and solution. Our observations of activities during Innovation Week also provide evidence that visual communication skills support and enhance design thinking skills. In fact it is difficult to imagine how design thinking could be totally effective without some level of visual communication skills. As shown by the results of the condensed workshop, design thinking can be used to rationalize and resolve unexpected problems and also to resolve familiar problems in unexpected and surprising

ways. In the condensed version of Innovation Week we were surprised by the ease with which non-design people participated and quickly generated results. Design thinking and visual thinking were used to explore and better define solutions to complex and very unexpected problems. As can be seen from their reflections, the session was positively received and the main area for further thought (circling) was in how design and visual thinking might be applied in non-design disciplines.

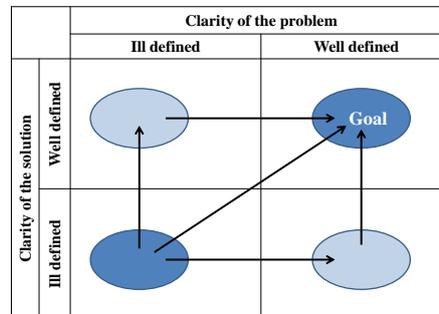


Figure 4: Design start and end points

Acknowledgements

Innovation Week has been delivered eight times since its first delivery in April 2005. The students, SEC workshop participants and colleagues who have participated in the workshops have been instrumental in the way it has developed.

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SEC1: The First University of Leeds Student Education Conference. Friday 6 January 2012. Details available from http://www.lts.leeds.ac.uk/Student_Education_Conference/SEC_index.php.