

Bombs Away: visual thinking and students' engagement in design studios contexts

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Abstract

In design studio, sketching or visual thinking is part of processes that assist students to achieve final design solutions. At QUT's First and Third Year industrial design studio classes we engage in a variety of teaching pedagogies from which we identify 'Concept Bombs' as an instrumental in the development of students' visual thinking and reflective design process, and also as a vehicle to foster positive student engagement. Our 'formula': Concept Bombs are 20 minute design tasks focusing on rapid development of initial concept designs and free-hand sketching. Our experience and surveys tell us that students value intensive studio activities especially when combined with timely assessment and feedback. While conventional longer-duration design projects are essential for allowing students to engage with the full depth and complexity of the design process, short and intensive design activities introduce variety to the learning experience and enhance student engagement. This paper presents a comparative analysis of First and Third Year students' Concept Bomb sketches to describe the types of design knowledge embedded in them, a discussion of limitations and opportunities of this pedagogical technique, as well as considerations for future development of studio based tasks of this kind as design pedagogies in the midst of current university education trends.

Keywords

Visual thinking, Design sketches, Design studio, Student engagement

In any design studio on any given day, someone will always be working with pens, pencils and paper. Whether it's a mock-up, mood board or concept, sketching is the quickest way to produce visual representations of ideas. Sketching constitutes a natural thinking process in design; it is part of a process in which final design drawings are approached through a series of drawings (sketches); it is the designer's dialogue with his/her ideas (Cross, 1999). Sketching as concept development technique and the ability to visually communicate ideas is a fundamental skill and essential in design practice.

In traditional design education, sketching is part of design studio pedagogies. It is through the iterative practice of sketching that design students learn about design visual thinking; that is, the process by which visual elements—codes, symbols, and other representational forms—are integrated into the tangible forms (whether drawings, prototypes, etc.). This pedagogical approach, adopted from the Architectural design studio tradition, is also present in other disciplines: Engineering, Games Design, Fashion, Filmmaking, etc.

In this paper we introduce “Concept Bombs” as one of the approaches employed in design studio pedagogies at the Industrial Design discipline of the Queensland University of Technology (QUT). Concept Bombs are design studio tasks that require students to engage in a rapid visual thinking process to generate a conceptual solution to a supplied design problem in a very short time. The context is the design studio and thus this paper reviews key literature on design studio pedagogies and visual thinking. Through the analysis and comparison of First and Third Year students’ Concept Bomb sketches, this paper describes the types of design knowledge embedded in students’ sketches; benefits, limitations and opportunities of this pedagogical technique.

Finally, the paper presents a discussion of how this kind of studio activity promotes reflective design process and consideration for future development as design pedagogy in the midst of current university education trends. Amongst other challenges for educators, current higher education trends promote an ‘outcome focused’ approach where students, instead of being deeply immersed in the process of learning are eager to complete tasks, finish assessments, graduate and become employed. While this is understandable in light of economic trends, processed based learning task become more crucial for a student’s education and development as good designers (Taboada & Coombs, 2013).

Design studio pedagogies, design sketches and visual thinking

Design studios are the traditional educational models in design education and it has also been seen as producer of knowledge and social practices in design (Dutton 1987:17). The design studio pedagogical approach is widely known as foundational for design education and is an important part of the educational curriculum. The primary aim of studio-based teaching is not only focused on how to design but on what design is through a creative and analytical way of thinking. The design studio is the first place where a design student will experience the design process. This view is firmly supported on the Architecture studio tradition where the act of designing—generating, evaluating, and developing alternatives—is learned and practiced (Gross et al; 1997). The literature refers to a variety of well-established pedagogies that are employed in design studios where the student’s individual designing process during the studio is the central activity. Some of these pedagogies are: field trips, expert lectures and panel discussions, pin up sessions, desk critique sessions, formal juries, consultation during class work time, and a propose-critique-iterate stance (Broccato, 2009).

Traditionally, the design studio provides the physical setting that enables a pedagogical basis focused on the ‘design problem’ and on ‘learning by doing’ (Broadfoot & Bennett, 1991). Studios are usually organised upon replication of professional task performance; this means, through the use of client design briefs that present ill-defined design problems. This problem-based context prompts students to experience ‘designing’, through the exploration and redefinition of the problem as part of the design problem-solving process. Schön (1992) described this experience as ‘reflection-in-action’ and identified it as the basis of any design process. He furthered described that there are types of ‘know-how revealed in our intelligent action: knowing in action (tacit knowledge), reflection in action (questioning and challenging taking place while designing), and reflection-on-action (questioning emerging after design solution has been reached). One

of the manifestations of this process is evident in the development of conceptual design sketches.

Design sketches are commonly employed by designers to develop ideas. Schön defined the sketching process as a conversation between the designer and the drawing (1983), a process in which designers do not only record an idea but generate it. Along this idea, Menezes and Lawson (2006) state that conceptual sketches are at the core of emergence and reinterpretation during the design process. As new ideas emerge and are drawn (emergence), drawings become visual clues that trigger and help developed and transform new images during sketching. In earlier design studies, drawings have been seen as communication aid but also as part of a cognitive process of thinking and reasoning. According to Do (1996) design reasoning is embedded in the act of drawing, as it supports rapid exploration, and incremental definition of ideas.

Studies about sketching in design as a cognitive reflective thinking process (Schön, 1992); have found different stages of visual thinking. The dialectics of sketching discovered by Goldschmidt (1991) refers to: 'seeing that' (reflective criticism) and 'seeing as' (analogical reasoning and reinterpretation that provokes creativity). The importance of design thinking activity has been eloquently described by Cross (1999, p.36):

Without writing, it can be difficult to explore and resolve our own thoughts'; without drawing it is difficult for designers to explore and resolve their thoughts. Like writing, drawing is more than simply an external memory aid; it enables and promotes the kinds of thinking that are relevant to the particular cognitive tasks of design thinking.

In design research, drawings have been employed in the study of design knowledge and as a source to analyse visual thinking and the design activity (Dahl et al., 2001; Rosch, 2002; Tang, 2002). These studies assert the notion that there is a relationship between drawing and experience, and that drawing is an iterative act that involves seeing and thinking. According to Kosslyn (2003) visual mental imagery is seeing in the absence of an immediate sensory input, and it is related to human experience where memory not only comprises an image or an event, but also information about its sensorial context. Therefore, it can be said that knowledge in visual thinking is associated with contextualised human experience. For example, a study conducted by Chamorro-Koc et al (2008) in which design sketches from novice and expert designers were compared, identified four types of knowledge embedded in visual representation of concepts: familiarity (experience from seeing), individual experience within context (experience from doing), principle based concept (knowledge of product from experience of using it), descriptive based concept (knowledge of product from seeing it). Her analysis of those four types of knowledge embedded in sketches led to discover references to: individual experience, knowledge to a product's use, and its context of use and revealed that particular areas of human experience that trigger people's understandings of products. Figure 1 illustrates it by comparing sketches of a novice (left) and expert designer (right) done as part of such study. Drawings were produced during a collaborative design task where both novice and expert designer were asked to discuss while designing in response to a given design brief (Chamorro-Koc et al., 2009).

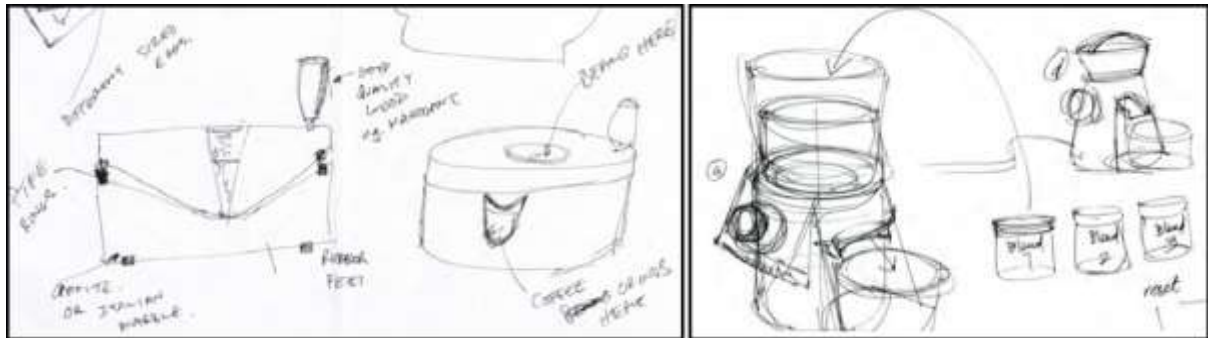


Fig 1 Segments from a novice (left) and expert (right) designer sketches

One conclusion emerging from the analysis of these drawings established that novice's visual thinking demonstrate an emphasis on features, functions and mechanisms of the product being designed, while the expert's visual thinking demonstrate understanding of principles of use and of the functionality of the product. This type of analysis mostly focuses on the action of sketching and visual thinking and not the specific type of knowledge embedded in the sketches themselves. It adds to the extant theory postulating that drawing and re-interpretation support different kinds of cognitive activities in design. So we ask: could this approach be instrumental in design pedagogy to understand students' learning? What types of knowledge/thinking processes are manifested in design sketching during Concept Bombs tasks? and why is this important to understand in the shifting context of educational delivery systems (blended learning environments) and an outcome-focused approach to education.

Concept Bombs: a visual thinking technique as part of design studio pedagogy

A pedagogy that utilises visual thinking through rapid sketching in our Industrial Design studio sessions is the 'Concept Bomb'. This format consists of a short design task undertaken in class followed by immediate staff and peer feedback. Students are given a five-minute briefing and asked to generate one or more design concepts for a simple product. In Third Year design studio the brief is often quite 'blue sky' and conceptual or a fairly superficial styling challenge. In higher years the brief focuses on elaborating on particular aspects of a larger project. In each case the task is achievable in a short space of time. The session concludes with immediate tutor-guided peer-assisted assessment during the same session. The focus can be on different aspects of design in initial and advanced semesters. In this paper we compare First and Third Year Industrial Design students' Concept Bombs, as these are the design studios in which this pedagogy is utilised the most.

In First Year, Concept Bombs are 30 minute design tasks. The design brief is usually comprised of a single design challenge with two or three factors for students to consider. The tutor presents the design brief to their studio group and responds to questions before the design phase commences. The expected outcome is one or more conceptual sketches in marker on A3 paper briefly annotated to facilitate explanation of the design ideas. At the end of the session students pin up their sketches and review each other's

work. Sometimes time is provided to review the work of other studio groups who have been working in parallel. Teaching staff review the work simultaneously and the group reassembles for a brief public critique of each presentation. Figure 2 shows an example of a First Year design Concept Bomb and the design brief.



Fig 2 A First Year student's Concept Bomb (left) and the Concept Bomb design brief (right)

Concept Bombs in First Year design studios are employed for two different purposes: (a) to 'pace' tasks and projects within the semester; and (b) to give students the opportunity to refine their understanding of sketching for rapid ideation in a supervised setting. There are four characteristics:

Pace and focus: Three to four Concepts Bombs in a semester help punctuate the semester experience within or in between larger projects. As some First Year students experience difficulty maintaining engagement and motivation throughout long design projects, Concept Bombs provide a change of pace. The briefs are 'object' oriented with topics based on familiar daily experience that don't require research. Students apply the foundational design knowledge and methods they have been learning in class.

Rapid feedback: Concept Bombs enhance learning by closing the feedback loop. As there is little pause between doing the sketches and getting feedback and assessment they provide 'instant gratification' to students. Staff moderated peer feedback also encourages student engagement with assessment criteria and promotes peer learning.

Ideation technique: Concept Bombs are about using sketching as a rapid ideation tool. Given the same project brief as homework students would likely spend four or five times as long on it. Left to their own devices novice designers tend to draw slowly and carefully investing too much time on too-few sketches without necessarily engaging in deep ideation. Forcing students to practice rapid sketching forces them to streamline their technique and see the value of sketching without the formality of formal project presentation. Doing this within a supportive studio context within the framework of an imminent deadline encourages useful engagement with relevant skills. Students learn that

fast sketching is a means to become more efficient and explore more ideas in a shorter time.

Repetition: Repetition is a key part of Concept Bombs both in the development of sketching skills and in managing performance pressure for students. Since Concept Bombs are effectively an examination of sorts students might be forgiven for feeling considerable pressure to perform. This is managed in two ways. Firstly the assessment weighting for Concept Bomb assessment within the unit is quite low—rarely more than 20%. Secondly this mark is derived from the best three out of four (or best two out of three) Concept Bomb submissions. The consequences of poor performance in any single Concept Bomb is thus quite low and the addition of a ‘spare’ gives students a safety margin that moderates the pressure they feel on any single exercise. The outcome is that students report high levels of engagement and enjoyment with Concept Bomb activities.

Third Year Concept Bombs are also short 20 minute design tasks but they form part of a larger project and prompt students to explore particular aspects of the main semester project. Three design briefs take place one after the other during a single intensive design studio session with minimum time allowed in between for pin-up of the work. This experience is repeated at key stages of the semester project. Design briefs are delivered to students by including a user scenario to help contextualise particular design problems. The expected outcome is blue-sky design propositions which form the basis for later in-depth exploration. At the end of the third task, students review each other’s work and indicate, on a feedback label that accompanies each submission, the best of the three designs from each student. In some projects it has been possible to engage industry collaborators in the feedback phase which gives students ‘real world’ input via informal conversation on the merits and limitations of their ideas. Figures 3 and 4 show examples of Third Year students’ Concept Bomb sketches and the associated design brief.

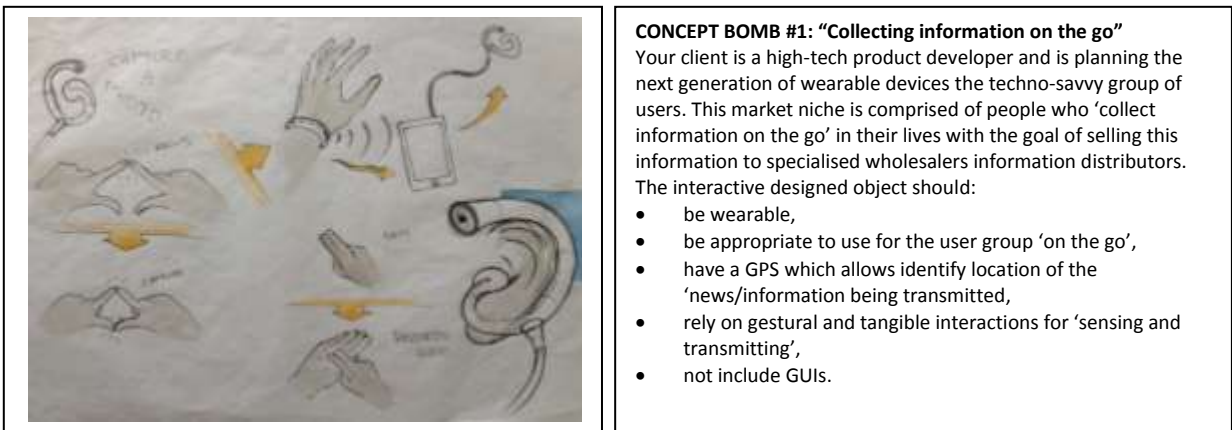
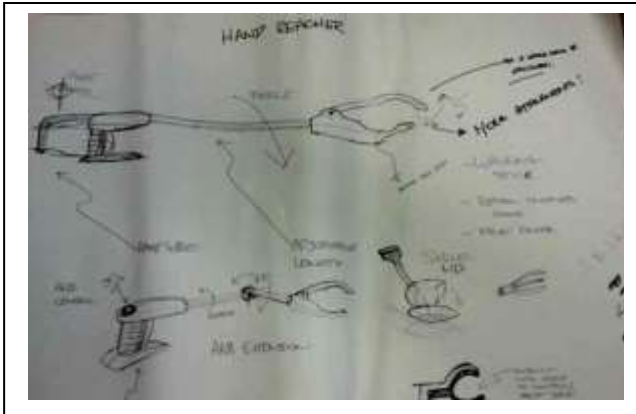


Fig 3 A Third Year design student’s Concept Bomb sketch (left) and the design brief



CONCEPT BOMB guided by Industry collaborator (*)

- Choose an assistive technology from the ones presented in the exhibition
- Role-play a device of your interest, imagine using it in your everyday life
- Assess the device affordances and think how could it benefit other users
- In your teams (4), re-design the device by extending its functionality to a broader range of users.

*Industry collaborator is a non-for profit organisation that provides information and services to people with disabilities and the senior population.

Fig 4 A Third Year design student's Concept Bomb sketch provided by industry collaborator

Concept Bombs in third year design studios are employed for two different purposes: (a) to encourage focus on particular areas of the project that are of pedagogical interest, and (b) to give students the opportunity to enhance their sketching techniques and visual thinking skills. The application of Concept Bombs in Third Year shows four characteristics:

- **Pace and focus:** Concept Bomb briefs focus on particular aspects of a project that otherwise students would not explore at first. Such areas are usually related to new theory being presented to them. In order to bring all elements together in a concise format for students, Concept Bomb tasks use scenarios to introduce a design problem, illustrate a user situation and the context of use. Design requirements are presented as a set of problem boundaries.
- **Rapid Feedback:** The tight loop between the sketching activity and feedback allows students to quickly learn from the experience and bring their learning into the initial stage of the semester design project. Peer feedback plays a more important role with these students as there is no formal assessment attached to the task. Peer feedback becomes a vehicle for students to expose their ideas and be competitive, be aware of how effective they are at communicating their design ideas, appreciate differences between what they think is their best concept design versus what other people perceive is the best, push themselves out of their comfort zone and think about design aspects they would not consider otherwise.
- **Ideation technique:** As in First Year, Third Year Concept Bombs cultivate student sketching as a rapid ideation tool however here there is a higher expectation of design resolution and effective visual communication
- **Repetition:** Repetition of Concept Bomb activity within same studio session allows students to quickly gain confidence from Concept Bomb task one to task three. Usually by Concept Bomb three students are working at that most confident and effective level.

There are evident differences between outcomes from the two students cohorts. It is interesting to observe that beyond the quality and detail of the design development observed in the sketches, there are different types of experiential knowledge embedded in the visuals. Input from a Second Year unit, *Culture and Design*, seems to contribute to Third Year students design thinking when addressing the Concept Bomb briefs, as in this unit students explore how culture influences product design and how people interact and

use products in everyday life. The following section presents an overview of a comparative analysis that aim to uncover characteristics described in this section.

Understanding visual thinking behind Concept Bombs: an initial analysis

An initial exploration of sketches produced by First and Third Year design students was conducted to find out what aspects of the learning experience of designing and visual thinking can be evidenced through Concept Bomb tasks. This analysis is based on Chamorro-Koc et al (2009) study in which design sketches were categorized to reveal types of individual knowledge.

Analysis of students' Concept Bomb sketches

The analysis of sketches was assisted with ATLAS.ti, a software-based qualitative analysis package. A system of categories was employed that focus on identifying elements in sketches that reveal students' individual experience, knowledge of the product, and of the product's context-of-use.

Drawings were analysed and interpreted to identify references made to students' knowledge of the product design, their individual experience with similar products, and references to context of use employed in their design concepts. The following table shows the coding system.

Categories	Subcategories	Codes
Experience	Features with indication of usage	FE
	Individual experience within context	IEC
	Episodic data	ED
Knowledge	Principle-based concept	PBC
	Description-based concept	DBC
Context-of-use	Intended use	IU
	Situation	ST

Table 1 Coding system

The coding system reveals different types of knowledge due to individual experiences: individual experience with similar products (tacit knowledge), reference to a particular experience situated in a particular context (individual or episodic experience). The coding system was applied to the appropriate segments of drawing. For example Figure 5 shows how the coding was applied to a student's Concept Bomb sketch. It uses images and written notation to describe a design concept for a product with three components, a bracelet, an earpiece and a screen, and the gesture-based interface of the device. It can be seen that the drawing does not provide detailed design features however, arrows, annotations and images provide a sense of the principles behind the functionality of the design. Thus PBC—Principled based concept—is the code applied to the segment of the drawing where it clearly indicates how bracelet, screen and earpiece interact. The segment showing a detail of the earpiece placed on the ear indicates IU—intended use.

The literature indicates that the notion of students' engagement is one with many meanings (Bryson; 2007), usually referring to: behaviours in the classroom, staff-student interaction, cooperation among students, and a dynamic relationship between learner and environment (Chamorro-Koc & Scott, 2012). In our experience student engagement tends to be viewed as a reflection of learning processes and it is a crucial means of an educational process that establishes the foundations for successful later year studies (Krausse & Coates, 2008). As a pedagogical tool to support for students engagement, Table 2 shows differences between First and Third Year students in each of the four identified Concept Bomb characteristics. Pace grows in intensity, focus changes from object to context, feedback shifts from individual gratification to peer pressure through formative assessment, ideation moves from the facilitation of fast exploration of ideas to the facilitation of fast exchange of ideas.

As a pedagogical tool to understand 'how' design students conceptualise their design propositions, the analysis of students' Concept Bomb sketches reveal that their work moves from basic descriptions of features or functions to descriptions of context and practices. This could be a reflection of students' enhanced understanding of social issues learned through the Second Year Design and Culture unit. For example, hand gestures showed in Figure 5 indicate a Gen Y form of gestural communication. In this case, this Concept Bomb reveals the learning from socio cultural issues previously learned from case studies, and shows how a student might design an object with social considerations in mind.

Discussion

Design studio is the context where learning emerges through action; it is distinguished by emphasis on project-based work, learning through praxis, learning through workshop, and learning through first hand observation (ALTC, 2011). With the aim to assist students connecting theory and the application of design principles to design projects, Concept Bombs are employed as one of the design studio pedagogies in Industrial Design education at the School of Design at QUT. Besides the importance of industrial design students enhancing their visual design thinking and communication techniques from the pedagogical point of view, the practice of fast sketching is critical for novice designers to become more effective at exploring more ideas in a shorter time, which is a valuable skill as a practicing designer.

The comparison between First and Third Year design students' Concept Bomb sketches has shown some of the aspects that contribute to promote visual thinking and reflective process. In this sense, Concept Bomb tasks in design studio environments is a strategy that assist students learning processes of conceptualising and producing designs. Understanding the type of experiential knowledge embedded in students' design work at different stages of their education is important to inform design pedagogies and to devise strategies to attain and support learning objectives.

The analysis and comparison of visuals show that Concept Bomb sketches convey some references to socio cultural considerations. This suggests that the use Concept Bomb tasks can provide insights into how our students' generation designs for society and for the future, and therefore, it can help identify emerging challenges for design education. Although we have indicated instances where this kind of content is observed in our

students' Concept Bombs, this aspect has not been fully addressed in our study. Further research into this aspect and students' design processes; require involving observational studies and retrospective interviews to uncover the various experiential and conceptual considerations informing student's design decisions during Concept Bombs activities.

Conclusion

This paper has described Concept Bomb approaches in design studio that promote students engagement and visual thinking skills. These practices are adaptable to the differing needs of students and curriculum demands of different levels and of study.

In the shifting context of educational delivery systems, for example, blended learning environments, we wonder how could this type of experience take place in future university contexts? What can be done through virtual design studios? In a virtual studio, the dynamic of Concept Bombs would certainly change but benefits may remain if the immediacy of the experience can be duplicated. The process would probably not be as effective since part of the success is due to peer proximity, short timed duration and immediate feedback, all which would be relatively compromised in an online scenario unless teams of students are co-located.

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Andrew Scott

Andrew Scott has been practicing and teaching industrial design for two decades. His experience as a design consultant has included work in industrial design, ergonomics, corporate identity and entertainment concepts for clients such as World Expo 88, the Civil Aviation Authority, Spectra Lighting and other businesses in the Brisbane area. He is Head of Studies for the School of Design, Queensland University of Technology and teaches predominantly in the first year of the Industrial Design Course. In 2010 he received the Australian Learning and Teaching Council's award for Teaching Excellence for his teaching pedagogies. Andrew completed his masters (research) in touch screen interface design and his PhD research focuses on product attachment and personal identity. Other interests include product aesthetics, graphical literacy and information design.

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