INTERNATIONAL ENGINEERING AND PRODUCT DESIGN EDUCATION CONFERENCE
2-3 SEPTEMBER 2004 DELFT THE NETHERLANDS

RECONSIDERING THE DESIGN STUDIO – ITS ROLE IN ENGINEERING PRACTICE

Jennifer K. Whyte, Boris Ewenstein and David M. Gann

ABSTRACT

The studio is at the heart of modern design education. Whilst it is usually understood in the university context, studio activities in leading engineering and design firms are providing new perspectives on the 'design studio' model. In this paper we describe our observations from participation at the Arup Europe Division Design School. Here studio activities are structured as intensive 'time out' or 'play' in which young professional engineers work together in multi-disciplinary teams. The focus is on developing collaborative design skills and becoming part of an organisation-wide community of peers within the firm. We compare the role and function of this practice-based design studio with the university model and highlight implications for future research and practice.

Keywords: design studio, university, engineering practice, inter-disciplinary, skills

1 INTRODUCTION

The studio is at the heart of modern design education. It provides a physical and temporal space for mentored practice [1,2]. Though it is usually interpreted and understood in the context of university teaching, it is widely used as a pedagogical tool across a variety of institutional and cultural contexts. This paper describes observations of studio-based training activities in Arup, a leading international engineering consultancy with a reputation for design excellence. We compare these practice-based activities with university-based studio activities and look at the implications for wider understanding of the studio and its role in 21st century design education.

Within the university, the design studio is a major component of degree courses such as architecture, fashion, graphical and industrial design. In European design education, the studio has roots in both the 19th century French *Beaux Arts* where architectural students worked in an *atelier* under the leadership of an experienced architect [1,3]; and in pedagogical experimentation of the 20th century German Bauhaus School where studio design emerged with a separate identity to workshop-based model building activities [1]. In contemporary higher education, design exercises are typically set out by the tutor and addressed, within a specified timeframe, by students working individually. There is a competitive element to the work as students' individual performance is assessed relative to that of their peers. Students must make sense of the exercise, which may have a relatively unconstrained brief, and also work on it. The time frame for each project is reasonably long and in many cases exercises may last several weeks to a full year.

Several features of the university design studio are worth noting at the outset of this paper. First, the studio activities take place in proximity to theoretical education which is delivered through classroom teaching. They are central to the wider programme of

ongoing training. Second, the work is usually undertaken on an individual basis and the focus is on the development of individual skills and expertise. Design work is often assessed and a formal mark is assigned at the end of a project. Third, the focus is on design development activities. Students are encouraged to learn from each other and to consult precedents. Their work is critiqued in progress by peers, instructors and visitors, through a number of interim critiques ('crits') at the group level, and through 'desk-crits' at the individual level. Students are encouraged to use multiple representations and a variety of design media that support ambiguity and emergence [4] as well as clear representation. At the end of the project they present their drawings and/or models of the proposed design in a final 'crit', which is witnessed by the whole group.

This type of design studio has been both praised and highly criticised. Whilst conscious of the inherent dilemmas, Schön [3,5] sees the design studio playing an important role in educating the reflective practitioner, providing contexts for problem-setting as well as problem solving activities. He argues that the studio not only provides a model for design education but also for the wider education of professionals. In architectural education, however, studio approaches has been challenged by theorists who claim that they fail to respond to a changing industrial context, exalt the *avant-garde*, privilege architecture as an act of form-making and promote the expression of personal creative genius rather than cultural values [6].

The practice-based design school is, in many ways, quite different. In this paper we argue that practice-based activities provide new perspectives on the nature and role of the design studio in the 21st century. The argument is based on our study of the Arup Europe Division Design School. We describe the method used in our study in the next section and in the following section we detail our observations of one of the design activities that we followed in depth at the School. The findings are discussed and compared with the university design studio approaches. We then draw conclusions and set out implications for future research and practice.

2 BACKGROUND AND METHOD

Arup is a multi-national, multidisciplinary engineering design consultancy employing 7000 graduate engineers, with an intake of about 400 new graduates each year. They are a prestigious firm with a strong internal culture and a good brand. Young engineers are keen to work for them.

The Arup Europe Division Design School is run for young professional engineers from across the company's European offices. It was founded in the recognition that innovative engineers work beyond the scope of available material and building codes. The intention is to improve young engineers understanding of the design process; and to promote rapid team-building skills. Expert engineering designers use a form of creativity or design expertise, which Hough calls intuition [7], to select potential solutions for analysis. This is gained through practical design experience. Hence, in a leading inter-disciplinary engineering and design firm such as Arup there is an incentive to develop organisational abilities to exploit diverse knowledge sets in design.

At the Design School, the approach taken to design is one of synthesis. There is an understanding that no one person is a genius all of the time. The most valuable members of a design firm are those who can build on the thoughts of others within the group and refines and defines ideas through discussion. The risks are minimized through interaction with others as this maximizes the potential of identifying problems.

The Design School is usually a three day event taking place at a weekend and is structured with a specific theme. Participants at the School have been chosen to attend

by their groups and have typically been at Arup for 3-4 years. There are usually 36 attendees, and they are split into six groups. The exercises and activities are designed to encourage participants to think in a broader manner than they may do on narrowly defined technical problems encountered in day-to-day project work. Participants don't know each other before attending the School.

We have been involved in the Design School from the start and have participated in six Design Schools over the last five years. Between us, we have attended the majority of Schools and each of us has attended at least one School. We have also conducted a survey of participants at every Design School. In this paper, we draw on our research as participant observers to consider the nature of activities and learning at the School and to discuss issues relating to the creation of effective contexts for learning about design. Below, in the results section, we build in particular on detailed notes taken by the second author at the Design School themed "21st Century Fix." This was held in Bristol on 16-18 October 2003.

3 SUMMARY OF RESULTS

The organisers described the aims in information given to attendees before the school. This bound set of documents begins with a meditation on design, drawing on Lawson's book, *How Designers Think* [8]. The introductory writing contains as its central theme the notion that design involves neither predominantly technical nor expressive competence, but always a well-balanced combination of the two. Both "imaginative thought" and "mechanical calculation" are needed.

The Design School consists of two types of activities; social activities and scheduled activities. An important part of the event was a lavish dinner on the first night. This involved a presentation by a world record holding paragliding pilot. After the dinner the participants could socialise and there was a free bar. This provides an opportunity for participants to meet their peers from across the European Division of the firm.

The timetabled part takes place in a conference room, where participants are grouped into multi-disciplinary teams: comprising structural, mechanical, electrical and other engineers. There is a packed schedule and participants start their design work early and leave late, but the atmosphere is laid-back and informal. Participants work at tables with their groups with music playing in the background.

Group exercises are supported by the assistance of older engineers who participated in previous design schools and by group presentations. Assistants move from group to group and reiterate the brief, then ask the group how they see their work relating to the brief. They gently question the approach asking what the main concepts are in the design and tutor on how best to communicate the design. In the group presentation the Design School organisers moderate the discussion and link the activities within the six groups to the wider themes at the heart of the Design School – thrills, risk and innovation. The most distinctive features of group work are summarised and compared with that of other groups.

We will focus on a specific group exercise conducted in this weekend and describe design activities in two of the six groups at different stages of this exercise. This exercise, which is the first design exercise of the weekend, is about the theme of calculated risk. Its central focus is on paragliding and the way in which the thrill of paragliding could be extended to involve more people. The design brief specifies further that the exercise should include some redesigning of existing paragliding equipment. The Design School organisers explained that the morning was intended for engaging with the open brief innovatively, for being creative and inventive. The afternoon,

however, was allocated specifically to what was termed as the solution finding phase, involving also the construction of a physical model.

3.1 Brainstorming in group 1

With the introduction of the first exercise by one of the organisers, animated discussion begins within the groups. Group 1 begin their design with an inquiry into the constitutive elements of the paragliding experience as represented by the paragliding world record holder who presented her sporting adventures and some of her equipment the night before the exercise. The initial ideas articulated within the group include multi-person gliders, team activities with gliders (namely, water-polo and paint-balling) and controlled indoor paragliding. These ideas emerged as recurrent themes within the Design School alongside designs that concentrated on the interactive simulation of the paragliding experience. The reasoning behind these designs could be traced through the notes taken during the brainstorming activities within groups.

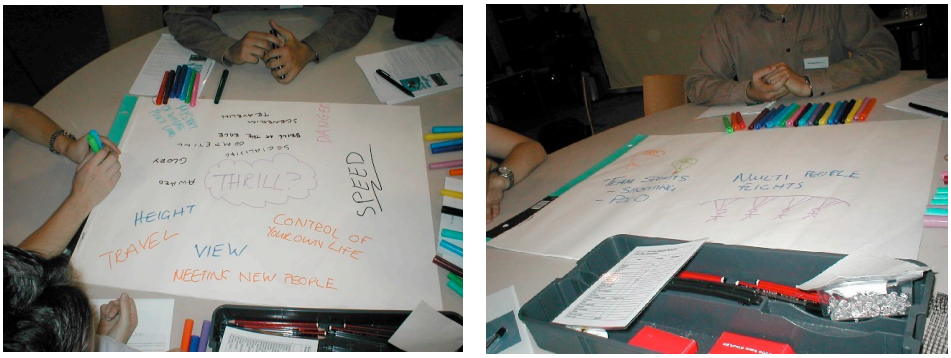

Figure 1. Activities in group 1 – a) brainstorming and b) developing design concepts

As groups jotted down keywords that emerged in their brainstorming, associations were made, moving from one particular aspect of paragliding to a particular solution involving more people (existing paragliding competitions, developed to involve more spectators through several technological applications such as helmet cameras relaying the pilot's perspective). The other dominant mode of reasoning resembled a form of induction in which a general principle underlying aspects of paragliding was sought. From this general principle (e.g. "control of your own life"), another, not immediately connected design idea could be deduced that would involve more participants.

3.2 Modelling in group 5

The approach of group 5 to make the thrill of paragliding available to more individuals is based on the principle of simulation. However, rather than to attempt a mimetic reproduction of the paragliding experience in a simulator, the group tries to design a device that would manage sensory input so as to stimulate only certain senses in specific and selected ways. Their aim is to control individuals' reactions. The group agrees that the central focus of their approach is to get away from everyday sensual experience as this emerges as the core of extreme sports in their group discussions.

The approach to realising their idea then begins with thoughts on how to induce the deprivation of the senses. The ideas of being suspended in a darkened space, being in water and being weightless are offered. Other group members add the need to create the

impression of being nowhere, losing one's bearings and taking sound and vision away from the individual experiencing the group's 'simulator'. How certain senses are to be re-stimulated, however, remains unclear. A discussion ensues over how to manage sensual stimulation without falling back on the principle of virtual reality. As one attendee notes, "*It should be unlike reproducing paragliding in a box*". Unhappy with an increasingly apparent impasse (simulation and sensory stimulation without wishing to opt for VR), a group member suddenly puts forward the idea of inventing a new sport which is to contain all the characteristic elements defined as significant to the experience of paragliding: "*It should involve risk, community and adrenalin*". This sudden change of plans, however, is quickly abandoned as the Design School organisers announce to the group of attendees that they should now begin constructing a model of their conceptual designs. Realising that the idea of inventing a new sport is not sufficiently developed to represent or model - "*We can't build any of that*" - the sensory deprivation and simulation plan is reconstituted. This earlier design decision is thus revisited, but not, in order to qualify it as the design evolves. Rather, the original plan is recovered so as to be able to complete the Design School exercise within the given period of time. This decision is recovered partly due to practical considerations, as there is a limited amount of time, but also as a product of the co-ordination and negotiation process. The group thus quickly decides to build a life-size model of their deprivation/re-stimulation box.

Figure 2. Activities in group 5 – model-making

The modelling process begins abruptly and spontaneously. It is characterised by frenzied activity, intensive teamwork, improvisational tinkering with the available materials (empty plastic bottles, a piece of slate, string, clear tape, staples, wire, mounting board) and pragmatic making-do. Though there is little space and time to link the ongoing (largely ad hoc) design and modelling efforts with the conceptual evaluation of the exercise brief, the modeling leads to inventive use of the available material.

4 DISCUSSION OF FINDINGS

This design school is different to the university-based model along a number of dimensions. The focus here is on working collaboratively with other people, whilst studio activities in universities are focused on development of an individual and their assessment for a degree. This has a number of implications. First rather than taking place as part of ongoing theoretical education, this design studio is structured as intensive 'time out' or 'play'[9] for young professional engineers. Second, instead of focusing on the development of individual skills the focus is on work in multi-disciplinary teams. The approach is collaborative rather than competitive and there is no formal marked assessment. Third, the focus is on idea generation, rather than the process of design development. This may in part be due to the short timescales for the exercise, but is further emphasised by the basic physical nature of the materials used for design. These differences are summarised in Table 1.

Table 1. Comparison of the university-based and practice-based design studio models

University-based design studio	Practice-based design studio
1. Ongoing training alongside theoretical education; long projects lasting weeks or months.	1. Intensive 'time out' from practical apprenticeship; short projects in one weekend (compressed time frames).
2. Focus on individual skills, competitive, formal marks.	2. Work in multi-disciplinary teams, collaborative, no formal assessment.
3. Focus on process of design development – use of precedents; critique of work in progress by peers, instructors and visitors.	3. Focus on idea generation – brainstorming; negotiation of group solutions; critique of work by mentoring design school assistants and peers; group presentations.

The engineers that attend the Arup Design School have experience of work on real-life projects, and hence are better equipped than undergraduate students to interpret the relevance of studio-based activities for their day-to-day working lives. Yet, at the same time, engineers typically have had a formal education that is focused on engineering analysis rather than design and enter practice as relatively inexperienced designers. In critically considering the Arup Design School we highlight its role in developing the engineers collaborative design skills and helping them to become part of an organisation-wide community of peers.

4.1 Developing collaborative design skills

The Design School plays an important motivational role in developing young engineers design skills. It aims to provide space for reflection about engineering design: the written introduction urges attendees to think "*about what we do, how we do it, and how we might possibly do it better*". The focus is not on extending specific professional competence ("*not about filling gaps in our technical knowledge*") but about giving young engineers space to play, and to reflect on their role in design through their play. Though activities are structured as play, they are intended to develop the engineers collaborative design skills.

Given the compressed time frames within which the studio work takes place the process is a compressed version of the normal design process and the emphasis of the design activities is on idea generation and not on design development. Group 5, for instance, struggled to fully conceptualise, develop and build their design in the time allocated to

the exercise. As one group member notes, "*You don't have enough time to develop ideas and build models*". Yet in such instances this compressed time frame may be an advantage, forcing engineers to work together to develop ideas through their model building activities.

4.2 Becoming part of an organisation-wide community of peers

In addition to the role of the Design Studio in developing design skills, the intense collaboration at activities on this weekend away help to develop weak ties [10] between members of the organisation located at different offices around the globe. These may be useful to participants later in their careers, perhaps after years or even decades of no communication. Indeed when members of multi-national organisations feel kinship with others in their organisation it has been found that total strangers may spend several days helping other members of the organisation even when there is little likelihood of reciprocal help [11]. The Arup Design School may help to develop this kinship with the organisation.

5 CONCLUSIONS

This paper contributes to wider reconsideration of the changing role of the design studio by describing a practice-based design studio model and comparing this with the university model. In the new model we describe, studio learning sits alongside practical apprenticeship in the firm. The nature of the activity is changed and its purpose is augmented to focus on developing collaborative design skills and becoming part of an organization-wide community of peers.

So, what can university teachers learn from the practice-based design school model? Our observations at the Arup Europe Division Design School raise many questions about the role of design activities in engineering education and practice. Should university-based design studios develop collaborative design skills? Should educators see the development of a community of peers as important to the design studio experience? When is it appropriate to introduce studio-based work? The shift of focus from the individual to the group may provide important lessons for design education within the academy. The collaborative 'playful' nature of the practice-based model is in sharp contrast with the individually focused assessed work in many university design studios. The focus is firmly on the interaction and negotiation activities associated with collaborative design rather than expression of personal creative genius.

Further research is needed to augment the comparison of practice-based and university-based design studios and develop detailed recommendations for the educational field. There may be particular lessons for engineering education, where the importance of design to engineering has been highlighted [12] and there are a number of initiatives to introduce studio design exercises into the engineering curriculum [13-16]. We believe that university-based design studios have much to learn from this practice-based model, however it is also a relatively young model and there may also be ways of improving it.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the help of the organisers of and participants in the Arup Europe Division Design School. We would particularly like to thank Tristram Hope, who commented on a draft. The authors are responsible for any errors and omissions.

REFERENCES

[1] Salama, A., *New Trends in Architectural Education: Designing the Design Studio*. 1995, Cairo Egypt: The Anglo-Egyptian Bookstore.

[2] McCullough, M. and Mitchell, W. J. (eds.) *The Electronic Design Studio: Architectural Knowledge and Media in the Computer Era*. 1990, MIT Press: Cambridge, MA.

[3] Schön, D. A., *The Design Studio: An Exploration of its Traditions & Potential*. 1985, RIBA Publications Ltd: London.

[4] Oxman, R., Design by re-representation: a model of visual reasoning in design. *Design Studies*, Vol. 18, 4, 1997, pp 329-348.

[5] Schön, D. A., *Educating the Reflective Practitioner: Towards a New Design for Teaching in the Professions*. 1987, San Francisco: Jossey-Bass.

[6] Wortham, B. D., Everything I Know About [Modern] Architecture I Learnt In School. *ACSA Northeast Regional Meeting*, 2002, McGill University, Montréal.

[7] Hough, R., *Intuition in engineering design*, in *ARUP on Engineering*, D. Dunster, Editor. 1996, Ernst & Sohn: Berlin. pp 18-27.

[8] Lawson, B. R., *How Designers Think*. 3rd ed. 1997, Oxford: Architectural Press.

[9] Schrage, M., *Serious Play: How the World's Best Companies Simulate to Innovate*. 2000, Harvard Business School Press: Boston, MA.

[10] Granovetter, M. S., The strength of weak ties. *American Journal of Sociology*, Vol. 78, 6, 1973, pp 1360-80.

[11] Levine, S., The strength of performative ties: dynamics of network exchange in a knowledge intensive firm. *Organization Science Winter Conference*, 2004, Steamboat Springs, Colorado.

[12] Simon, H. A., *The Sciences of the Artificial*. 1969, Cambridge, MA: MIT Press.

[13] Sheppard, S. D. and Jenison, R., Thoughts on freshman engineering design experience. *Frontiers in Education*, 1996, Salt Lake City, Utah: IEEE.

[14] Little, P. and Cardenas, M., Use of "studio" methods in the introductory engineering design curriculum. *Journal of Engineering Education*, Vol. 90, 3, 2001, pp 309-318.

[15] Higgins, J. S., Maitland, G. C., Perkins, J. D., Richardson, S. M. and Piper, D. W., Identifying and solving problems in engineering design. *Studies in Higher Education*, Vol. 14, 2, 1989, pp 169-181.

[16] Adams, R. S., Turns, J. and Atman, C. J., Educating effective engineering designers: the role of reflective practice. *Design Studies*, Vol. 24, 3, 2003, pp 275-294.

Contact Information:
Dr Jennifer K. Whyte,
Innovation Studies Centre,
Tanaka Business School,
Imperial College London,
United Kingdom.
Phone: +44 20 7594 5940
Email: J.K.Whyte@imperial.ac.uk

Co-author Information:
Mr Boris Ewenstein
Professor David M. Gann
Innovation Studies Centre,
Tanaka Business School,
Imperial College London,
United Kingdom.