World Transactions on Engineering and Technology Education
Vol.2, No.2, 2003

Studio-based teaching: history and advantages in the teaching of design

Lance N. Green† & Elivio Bonollo‡

University of New South Wales, Sydney, Australia†
University of Canberra, Canberra, Australia‡

ABSTRACT: The teaching of industrial design and product design is usually conducted in an industrial design studio, a place that has developed traditions of learning-by-doing within the traditions of project-based and problem-based education. However, the design studio has been, and still is, an anachronism within the university context, perceived by some as craft-like and imprecise, lacking rigour, when compared to the intellectual arts and objective credibility and when set against the methods used by the natural sciences. The paper describes the historical background of the architectural studio and how the studio evolved to better facilitate industrial design thinking and learning. It will discuss the educational advantages of the studio together with certain shortcomings and suggest ways that it could be enhanced in order to enable it to be more effective for the teaching of both product designers and design engineers.

INTRODUCTION

The design studio is at the heart of most industrial design curricula and is a place where students learn to visualise and represent aspects of a problem graphically and to *think as a designer*. In the studio, emphasis is placed on creativity, drawing, problem solving and communication. Industrial and product designers are coached to think widely and deeply, formulating the problem using the right side of the brain, in contrast to the left-brain approaches of other disciples, such as engineering and science where thought processes associated with learning draw upon established principles and methodologies. Discussion, conjecture, imagining and stretching the boundaries of issues are tenants of design thinking and the nature of the way projects are executed in the studio. However, Maitland's writings of studio teaching suggest that the studio is not just a space marked *studio*; it is a way of thinking and learning [1].

The industrial design studio has evolved from just the studio-based teaching of architecture to a stage where more rigorous aspects associated with manufacturing and engineering have been introduced to meet the evolving requirements of industry. Thus, the modern-day studio includes not only a principal focus on the aesthetic but also upon usability, sustainability and design for manufacture. Because this model of teaching has evolved over time, it is also useful to briefly review historical developments and the context of the role of the studio in industrial design teaching.

THE DESIGN STUDIO: HISTORY

The nature of the modern-day design studio is consistent with the model of teaching exemplified by Plato, who encouraged the free, unfettered exchange of knowledge. He brought disparate thinking into a forum of discussion, much like that experienced in a modern-day studio. His model of teaching became known as Platonism and his community of scholars referred to as Academy [2]. In Italy, during the latter part of the 15th Century, a large number of schools flourished based on humanistic discourse; a free, sociable and informal means of discussion so vastly different in nature to the scholastic pedantry of the universities of that time. These schools later came to be known as *Academia Platonism*.

The Academie Royale d'Architecture was established in 1671 to standardise French architectural education. By the early part of the 18th Century, the Acadamie had become entrenched and unfashionable and, as a result, Blondels's Ecole des Arts was established in 1743. This school, together with many others across France, was a deliberate strategy to ensure a steady stream of skilled pattern designers who were responsible for the establishment of French design [3]. The Ecole, offering full-time studies, was open six days a week: the mornings given over to discussions with the professors, while in the afternoon, there were lectures on fortification, mathematics, geometry, mechanics, perspective, water supply and drainage.

The architectural studio emerged as a special form of education within the Ecole des Beaux Arts and, concurrent with the programme offered by the Ecole, involved the part-time study of individual subjects, supplemented by employment, in the manner of the old atelier system of indentures and articles [4]. Many practitioners believed that this system of architectural training produced superior architects. Two *masters* of the modern architectural movement, Frank Lloyd Wright and Le Corbusier, were both trained in this way [5].

Around the same period, the education of engineers in England was undergoing significant change. In the period immediately following the industrial revolution, many famous engineers gained their first knowledge as millwrights or as colliery

enginemen. For those that followed, the recognised routes into the profession became more regular, principally through an apprenticeship of three years in the office or workshop of an established engineer. However, there was a strong movement towards a greater level of academic training in the discipline of engineering and resulted in King's College London establishing its Department of Civil Engineering in 1838, soon after widening its courses to include architecture. Glasgow University, Glasgow, Scotland, established a chair of engineering in 1840 and, in 1841, a similar appointment was established at the University College, London.

At this point, considerable tension existed between the philosophical approaches to the education of engineers, namely theory-based verses apprenticeship. Concern developed about Britain's slipping economic performance around the time of the Paris Exhibition in 1867 and, as a response, greater effort was applied to the development of engineering teaching within academic institutions. By 1914, British university institutions had reached a position where they provided an ample source of scientifically trained engineers for industry [4]. This emphasis on scientific rigour and its application in professional practice assisted England particularly to develop advanced products; however, the trend towards scientific emphasis set a future pattern for engineering education.

The Royal Academy of Arts in England established courses in architecture in 1736 and instruction continued until 1836. These classes were conducted on a part-time basis with students employed in an architect's office while also attending classes in the evening. However, a major criticism of the architecture courses was that the schools did not encourage dialogue and the courses were essentially lecture-based. There was neither written work nor organised group discussion, which was different to the studio-based discussion that occurred at the Ecole in Paris.

The character of most institutions now existing in architectural education was formed during the period 1900-1914. Thereafter, the alternative mode of education departed from the previous tradition of pupillage and endorsed universities as the sole provider of architectural training. Even though there was a strong culture associated with materials and construction, architectural schools found that the attractiveness of programmes for potential students depended on making design and drawing the core of the curriculum. This established historically the culture of communication by pictures rather than words and reinforced the nature of the studio.

The rapid rise of mass production in the early part of the 20th Century further established the separation of designing from making and the role of the designer became important to specify the nature of products so that they could be manufactured effectively. Certain key designers created an awareness of industrial design and the profession was more readily accepted by many organisations. The major schools of design that arose out of this period were the Bauhaus in Germany and those in the USA.

The Bauhaus was a teaching institution founded at Weimar, Germany, in 1919. It amalgamated the art and craft schools under the direction of Walter Gropius. The early years of the Bauhaus were focused on uniting art and craft. In the laboratories of the Bauhaus, the objective was to train a new kind of collaborator for industry and the crafts who had an equal command of both technology and form [3]. Gropius maintained that:

> *The school should be absorbed into the studio and that the manner of teaching should arise from its character, that is, the studio should not be an adjunct of the other teaching programmes. On the contrary, all the teaching programmes should exist only to support the studio and the design problems it is working on, reflecting the reality of professional practice, which is entirely driven by the needs of the project* [6].

Gropius meant that the studio should be a place where studio projects were executed and these should reflect professional practice. The adjunct courses, such as mechanics, manufacturing and materials science, should not be isolated from the project activity in the studio, but rather be complementary to it.

In the USA, industrial-design education formally started at Carnegie Technical College (later to become Carnegie-Mellon University) in 1935-1936, under the direction of Don Dohner. This was followed by the Pratt Institute of Art in New York and these developments, together with those occurring in industry, served to establish the industrial design profession. Design education in this period grew from the demand for mass-produced products and the vision of design educators to delineate industrial design apart from architecture and engineering [7].

The trend towards more logical and systematic methods of design became evident during the 1950s. During the same period, the techniques of creative engineering and brainstorming were introduced and these provided some bases for idea generation. The design methods introduced in the 1960s and 1970s were significant in that they drew attention to the need for design to be more transparent and more substantially based on a structure of analysis. However, these failed to achieve wide acceptance as part of the normal process of design and were not incorporated into the studio teaching on a significant scale. The generation of design educators that experienced the ill-fated introduction of design methods did not consider their relevance to the process of design and, as a consequence, did not integrate these into studio teaching.

Between 1980-1986, Donald Schon at the Massachusetts Institute of Technology (MIT) studied the manner of education of a range of professions and was intrigued by the apparent deviant nature of the architectural studio. He argued that the schools of other professions should learn from it. The movement towards revived studio functions led by Schon suggests that subjects can be taught in an academically rigorous way without their application in the studio having to take a similar approach. Schon rejected the established procedure in professional education of building application upon basic science and theory; he dismissed the notion that professional practice was based on the rigorous application of theoretical knowledge [5].

The industrial design studio of the 1980s did not differ significantly from the models exemplified by the Bauhaus and the American schools. They were essentially an amalgamation of art and craft. However, during this period, concern about the environment created the need to include considerations of sustainability in studio projects. Similarly, the trend towards globalisation and world-competitive products demanded a greater emphasis on usability and cultural issues. The worldwide

emphasis on quality during the 1980s identified that design was central to product quality and issues of consideration developed including Design for Manufacture (DFM), Assembly (DFA) and Disassembly (DFDA). Therefore, the studio of the 1990s had to embrace much more than the blending of art and craft. In many schools, the studio became a place where issues of art, design, culture, manufacture, sustainability and usability were integrated into a design process. Issues concerning mass customisation, as well as lean and agile manufacturing, have recently competed for consideration within the design studio.

THE DESIGN STUDIO: NATURE

The studio is usually a large room, sometimes equipped with computer workstations, but mostly consisting of drawing tables and chairs to enable students to work independently on projects. The design of the room contrasts the traditional teaching classroom and, while lectures occur within the studio, their nature is more in the form of presentations and discussions. These presentations usually seek to explain the nature of a project, the associated milestones and submission requirements. A studio director supervises the studio-teaching process and a number of tutors assist in guiding the students as the project progresses.

Many studios incorporate facilities that enable the student to experiment with the form or function of a product and shaping tools and foam materials may be provided. This encourages learning by *doing* and frees the student to experiment and consolidate intangible aspects such as shape and feel. The industrial design workshop incorporates both woodworking and metalworking machine tools and is actually an extension of the studio. The workshop allows students to construct models of products made from plastic, wood or foam and its importance to teaching and learning as a means of realising student projects cannot be overstated. The importance of the model is the answer(s) that are provided as a result of the modelling process. Models signify the object; modelling signifies the process and in the end it is the process that provides the answers [8].

The studio brings together disparate thinking into a forum of discussion and idea exchange. Students experience the transient nature of the studio, ie the struggle for understanding the requirement: the inclusion of features in a product; the expression of cultural and regional identity; and the appropriateness of a design solution. The nature of the work in the studio may progress from early, vague understandings of the product requirement and finally arrive at a superior outcome.

The design activity called critique has been derived from architecture and fine arts. The definition of critique is faultfinding centred on fine arts and literature. The use of the critique is central to the design process within the studio; however, the activity is more correctly termed review, assessment or evaluation. The theory of learning applicable in the studio is sometimes wrongly assumed as Problem-Based Learning (PBL). The studio employs PBL and the essence of the studio is tied up in the difference between Problem-Based Learning and project-based learning. In PBL, a student is given a problem and then proceeds to solve it using established principles or carrying out research in order arrive at a satisfactory solution. Yet in project-based learning, students may have to *find or establish the problem*. The studio approach to teaching and learning differs from the dominant models of professional knowledge that are applied in science and engineering. However so, these models are based on the premise that a collection of principles, rules and methods can be applied to the solving of rational problems and that real-world problems are not necessarily rational. In many instances, these problems may be referred to as ill-defined.

The industrial design studio project may include responsibility for the design of the user interface and product function, and emotive aspects such as *product appeal* (visual, tactile *style*), together with perceived quality and value. In addition, the designer is working with materials and structures that must have appropriate engineering properties and be manufactured, assembled, distributed, maintained, used and responsibly disposed of. Industrial design problems thus involve dealing with a very large number of constraints to meet goals that may not be clearly defined. Such design problems are usually ill-defined (as opposed to well-defined problems that can be solved using well understood procedures and have clearly identifiable, correct solutions).

Rowe provides a summary of the features of ill-defined problems, particularly those that are so ill-defined that they are known as *wicked* problems [9]. Rowe suggests that:

> *First, they are problems without a definitive formulation, or indeed the very possibility of becoming fully defined. Additional questions can always be asked, leading to continual reformulation. Second, they are problems with no explicit basis for the termination of the problem-solving activity – no stopping rule. Any time a solution is proposed, it can, at least to some significant extent, be developed still further. Third, differing formulations of the problems of this class imply different solutions, and vice versa. Finally, solutions that are proposed are not necessarily correct or incorrect* [9].

Cross agrees and adds: *that proposing of solutions is a means to understanding ill-defined problems* [10].

Compounding the complexity of the studio in setting ill-defined projects are rapid changes in technology all requiring some change in the nature and methods of teaching employed in the studio. Computer-Aided Drawing has been integrated into studio projects and, in some schools, the studio is equipped with workstations to enable a significant amount of the design work to be done on the computer. This has led to computer modelling of concepts and components enabling the integration of rapid prototyping as part of the studio project. Similarly, the project may have to include considerations of culture, sustainability (materials and disassembly) and manufacture including assembly.

THE DESIGN STUDIO: ISSUES, ADVANTAGES AND PROBLEMS

The design studio exists within the university system but does not sit entirely comfortably. It is a throwback to an earlier mode of education that has long been abandoned by other disciplines. Some view the function of the studio as craft-like, lacking in precision and without rigour. Those that take this view support the more methodical approach of the intellectual arts and the methodical approaches of the natural sciences. The schools of the modern university are premised on technical rationality and their perception of professionalism is grounded in systematic, preferably scientific knowledge [11]. Thus, a certain tension

exists between proponents of the studio process where intuition and reflection, processes critical to imaginative problem solving, are in some conflict with scientific training, which provides only a range of the technical and behavioural knowledge derived from a rapidly expanding database.

Despite the advantages of studio teaching, the outcomes can be disappointing where many students depend on lecturing staff for the generation of ideas and the resolution of those ideas. This is a common problem in many design programmes where the process of idea generation, screening and resolution of concepts is difficult for the majority of students. Frost, writing of his experience with engineering design students, describes the confusion of students when faced with many possible alternatives of approach, but these are not identifiable as clearly right or wrong. He states that *the path from the problem to the solution is not clear, but paradoxically, solutions are legion and heavily, if mysteriously contextual. None, however, is clearly right or wrong* [12].

It is the decision-making process that is difficult because decisions depend on as-yet-absent experience. It is obviously very difficult to conceptualise and make decisions on issues, such as the market, function, usability, manufacturing methods and cost, when these issues have not been experienced by undergraduate students.

Many students are not able to pull together the disparate lectures on mechanics, materials science, manufacturing and marketing and relate these to the design process. There is little time for reflection in most undergraduate programmes and it has to be said that this is also a major issue in industrial design. The process of reflection-upon-learning is strongly advocated by Schon, and consistent with the theories of learning advanced by Skinner and Bruner [13].

The studio, despite the rapid developments in technology and the breadth of considerations within typical projects, remains a place where art and craft are blended in a process of intuition and reflection. It is a place that, to a large degree, has not embraced scientific and systematic thinking. The nature of the studio inherently considers such approaches constraining and limiting. Certain design methods, such as design-by-drawing, Computer-Aided Design and brainstorming, are employed in the studio, but the broader use of systematic techniques has largely been rejected. Although the application of design methods are not new, their application in industrial/product design programmes has seldom been encouraged in the didactic sense. Consequently, apart from what is often a disorganised approach, many students tend to concentrate on shallow visual outcomes without the necessary cognitive analysis and synthesis required to achieve sustainable and contemporary designs with justifiable features.

Therefore, it is argued that the studio could be enhanced by the adoption of systematic procedures that may assist in the management of research findings and information and guide the student in a more structured progression through the design process. Earlier published papers by the authors describe in more detail the type of methods that can be incorporated into the studio-design process [14][15].

CONCLUSIONS

This paper has briefly explained the origins of studio teaching and linked the evolution of the teaching with that of engineering. What has been revealed is that the basis of studio teaching dates back a long time and is principally based on the model developed at the Ecole des Arts in Paris. In the early part of the 20th Century, developments arising from mass production ushered in many changes that distinguished the industrial design profession. Similarly, these changes led to educational curricula more focused upon industrial and product design, that is, more focused upon *products for people*. Continual changes in curricula and approach was driven by the quality management and environmental movements, and, in response industrial design programmes, have endeavoured to respond to the evolving needs of industrial innovation. The nature of the studio has been described by the particular emphasis placed upon ill-defined projects because these distinguish the nature of the studio in comparison with projects set in other disciplines where established principles are employed.

Studio design projects that allow for intuition and reflection encourage a deeper learning. However, the rapid developments in technology and issues of consideration requiring inclusion in the project mean that project activity is difficult for the student. The paper argues that the rigour introduced by certain design methods, as part of the design process, may lead to a better and educationally sound project execution together with a more professional communication of results.

REFERENCES

1. Maitland, B.M., *Problem-based Learning for an Architecture Degree*. In: Boud, D. and Feletti, G. (Eds), The Challenge of Problem-based Learning. London: Kogan Page (1991).
2. Pevsner, N., *Academies of Art – Past and Present*. Cambridge: University Press (1940).
3. Heskett, J., *Industrial Design*. London: Thames and Hudson (1997).
4. Bingham, N., The education of the architect. *Proc. 22nd Annual Symp. of the Society of Architectural Historians of Great Britain*, UK (1993).
5. Proudfoot, P., Phenomenology, a model for architectural education? *Architectural Science Review*, 32, 95-100 (1989).
6. Gropius, W., The Bauhaus. *Architectural Educ.*, 1 (1983).
7. Kaufman, J., TNT - industrial design curriculums. *Proc. IDSA Design Educ. Conf.*, Chicago, USA (1999).
8. Giard, J., Industrial design education: incompatibility with education in art and architecture. *Proc. IDSA Design Education Conf.*, Chicago, USA (1999).
9. Rowe, P.G., *Design Thinking*. Cambridge: MIT Press (1987).
10. Cross, N., *Engineering Design Methods*. Chichester: John Wiley and Sons (1989).
11. Schon, D.A., *Educating the Reflective Practitioner*. San Francisco: Jossey-Bass (1987).
12. Frost, R.B., The future of machine element design courses. *Conf. on Teaching Engineering Designers*, Sydney, Australia, 4 (1992).
13. Romiszowski, A., *Designing Instructional Systems*. London: Kogan Page (1981).
14. Green, L. and Bonollo, E., The development of a suite of design methods appropriate for teaching product design. *Global J. of Engng. Educ*., 6, **1**, 45-51 (2002).
15. Green, L. and Bonollo, E., The application of methodologies to product design teaching within the industrial design studio. *Proc. 3rd Asia-Pacific Forum on Engng. and Technology Educ*., Changhua, Taiwan, 210-213 (2001).