Project X experiences of multidisciplinary Arch/COFA/Eng teaching

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ABSTRACT

The present paper describes two multidisciplinary design courses, named Project X and Project X^2, that were available for the first time in 2007 to students from three design–based faculties at the University of New South Wales (UNSW): Faculty of the Built Environment (FBE), College of Fine Arts (COFA) and Faculty of Engineering (FE). During these courses, the students designed, fabricated and constructed from cardboard and timber an enormous sculpture of a snake, nick–named Ed and consisting of five massive arches and a five meter tall head. Ed was displayed for a period of five weeks on the UNSW main walkway to celebrate multi–disciplinary design education and the ConnectED2007 Conference. In addition to discussing Project X, this paper also explores some of the challenges in education of today's structural engineers and the benefits of the newly introduced BE Civil Engineering with Architecture Program at UNSW.

PROJECT X

The project consisted of two parts, namely Project X and Project X^2. Project X, the scheme design course, was run as an intensive three–week course in February 2007. Students from the three Faculties worked together in teams to produce scheme designs against a brief set by the ConnectED 2007 Conference Organising Committee, the actual Client. (The ConnectED Conference, held at UNSW in July 2007, provided a platform for the discussion of research and strategies that address the promise and possibilities of design education that crosses disciplinary boundaries.) The scheme designs were evaluated first within the course by the Interim Jury and then by an external Project X Final Jury. The Final Jury selected the winning design which was then further developed, fabricated and constructed by multidisciplinary teams in Project X^2 (the Fabrication and Construction Course).

The brief invited a design that was a building, or a sculpture, or some other sort of intervention or installation that would symbolize the theme of the Conference. The design brief included artistic, formal, functional, loading, sustainability, budgetary, and other performance criteria. The design concept (the final product) had to be capable of subsequent fabrication and construction. The site for the erection of the selected project was chosen to be at the heart of the campus, the main walkway just below the Scientia Building, the venue for the Conference. This framework provided staff and students from the three Faculties with an opportunity to work together by applying their skills on a real project, with real time constraints and a defined budget.

Project X was held at COFA in a large studio space sufficient to accommodate 65 students, 4 full time members of staff and various guests. A workshop studio environment was adopted with teams of three to four students working on the "open ended" design brief, with approximately equal numbers of representative students from the three Faculties. Students came from a wide range of design–based undergraduate degree programs: Civil Engineering, Architecture, Design, Industrial Design, Fine Arts, and Building Management.

Coursework included lectures, individual research, design, team management, digital and physical modelling, reporting and presentation. The primary role of the academic staff was to facilitate the design studio environment and to be available to the multi disciplinary teams. At any given time there were at least one architect and one engineer in attendance providing team support. The lectures were given by practising designers from artistic, architectural, and engineering backgrounds. There were also lectures by potential materials suppliers and by sustainability specialists. Students also had access to computing labs, printing facilities, welding and timber workshops and the purpose–designed electronic interface, known as Omnium website (Bennett 1999), which facilitated communication between academics and the student body, as well as communication between team members in a format that encouraged participation without detracting from the studio process.

A typical Project X working day (minimum of six hours per day) consisted of a morning lecture, followed by teamwork and consultation in studio. The Interim Jury was held on the seventh day and this Jury comprised the client representative, guest critics, and the four studio tutors. Selected student representatives assisted with the development of the assessment criteria. For the Interim Jury process the students were expected to present a poster, a physical model in site context, and evidence of construction feasibility. A digital model was encouraged but PowerPoint was banned. An exhibition of the work for the Final Selection Jury, which comprised a distinguished artist, architect, and engineer, and non–academic guest jurors, was held on the last day of the course. Figure 1 below shows the winning design and Figure 2 shows examples of other designs. The selected brief was then handed out to students enrolled in Project X^2; this course commenced one week after the Final Jury.

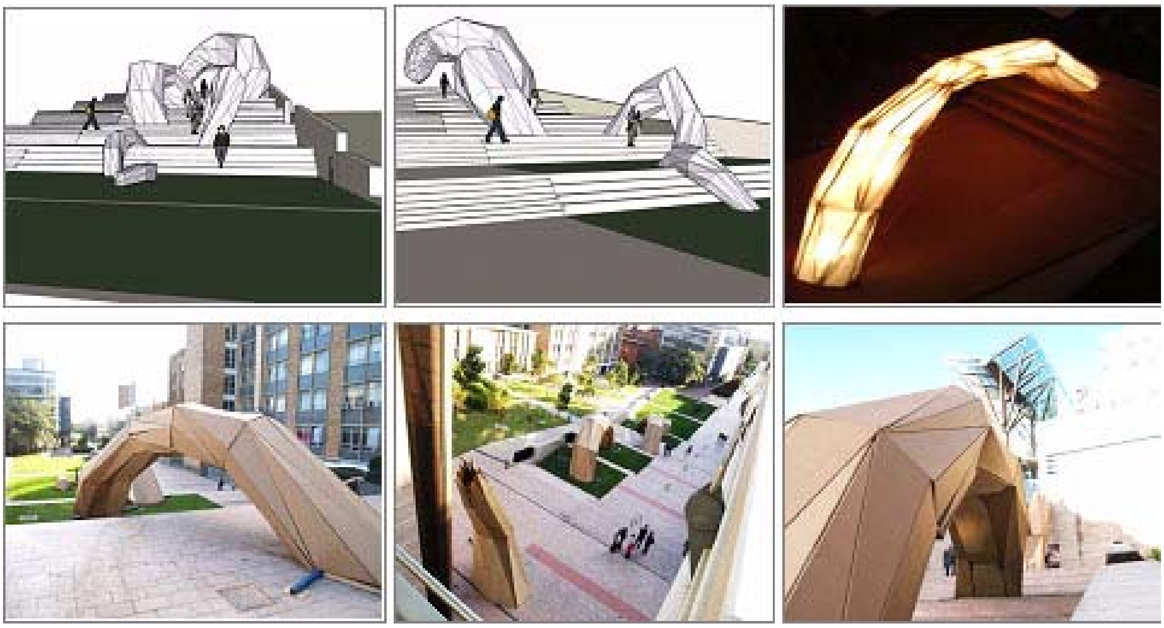

Figure 1 The winning design

PROJECT X^2

Project X^2 was offered as a standard once–a–week course in Session 1 2007. The three faculties produced course outlines based on a common agreed model, after agreement on project aims, outcomes, methods of delivery, assessment and the like. The aim was to empower the students to lead the process; to design, fabricate, construct and to manage the project to and to dismantle on time and within the specified budget. To ensure the students' lead a Student Project Manager (executive student) was appointed. The Student Project Manager was also enrolled in the course.

Project X^2 included several distinct phases: design development, sponsorship, prototyping and testing, prefabrication and construction, erection and deconstruction. For the first six weeks, during the design development phase, Project X^2 was located at the Kensington campus. The teams then moved to the Randwick campus for the prefabrication phase. Once the prefabrication phase was completed, the installation components were transported back to the campus for erection. An academic staff member was engaged as the certifying engineer.

Figure 2 Examples of other Designs

MULTIDISCIPLINARY EDUCATION

Multidisciplinary project–based courses give students a better understanding of what to expect in the workplace. Project X for example, as discussed by Longbottom et al (2007), provided the following educational elements of multi–disciplinarity:

1. Identity. Each member of the student team tended to take on an identity associated with their background programs. The engineering students behaved as engineers within their group context. Likewise the group members from FBE behaved as architects and the student members from COFA as 'designers'. The students were in a continual role play through the course (Figure 3). They communicated as if they were professionals and were under scrutiny to perform. They also learnt from each other. COFA students witnessed the role of engineering design calculations while engineering students participated in discussions on the fundamentals of the design process, and on aesthetics. It would be easy to exaggerate the openness of these communications. In fact continual effort was needed on the tutors' part to challenge stereotypical attitudes, sadly already adopted by many of the students. The reach of the project was of course exceptional, from artists to engineers, and staff themselves needed first to address their own preconceptions and attitudes in preliminary discussions, many of which are still ongoing.

2. Responsibility. Beyond cross–disciplinary discussion, team members also needed to perform their assigned role. COFA students would often conceive an imaginative idea which demanded a quick response on practicability from the engineers. Those engineering students who could present their findings in an open rather than a closed manner, assisted their team to progress toward acceptable solutions, rather than having to abandon whole themes.

3. Individuality. The brief was open–ended and each group devised its own individual solution. There was little scope or incentive for copying, and group members provided original and individual contributions.

4. Innovation/Uniqueness. Having an external jury introduced competition and realism into the course. The winning design as decided by the external jury would be built. The jury process emphasised the need for innovation and uniqueness. The outcome was not predictable.

Project X and Project X^2 have provided an exceptionally broad and rich multi–disciplinary design learning experience for around a hundred students at UNSW, from a wide range of design–based undergraduate programs. Some students' comments are included below:

"The course helped me find out how wrong I was for having the impression that artists and designers are weird people that we as normal people can not work with. I found out that they can be smarter than us, " more normal" than us, and that we had to think a little bit outside the square to get to understand them more" (FE student)

"I learnt the role of each professional area in the design process, encouraging creative thinking and group dynamics." (COFA student)

"Learnt what designers and architects do. Hands on experience of what it would be like in real life." (FE student)

"The experience with working in a compressed workshop environment was stressful at times due to impending deadlines, but it was all a good learning experience to plan our time effectively in order to meet these deadlines." (FE student)

"At first there was less acceptance. But we slowly grow and LEARN from each other. Once we opened up and actually "see" each others capabilities we begin to learn more. Everyone taught one another something that is not in the textbook." (FE student) "This class has helped me develop skills required to reach a consensus. This critical skill I'll be using in my professional career." (FE student)

"I even learnt different jargon from the other disciplines." (FE student)

"Overall in my opinion, this 3 weeks has been really challenging and useful to our future in possible work place." (FE student) "I learnt that there's so much more to engineering than just technical structural analysis." (FE student)

"Learnt to work in a flexible manner, allowing for changes in the structure throughout my analysis." (FE student)

"This is more like the real world." (FE student)

"Good to know how engineers think." (FBE student)

"Excellent. Working with engineers fantastic opportunity to resolve structural design." (FE student)

"Every member in the team had something to contribute – surprisingly ideas from engineers were accepted into the design concept." (FE student)

"The team overall contributes equally to the design. Though there are ups and downs regarding the decision, especially engineering constraints on "why we can't build the structure". But most of the people in the team are open minded and accepts what we have to say." (FE student)

"The beauty of this project was that although we had a massive task, we also had 4 people working on it, hence lessening the workload." (FE student)

"As an arch student it was interesting being in between position between design and engineering, motivator, challenging, emphatic, CAD monkey, model monkey." (FBE student)

”Everyone in our group worked really well together¿

”Overall the group worked in an efficient manner, it was challenging for the group to keep a common goal, as students from different faculties wanted to work in different directions. However we managed to keep it all together and work as a team.” (COFA student)

”Although many of us have been complaining about time constraints and not enough guidelines, in other ways it really did push us to our limits and made us learn and grow from it! It’s GOOD!” (FE student)

”Sometimes it was very challenging to explain the whole conceptual process and design development to people who had never come across it before. The explaining time took longer than the time spent talking and generating ideas.” (FBE student)

Figure 3 Multidisciplinary design and construction teams at work

STRUCTURAL ENGINEERING AND ARCHITECTURE: HIGHER EDUCATION VS THE WORK PLACE

Current barriers and interfaces between engineering and architecture vary considerably from country to country, as do the methods of teaching architects and engineers. The architect has a more diverse education than does the engineer. A typical architectural curriculum covers a broad scope of subjects, both functional and aesthetic. For the engineer, the education is more narrowly focused. The eminent structural engineer, Professor Salvadori, has written: ”A good architect today must be a generalist, well–versed in space distribution, construction techniques and electrical and mechanical systems, but also knowledgeable in financing, real estate, human behaviour and social conduct. In addition, he is an artist entitled to the expression of these aesthetic tenets. He must know about so many specialties that he is sometimes said to know nothing about everything. The engineer, on the other hand, is by training and mental makeup a pragmatist. He is an expert in certain specific aspects of engineering and in those aspects only." (Salvadori, 1980)

Engineers are not commonly perceived as creative professionals. A recent Harris Poll sponsored by the American Association of Engineering Societies and IEEE–USA found that only two percent of the public associate the word "invents" with engineering; and only three percent associate the word "creative" with engineering (Stouffer et al., 2004). The creative side of design, especially regarding civil engineering, is commonly thought to belong to architecture. The architect is trained and conditioned to begin the process of design with requirements of the human being, while the engineer is trained and conditioned to achieve a result almost entirely by the application of the principles of mathematics and engineering to problems similarly dimensioned, a process which can in fact suppress the requirements of the human.

There is clearly a perceived need by the professions for engineers to be better educated in creative thinking and aesthetic values, enabling them to collaborate positively and constructively with architects and other professionals. Creativity is essential in all branches of engineering and is of paramount concern in engineering design. Yet while "creativity is an essential component in engineering design", focused interview with leading creative engineers has found that "engineering schools do not adequately prepare students for creative endeavours or for the realities of modern industry". (Richards, 1998)

A world–renown Spanish–Mexican architect Candela has written: "The second design phase consist of a tremendous battle between the engineer and the architect – the former willing to introduce modifications which, although sometimes necessary, many other times should be unnecessary. On the other hand, the architect wants to maintain his preconceived idea, but has no weapons to fight against the scientific arguments of the technician. The dialogue is impossible between two people who speak different languages. The result of the struggle is always the same: science prevails and the final design has generally lost the eventual charm and fitness of detail dreamed by the architect." (Faber, 1963)

Clearly, there is much that the two professions (both play essential roles in advancing human society) could learn from each other when obliged to work together and the best architecture comes from the successful collaboration of the architect and the engineer. The interface between engineering and architecture, therefore, only works if engineers understand what architects do and how they think, and architects understand what engineers do and how they think. (Dickson, 1999)

As described by Project X^2 students: "Through the design of the structural system, we have once again seen the contradicting views of design vs practicality. Good design sometimes has to be forsaken because of practical constants. While the engineers and architects do not necessarily speak the same language, it would still be productive for the two to work closely together, if not at the same time as it improves efficiency and smoothens out decision making process. I got a deep understanding about the team work and how important it is to cooperate within a team..."

Much has also been written about the need to transform engineering education (Bordogna, 1997) and the apparent disconnect between higher education and the workplace. The modern engineer needs to be educated to thrive through change. No longer do engineers layer directly on traditional disciplines. We all acknowledge that scientific and mathematical skills are necessary for professional success, nevertheless an engineering student must also experience the "functional core of engineering" – the excitement of facing an open–ended challenge and creating something that has never been created before. In today's education of structural engineers, for example, there is a strong emphasis on the role of structural analysis at the expense of understanding structural behaviour and synthesis – the art. The development of well–rounded, multi–skilled engineering graduates clearly relies not only on traditional subject material, but increasingly on the development of skills for utilising this knowledge in a creative and innovative manner. The challenge is therefore to make engineering education relevant, to reflect the new market–driven competitive environment, to use technology to enhance learning and to engage the Programs across university Faculties. In addition to being technically competent, engineers must also be creative in problem–solving, perceptive about the global economy, knowledgeable about management, and able to communicate their ideas effectively.

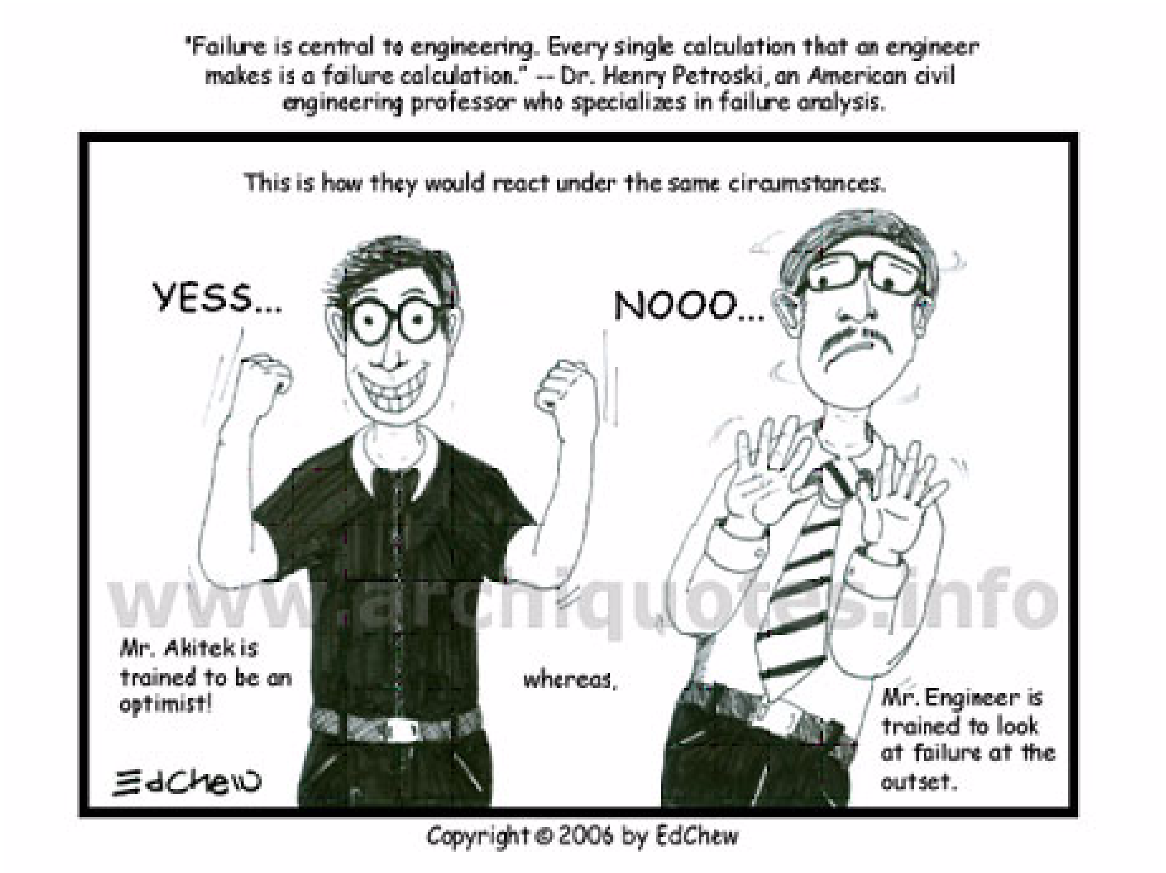

Figure 4 Architect vs Engineer

The BE Civil with Architecture Program, hence, introduced for the first time in Australia at the University of New South Wales in 2007, seeks in addition to achieving the objectives of the already existing undergraduate Civil Engineering Program, to address many of the aspects of how a modern engineer should be educated, and to provide an appreciation of architectural principles and an understanding of both the architect's role in construction and the interaction between architects and engineers. The BE Civil with Architecture Program is not a combined degree; it is a novel cross–disciplinary degree with a major in one Faculty and a minor in another. Because of recent changes to the curriculum structure of engineering degrees at UNSW it became possible to structure a minor stream of courses embedded in the four year core Engineering Program. The Program offers a unique opportunity to integrate engineering and architectural design. Creativity and inventiveness are the key attributes for this Program. It endeavours to close the gap between what is taught in school and what is expected from young engineers by their employers and clients with the ultimate aim to help students become conceptual thinkers, and to develop an appreciation for beauty with the mathematical ability to challenge the traditional boundaries of structural design.

CONCLUSIONS

Project X was designed to provide students with an understanding of the multi–disciplinary processes required for the design of a significant structure, relevant to their other coursework. Project X and Project X^2 have provided an exceptionally broad and rich multi–disciplinary design learning experience for around a hundred students at UNSW, from a wide range of design–based undergraduate programs. Together, Project X and Project X^2 celebrate both the design process and the education process, both in their multi–disciplinary dimension.

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