Civil Engineering with Architecture @ UNSW

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***Abstract**: This paper describes an innovative new multi-disciplinary single undergraduate degree with a major in Civil Engineering and a minor in Architecture completed within four years. The program is Civil Engineering with Architecture. It is not a combined degree, it is a "with" degree. The core of the Civil Engineering Program is maintained and supplemented with almost a full year of courses from the Architecture faculty. The program aims are to provide an appreciation of architectural principles, an understanding of the architect's role, the interaction between architects and engineers, and the importance of ethics, context, sustainability, unique innovative design and aesthetics. Students graduating from this program will be better equipped to collaborate with architects and other professionals in the built environment to produce integrated and sustainable design.*

Introduction

For a typical engineer, the double helix bridge in Marina Bay Singapore presents as a beautiful structure. It is an award winning design. However, a design colleague criticised the bridge design as coming from a Western perspective and therefore out of context in the Singaporean environment. Engineers often fail to look beyond the boundaries of their design, to see the human context of their work. Architects have a more diverse education than do engineers. A typical architectural curriculum covers courses both functional and aesthetic. Engineering curricula are often more narrowly focused. Professor Salvadori, an eminent structural engineer, wrote that:

"*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. 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 the built environment, is commonly thought to belong to the architect. An architect will often begin the process of design with an abstract conceptual brief, while the engineer achieves results almost entirely by the application of the principles of mathematics and science without any reference to the human context of their design.

There is a perceived need for engineers to be better educated in creative thinking and to appreciate 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)

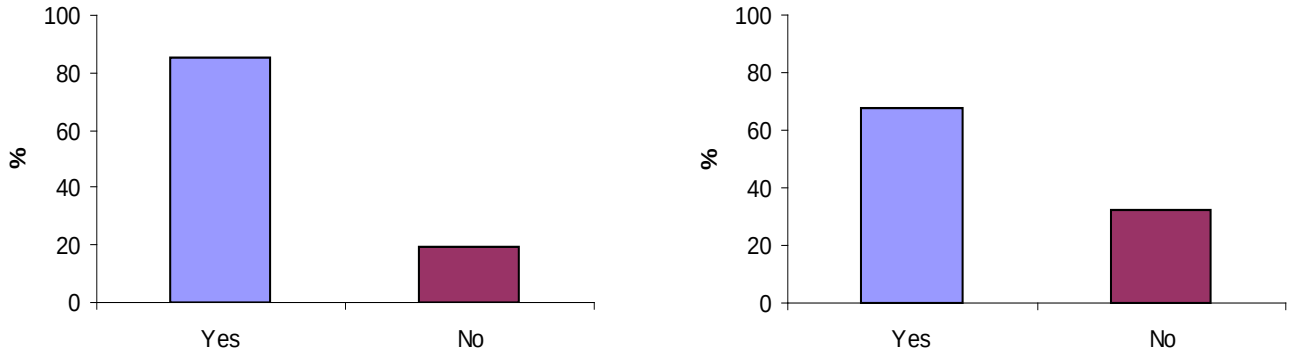
Although the Universities in Europe, USA and Asia (i.e. Department of Architecture and Civil Engineering, University of Bath, UK; School of Architecture, Civil and Environmental Engineering, EPFL Lausanne, Switzerland; College of Engineering, Architecture, and Computer Sciences, Howard University; Architecture and Engineering, Princeton University; Department of Civil Engineering and Architecture, HTWK, Leipzig; Department of Civil Engineering, University of Glasgow, UK; Tohoku University, Japan, etc., etc.) have a long history of very successful and well recognised undergraduate and postgraduate Civil Engineering with Architecture Programs, until now, there has been no such Program on offer at any of the Australian Universities. The Civil with Architecture program at UNSW had it first intake in 2007. Sydney University has recently advertised a double degree program in Civil Engineering and Architectural Design to begin in 2009.

The Civil with Architecture Program (CwA) at UNSW seeks 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. 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.

The CwA program at UNSW has now been running since 2007. The quota has been set at 30 students per annum. The quota is limited by the high running costs of the architectural design workshop courses. The number of applications for enter in 2008 was over 90 students and the current UAI for the program is 91.

Initial student opinion

Before the program was developed, students were surveyed about their support or otherwise for such a Program. A large scale survey involving Year 1 to Year 4 undergraduate and postgraduate students (130 students in total) in the School of Civil and Environmental Engineering, was carried out in May 2006. Seventy five (75) survey questionnaires were also distributed and completed during one of the 2nd Year lectures. Survey responses from other years were collected via email. The survey consisted of two questions only, namely: 1. Does the option of having an extended four years Civil Engineering with Architecture degree sound appealing to you?; and 2. If you were given the opportunity to enrol in such Program at the time of your enrolment, would you do so? The survey results are shown in Figs. 1a) & b) and clearly were in favour of the new program.



a) Question 1 **b) Question 2**

Figure 1: Survey question results

Program structure

The Civil with Architecture Program is not a combined or double degree, it is a "with" degree. It is a novel cross-disciplinary degree with a major in one Faculty and a minor in another. The Program offers a unique opportunity to integrate engineering and architectural design. Because of changes to the curriculum structure of engineering degrees introduced in 2006 at UNSW, it became possible to structure a minor stream of courses embedded in the four year core Engineering Program, as shown in Table 1. The Program complies with the flexible first year structure of all engineering degrees at UNSW.

Table 1: Civil Engineering with Architecture Program 2008

Year 1	Year 2	Year 3	Year 4
Semester 1			
• Mathematics 1A • Physics 1A • Engineering Design and Innovation	• Mechanics of Solids • Engineering Computations for Civil Engineers	• Applied Geotechnics and Engineering Geology • Structural Analysis & Modelling • Principles of Water Engineering • Water Resources Engineering	• Honours Thesis A or Design Practice A • Professional Elective 1
• **Enabling Skills and Research Practice**	• **Architectural History and Theory 1** • **Architectural Design Studio 1**		• **Architectural History and Theory 2** • **Architectural Design Studio 3**
Semester 2			
• Mathematics 1B • Engineering Mechanics • First Year Engineering Elective	• Engineering Construction • Soil Mechanics • Materials & Structures • Mathematics 2E	• Structural Behaviour & Design • Engineering Operations & Control • Water & Wastewater Engineering	• Honours Thesis B or Design Practice B • Professional Elective 2 • Professional Elective 3 • General Education (6UoC)
• **Architectural Communications**		• **Architectural Design Studio 2**	

In the CwA Program, the core of the Civil Engineering Program is maintained and supplemented with almost a full year of courses from the Faculty of the Built Environment which are generally taught in a multidisciplinary environment. The courses from the Faculty of Built Environment are show highlighted in Table 1. All engineering and architectural courses are 6 units of credit. A semester has 4 courses at a total of 24 units of credit. Architecture forms part of each year of the proposed Program, the amount varying from year to year but constituting roughly 20% of the total CwA Program. The Faculty of the Built Environment courses concentrate entirely on the history and theory of architecture, CAD drawing, creative drawing and model-making, architectural design, and design studio workshops.

In Year 1, the computing course Enabling Skills and Research Practice replaces the Engineering Computing in the Civil Engineering degree, and the new Architectural Communications course is one of the two recommended free electives common to all first year engineering degrees. In subsequent years, 6 units of credit of General Education (out of 12 UoC commonly adopted in all other undergraduate programs at UNSW), one third year Civil Engineering Practice course and the Sustainable Transport and Highway Engineering course are omitted to permit the introduction of Architecture Design Studios and Architectural History courses. The core Civil Engineering courses are retained, with the peripheral core course, Sustainable Transport and Highway Engineering made available in Year 4 as an elective course. In Year 4, students in the CwA program have an option of selecting 3 professional Civil Engineering elective courses and must complete 6 UoC of General Education.

Student feedback

We took the opportunity in preparing this paper to survey the current batch of CwA students by email and from focus group discussions. We received detailed responses to several questions which were designed to give us some general feedback about how the new program was going. One line of enquiry asked how students become aware of the new program. The most common response was through the internet either through the university's web pages or the web pages of UAC. This was not surprising given the mandatory use of the internet by school students. We asked if the program was what students expected. There were mixed responses with most courses "pretty much" what was expected while some found the architectural courses a bit too "artsy", some surprised by the depth of the architectural history and one student who expected more technical drawing and model making rather than abstract work in design courses.

For us an important question was whether students saw any advantages and/or disadvantages between themselves and the straight Civil students. Some examples of comments are presented below:

"The advantage is that we get to view the building process from an architect's perspective rather than just a civil engineer's point of view. This generates the ability for us to understand differences and similarities between the roles of an architect and an engineer. The disadvantage is that we have a relatively 'fixed' program structure compared to the straight Civil program, preventing us from choosing more general education subjects, and professional electives."

"The Civil and Architecture program, from the way I see it, is a really exciting program that allows students to understand why a building is constructed in the manner that it is rather than just see it as a plain building. However one of the downfalls of this program is the amount of time that the architecture side takes. The program is said to be 75% civil and 25% architecture but even though I try to manage my time, I always end up spending more time on the architecture side to make a good design rather than concentrate on civil engineering…..Besides that I have found the course to be very enjoying and fun."

The advantages are: *"the program's exciting and the subjects we do are a lot more varied. Also, we get to know and learn with architecture students. We get to appreciate architecture students' works and way of thinking (I found this sadly lacking in straight civil students). We get to learn many building softwares. Increase in employability (hopefully)"*, while the disadvantages are:. *"the archi subjects might not be that useful if one doesn't want to specialise in structural (not a problem for me since I do want to). missing out on some civil subjects. Thanks for coming up with this program, so far I find it to be very satisfying and exciting. this makes things a bit easier for many people who can't decide choosing between civil and architecture."*

"Having a creative balance with the Architecture subjects. Civil is creative to an extent but in a completely different way. Studying amongst Architecture students is great as we can see how they are being taught to think, and how different our work actually is even though we will be working so closely together in the future. You work hard for both the Civil and Architecture subjects, but the way that happens is very different; you lose sleep over finishing a major project for Architecture, and at the same time you do so many practise questions for the Engineering exams you go insane by the end of semester! I try to look at it all as positive though, in the end they are both very rewarding especially managing to do them at the same time. A lot of people think I am crazy for doing this course with the huge workload but however stressful it may get I very much enjoy it. I have learnt so much in the past year and a half and have become familiar with so many computer programs, it's all very interesting. As for disadvantages, the main one I have experienced is with Architecture projects taking up much more time than Engineering subjects, this is a disadvantage around exam time especially when you think you're putting in more time for the 'minor' part of your degree."

"*Ad.'s: a broader understanding of the processes and relationships that must be developed in the workplace (esp. with the architect). I've often been told that architects and engineers are like brothers: always competing to be better than the other, to have their own way. And whereas the architect may be more creative and optimistic, the engineer may be more rationale and realistic. What I'm getting at is that we should be better equipped with skills needed in the workplace. Dis-ad.'s: Sacrificing some*

civil subjects for architecture ones: computing, engineering surveying, sustainable transport & highway engineering, and civil engineering practice."

The feedback reinforces the view that the CwA program would allow the engineering students to appreciate architects, how they think and how they are motivated and to learn to be more creative in their design, to think outside the box, to understand the context of design and appreciate the abstract human element which should engulf all design. The major difficulty experienced by the students has been that the architectural courses are far more time demanding than their engineering courses.

Summary

The Bachelor of Civil Engineering with Architecture Program at UNSW had it first intake in 2007. It has proven to be a popular program with a present UAI in NSW of 91. The background to the development and purpose of the program has been detailed in this paper. The CwA program is a new innovative "with" program which extends the current Civil Engineer bachelor degree by the inclusion of a stream of courses in Architecture from the Faculty of the Built Environment. The "with" degree is a single degree with a major in one faculty and a minor in another. It is not a double degree and is completed in the standard four years for engineering degrees. The feedback has been overwhelmingly positive from students currently in the program.

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