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THE PAST, PRESENT AND FUTURE OF CONSTRUCTION EDUCATION AT UTS

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Abstract: This paper looks at the history of construction education at the University of Technology, Sydney from 1973 to the present and examines new challenges facing construction and construction education in the 21st century. It also examines the construction sub-major being offered in the Engineering faculty.

Key Words: Construction education, engineering construction, building, construction management, quantity surveying, construction economics

Introduction

The construction industry in Australia has a total value of the order of 5-6 % of GDP. Figure 1 shows the value of work done in the construction industry between 1995 and 2006 (ABS, 2007)

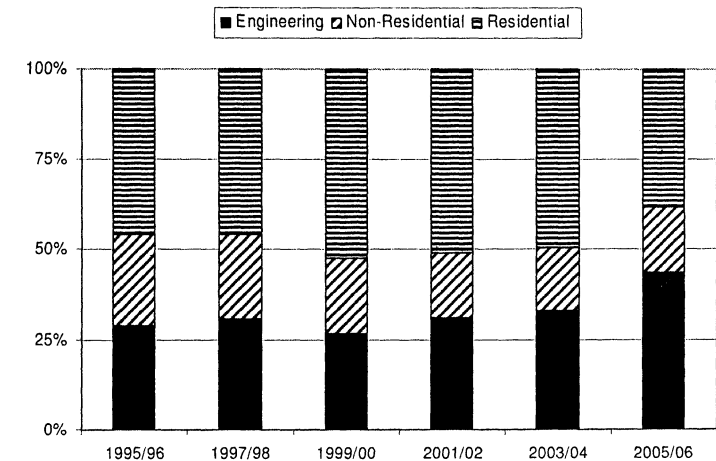


Figure 1 – Breakdown of Construction Industry Turnover

At the present time in New South Wales there are three education providers servicing the construction industry, and as a rough guide one might assign the construction work to these providers as shown below. Note that the percentages are obtained from the Australian Bureau of Statistics (ABS, 2007) but that the educational providers of each category are based on the experience of the author. There is of course considerable overlap between education in these three areas.

- Housing – Education mainly by TAFE – 25% of the market in 2005-06
- Non-Residential Construction and other Residential Buildings – Education by Building Faculties – 32% of the market in 2005-06
- Engineering Construction - Education by Engineering Faculties – 43% of the market in 2005-06

This paper looks at the history of (building) construction education at the University of Technology Sydney and discusses some recent developments, including teaching of subjects in the Bachelor of Construction course to engineering students as part of a construction sub-major in the Bachelor of Engineering degree.

Genesis of Construction Education

Whilst noting that the majority of those already in construction management in 1964 had no formal qualifications the Board of General Studies in the UK noted that “These men improve their technical knowledge in the course of their work” (Board of Building Education, 1965 ,p 41). They recommended that in addition to having a sound technical knowledge suitable men should be trained in the management aspects of construction.

”This training must be carefully organised to provide opportunities for acquiring experience of a wide range of management situations and for practising the skills and techniques upon which the success of management depends” (Ibid, p 40).

The report lists the following fields of management knowledge

- Management (history, processes, cost control, office management etc)
- Human Relations
- Communication
- Statistics and Sampling
- Personnel (inc safety)
- Plant & Transport
- Production (work study and planning)
- Technology
- Quantity Surveying
- Economics
- Law (Ibid, pgs 42&43)

It was around this time that specialised courses in building were being developed in non-engineering faculties in the UK, Australia and the USA. In 1968 a Diploma course in Building was started in the Architecture Department at what was then the NSW Institute of Technology (now the University of Technology Sydney). Concurrently with these developments engineering construction was being integrated into most engineering courses and in some cases specialist “engineering construction management” degrees were being developed. Engineering construction consists of the construction of major civil engineering works such as dams and bridges whilst “building construction” looks specifically at the construction of buildings. A similar distinction was being made in the USA

when the ASCE developed engineering construction courses and the Association of Construction Schools was formed by a collection of building courses, which had developed out of architecture courses.

History of Construction Education at UTS

Throughout the following reference will first be made to the “building” courses at the University of Technology Sydney (UTS) as these in general had approximately twice the numbers of students as the quantity surveying courses.

Initial Degree Course in Faculty of Architecture (1973)

The Diploma course in building at the Institute of Technology developed into a degree course, which started in 1973. Students attended lectures for 12 hours a week for 6 years. This course was essentially technically oriented and shared the first two years with Architecture students. The building students undertook the subjects given in Figure 1, with two semesters in a year.

Materials & Technology (25%)	Anatomy of Buildings (29%)	Management & Contract Admin (16%)
Technology 1	Anatomy of Buildings 1	Management 6
Technology 2	Anatomy of Buildings 2	Management 8
Technology 3	Anatomy of Buildings 3	Management 10
Technology 4	Anatomy of Buildings 4	Management 11
Structures 5	Building Practice 1	Management 12
Structures 6	Building Practice 2	Specifications
Structures 7	Building Practice 3	Contract Administration
Structures 8	Building Practice 4	
Properties of Materials 6	Services 5	
Properties of Materials 8	Construction 5	
Properties of Materials 9	Construction 6	
	Construction 7	
	Construction 8	
Quantities & Estimating (7%)	Economics and Finance (9%)	Contextual Studies & Law (14%)
Quantity Surveying 5	Accounting	Contextual Studies 1
Estimating 7	Costing	Contextual Studies 2
Estimating 9	Business Finance	Contextual Studies 3
	Feasibility Studies	Contextual Studies 4
		Contract Law
		Industrial Law

Figure 2 1973 Building Degree Course

In addition to the above students completed two subjects of Practical Studies and four elective subjects (or a thesis).

The Quantity Surveying students studied Quantity Surveying 6, 7, 8 & 9 in lieu of Properties of Materials 6 & 9, Structures 7 and Structures 8 and Building Economics 10, 11 & 12 in lieu of Management 10, 11 & 12

First Major Revision (1981)

In 1981 the course broke away from Architecture with two strands of Building (Project & Construction Management and Building Surveying) and a separate Quantity Surveying course.

The building students undertook the subjects given in Figure 3.

Materials & Technology (28%)	Anatomy of Buildings (17%)	Management, Contract Adm & Contextual Studies (24%)
Structures & Materials 1	Construction & Services 1	Management 1
Structures & Materials 2	Construction & Services 2	Management 2
Structures & Materials 3	Construction & Services 3	Management 3
Structures & Materials 4	Construction & Services 4	Management 4
Structures & Materials 5	Building Design	Management 5
Structures & Materials 6		Management 6
Drawing & Surveying		Professional Practice
Computations		
Quantities & Estimating (7%)	Economics and Finance (7%)	Contextual Studies & Law (17%)
Quantities	Economic Management 1	Contextual Studies 1
Estimating	Economic Management 2	Contextual Studies 2
		Contextual Studies 3
		Legal Studies 1
		Legal Studies 2

Figure 3 1981 Building Degree Course

The Quantity Surveying students studied Quantity Surveying 1-6 in lieu of Quantities, Structures & Materials 3-6, Construction & Services 4, Legal Studies 2, Professional Practice and Management 3-6.

The Building Surveying students studied Local Government Law & Administration 1-3, Maintenance Technology and Fire Technology in lieu of Management 5 & 6, Structures & Materials 5&6 and Economic Management 2.

Second Major Revision (1986)

In 1986 the Building Surveying strand was dropped in favour of a Building Services strand, this being abandoned in 1990 due to lack of demand. The building course was now named "Construction Management" and there were many more subjects common to the Construction Management and Quantity Surveying courses. Figure 4 shows the structure of the Construction Management course. The highlighted subjects were the only ones not common to both courses.

Instead of the highlighted subjects in Figure 3 the Quantity Surveying students did Quantity Surveying 2, Building Economics 1&2 and Quantity Surveying Practice.

Materials & Technology (29%)	Anatomy of Buildings (16%)	Management (23%)
Drawing & Surveying	Construction 1	Management 1
Computations	Construction 2	Management 2
Materials 1	Construction 3	Management 3
Materials 2	Construction 4	Management 4
Building Design	Services 1	Management 5
Building Science		Management 6
Structures 1		Professional Practice
Structures 2		
Structures 3		
Quantities & Estimating (13%)	Economics and Finance (6%)	Contextual Studies & Law (13%)
Quantity Surveying 1	Economic Management 1	Contextual Studies 1
Quantities	Economic Management 2	Contextual Studies 2
Estimating 1		Legal Studies 1
Estimating 2		Legal Studies 2

Figure 4 1986 Construction Management Degree Course

1986 saw the introduction of a full-time component of the courses, with students able to complete the course in 2 years full-time plus 2 years part-time in lieu of the normal 6-year part-time course. Subjects called Practical Studies 1 & 2 were introduced into the full-time years to provide "equivalent" practical experience for these students.

Split Between Quantity Surveying and Construction Management (1997)

In 1996 the Quantity Surveying Department decided to re-position their course in the market as a "Construction Economics" course, due to falling enrolments. There was therefore a significant split in the focus between the Construction Management and the Construction Economics courses. Both courses were revised as shown in Figures 5 & 6.

The courses were extended to 4 years full-time but remained 6 years part-time, with many students opting to do two years full-time and three years part-time. Little commonality remained between the courses except for the Construction and Legal Studies subjects.

The Practical Studies component of the full-time course in Construction Management remained with students attending skills based training at TAFE as well as completing real projects in the later years. In the Construction Economics course a simulated office environment was used to carry out practical training.

The Construction Economics programme attracted many full-fee paying students from Asia during this period and summer schools were introduced to provide students with a continuous program. These students were usually given advanced standing and were able to complete the last two years of the Construction Economics course in 18 months

Materials & Technology (30%)	Anatomy of Buildings (22%)	Management (22%)
Computations, Maths & Stats	Construction 1	Building Communications
Drawing & Surveying 1	Construction 2	Construction Project 1
Drawing & Surveying 2	Construction 3	Construction Project 2
Materials Science 1	Construction 4	Construction Project 3
Materials Science 2	Services 1	Construction Project 4
Structures 1	Services 2	Professional Practice
Structures 2		
Structures 3		
Quantities & Estimating (12%)	Economics and Finance (7%)	Law (7%)
Quantities	Building Company Performance	Introduction to Law
Estimating 1	Development Appraisal	Construction Law
Estimating 2		

Figure 5 1997 Construction Management Degree Course

Materials & Technology (17%)	Anatomy of Buildings (22%)	Management & Preparatory Studies (13%)
Design Evaluation	Construction 1	Preparatory Studies
Materials Science	Construction 2	Project Planning & Risk
Statistics	Construction 3	Contract Administration
Environmental Planning	Construction 4	
	Engineering Services	
Quantities & Estimating (26%)	Economics and Finance (13%)	Law (9%)
Quantity Surveying 1	Economic Development	Legal Studies 1
Quantity Surveying 2	Economic Analysis	Legal Studies 2
Quantity Surveying 3	Advanced Cost Engineering	
Estimating		
Cost Planning & Modelling		
Quantity Surveying Practice		

Figure 6 1997 Construction Economics Degree Course

Combined Bachelor of Construction Course (2003)

Commencing in the late 90's local demand for the Construction Economics course dropped off significantly due a slump in the industry, which co-incided with changes in government policy regarding the preparation of bills of quantities.

In 2002 it was decided to combine the staff members of the Construction Economics course, the Construction Management course and the post-graduate Project Management course into one program, which has subsequently become the Department of Project Management. This move was a recognition that there were significant commonality between the courses and that it was both uneconomic and educationally wasteful to have staff duplicating subjects.

Concurrently with this it was decided that the Faculty should replace the Construction Management and Construction Economics courses with one Construction course (Bachelor of Construction). The main reasons for this were.

1. It was felt that combining the courses offered students more flexibility in employment choices.
2. It was felt that combining the staff into one department would provide students with a bigger pool of expertise and allow greater synergy between staff members, both in lecturing and in research.
3. To avoid unnecessary duplication of resources.
4. Local demand for the Construction Economics course was low and although there was a strong demand for the latter years from overseas students this could not sustain that course.
5. By combining the courses whilst still retaining the essential elements of both students could obtain recognition with both the Australian Institute of Building and the Australian Institute of Quantity Surveyors.

The subjects offered in the new Bachelor of Construction course are shown in Figure 7. The course remained a 4-year full-time or 6-year part-time course.

Materials, Technology and Preparatory Studies (27%)	Anatomy of Buildings (23%)	Management (19%)
Preparatory Studies	Construction 1	Project Management 1
Drawing & Surveying	Construction 2	Construction P.M. 1
Planning & Design Process	Construction 3	Construction P.M. 2
Structural Appreciation	Construction 4	Construction P.M. 3
Structural Behaviour	Services 1	Construction MIS
Building Science & Materials 1	Services 2	
Building Science & Materials 2		
Quantities & Estimating (12%)	Economics and Finance (8%)	Law & Contract Admin. (11%)
Building Measurement	Building Economics 2	Introduction to Law
Estimating	Building Company Performance	Construction Law & Prac.
Building Economics 1		Contract Administration

Figure 7 2003 Bachelor of Construction Course

In addition to the above two case study subjects (Integrated Case Study 1 and Integrated Case Study 2) were introduced to provide simulated training exercises in construction management.

In order to maintain an option for students to specialise in one area of construction sub-majors were proposed in the following areas.

1. Project Economics and Finance
2. Project Management
3. Technology
4. General Practice
5. Building Surveying

The proposed sub-major subjects are shown in Figure 7

Sub-Major	Subject 1	Subject 2	Subject 3	Subject 4
Project Economics & Finance	Advanced Procurement Methods	Advanced Project Evaluation	Industry Economics	Financing Construction Projects
Project Management	PM Communication and Human Resources	PM Integration	Design Management	Project Risk
Technology	International Construction	Sustainable Building Technology	Building Assessment	Advanced Construction Technologies
General Practice	Expert Witness	Evolution of Technology	Professional Practice	Building Control & Regulations
Building Surveying	Fire Dynamics	Performance Based Certification	Fire Safety Systems	Human Behaviour in Fire

Figure 8 Sub-Major Subjects

Only the first two sub-majors are presently offered. In the project management sub-major the PM 1 subject was added as an option for non-construction students and more recently an additional subject “Construction in Developing Communities” has also been added as an option as well.

New Developments in Construction Impacting on Curriculum

Construction and Construction education face many challenges in the 21st century. Most of the developments have been around for quite a while now but it is only recently that they are filtering into curriculums

Sustainability

Sustainability has been high on the list of concerns for construction professionals in recent years. Central to the concept of sustainability are the concepts of minimisation and renewability.

“In the second Industrial Revolution, as we seek to contain environmental and ecological damage whilst making space for an improvement in the living conditions of three-quarters of the world’s population, the recent historic process will need to be reversed by using more renewables” (Davis, 1991, p39)

Minimisation and renewability in construction relates to such things as

- Minimisation of embodied energy in materials
- Minimisation of heating and cooling energy
- Minimisation and re-use of waste
- Re-use of building materials
- Re-use of contaminated ground
- Re-use of water

In their study on building for a sustainable future the Institution of Engineers offers the following response to the challenge of building green

- “Refurbish, adapt and reuse existing buildings
- Design and construct new buildings that are adaptable to different uses and therefore offer longer life
- Use recycled components and materials or those from sustainable resources
- Minimise energy needed to operate a building by essentially passive design
- Use or recycle waste produced during construction operation and deconstruction”

(Institution of Structural Engineers, 1999, p36)

Passive solar design principles and embodied energy in materials have been part of construction education for quite a while now but there is a need to look at including subjects on waste management, water management and re-use of contaminated ground as these become more of an issue.

Management Information Systems

Management information systems can be defined as systems that provide management with required information on a regular basis. Sun and Howard (2004) group IT in Construction into the following headings.

1. *Business and Information Management*
2. *Computer Aided Design and visualisation*
3. *Building Engineering Applications*
4. *Computer Aided Cost Estimating*
5. *Planning, Scheduling, Site Management*
6. *Computer Aided Facilities Management*

Sun and Howard see these groups as operating with a common database, and we have seen over the last few years an explosion in the use of the web as a means of exchanging data within companies.

“Contractors view web-based software that facilitates collaboration between key project participants as the technology that will most impact the industry”

(Toole, 2003)

Traditionally construction courses have covered 2D drawing with CAD being introduced into some courses in recent years. The use of 3D programs to virtually construct buildings will become more common and the linkage between 3D CAD and time schedules (4D CAD) is not far away from being practical on major buildings.

Data management is set to become a major concern for construction professionals and the need to educate our graduates in this area is urgent. At UTS we have recognised this and have provided a separate core subject in MIS in our new course.

Risk Management

Risk management has always been of concern to construction professionals but lately it has become increasingly more so, especially in the areas of safety, professional liability and project finance. Due to the increased employment of sub-contractors there is also a need to address the issue of the sharing of contractual risks. Although construction safety has always been covered in construction courses to some extent the increased emphasis on safe work methods and the increased tendency for litigation means that risk management would best be treated as a stand-alone subject.

Globalisation of Construction

There has been a tendency recently for a fragmentation of industries into global players and local operators, with medium sized firms being forced out of business. The larger firms are growing bigger and because more and more projects now require some form of equity involvement by the construction companies, it has become impossible for medium sized business to compete. Smaller specialised sub-contractors are required to service the larger projects. Globalisation has meant that large construction companies are operating in many countries, and at UTS we have developed a special elective subject called International Construction to equip students with the skills needed to operate in these countries, as well as other elective subjects, which look at project procurement and financing options peculiar to overseas projects. .

Educational Issues Facing Construction Faculties

Impact of Overseas Students

The economic necessity to attract overseas students is having an important influence on the subject content of some courses. In some cases the local construction industry from which these students come operates significantly differently from the Australian way and there is a need to balance the requirements of these students without weakening a course for local students.

“While every effort should be made to meet the special needs of foreign students, it should be recognised that it is not possible to “neutralise” the cultural context of education and that any attempt to do so would ill-serve the interests of Australian students”

(CRPE, Undated)

Every effort should be made to avoid a two-tier degree, where overseas students do different work to the locals. One way to avoid this is to have special elective subjects, which relate to a student's home country, with local students having the choice of other electives.

Women in Construction

Much has changed since 1964 when the Board of General Studies recommended that suitable “men” be trained in the management aspects of construction. Women now occupy senior positions in a wide variety of industries. Although many women have passed through the Construction courses at UTS the ratio of female to male students still remains fairly low, of the order of 5-10%. It appears that despite there being a significant effort to market construction to female students, the industry is missing out on some of the brighter female students because of the perception that construction is a trade, not a profession. This perception is particularly held by parents and the suggestion has been made that double degrees in Construction and Law would satisfy the aspirations of the parents whilst allowing women who might have a natural interest in construction to pursue their desired career path. Similarly a combination of Construction and Business might attract more females to construction.

Continuing Professional Education

Continuing education is set to become a major function of universities as professional bodies increasingly are forced to justify standards. Undergraduate courses cannot hope to cover all the academic needs of students. One solution is to have a core course of general construction competencies with some scope for specialisation in one or two areas prior to graduation but with a commitment to continuing education throughout the early life of the student. Yearly “top-up” courses could be made available to past graduates at a nominal charge.

Relationship between Building and Engineering Construction Courses

In 2000 the Civil Engineering Department of the Faculty of Engineering decided to offer a major in the area of Construction Management, and 7 semester long subjects from the 1997 Bachelor of Building (Construction Management) were chosen for it. They were

1. Construction Project 1 (One semester)
2. Construction Project 2 (Two semesters)
3. Construction Project 3 (Two semesters)
4. Construction Project 4 (Two semesters)

These subjects were changed after the revision of the construction management course in 2003 and have recently changed again. At the present time there are five 6 cp subjects forming the construction sub-major. They are

1. Project Management 1
2. Construction 1
3. Services 1
4. Construction 2
5. Construction PM 1

It is the author's view that the separation between “engineering construction” and “building construction” is largely an artificial one and that there are synergies in

be gained by combining the two. That the two are intimately related can be seen by the interchange of professionals between the two areas. Although there are subjects that are unique to building construction (eg building services) and others, which are unique to engineering construction (eg bridge construction) there are large areas such as planning, contracts, estimating and cost control which are common to both disciplines.

Conclusions

Examination of Figures 2 & 7 demonstrates that there has been little change in the core components of the construction course at UTS between 1973 and the present, as one might expect. The construction industry has however increased in complexity. Recent developments in management information systems, changes in project procurement options and the emergence of sustainability as a major issue have led to a more sophisticated syllabus at UTS. In addition the need for graduates to move around within that industry has resulted in the development of a more flexible construction course structure at UTS. We are now looking at a more rounded "Construction Professional" rather than a Construction Manager or a Quantity Surveyor. The addition of sub-majors has given students the opportunity to specialise in areas of particular interest to them. This is likely to lead to more motivated students and benefit the industry as a whole.

At the present time there are "Builders" working on managing engineering projects and "Engineers" working on managing building projects. There is a lot of commonality in the educational needs of both of these and it seems to the author that a single "Construction" course combining both engineering and building construction would improve efficiency in the construction industry.

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STRATEGIC CORPORATE REAL ESTATE MANAGEMENT RESEARCH AND TEACHING: DEFINING DIMENSIONS OF PRACTICE

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ABSTRACT

Strategic corporate real estate management (CREM) is an emerging property discipline with a concomitant evolution in its body of knowledge. There have been past attempts to define that body of knowledge, but much of the literature examines individual practices in isolation without locating them in a coherent, overarching theoretical framework suitable for strategic CREM.

From a study of CRE and competitiveness, 179 defined practices were clustered into 11 clusters of similar practice types and linked within a framework that supported strategic approaches to the management of CRE.

This framework and its defined practices describe a body of knowledge that became the basis of teaching CREM at the University of Melbourne. A final year undergraduate Facility Management subject has included aspects of CRE since 1999, and a standalone, postgraduate CRE subject was taught for the first time in 2006. This subject emphasises strategic and competitive practices in students' case study research.

Keywords: body of knowledge, corporate real estate, definitions, management practices, teaching

INTRODUCTION

The requirement for property for business' operational purposes is as ancient as the doing of business itself. However, the formalisation of operational or corporate real estate (CRE) practices is relatively recent. Corporate real estate management (CREM) is an emerging property discipline that is evolving towards managing operational property more strategically. While CRE exists in its own right as a