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Processes in Distilling Course Capability Profiles

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Abstract*: This paper describes the evolutionary processes employed to profile the development of student capabilities as they are progressively developed within the Bachelors of Engineering (Civil, Electrical and Computer Engineering, Mechanical) courses at the Queensland University of Technology (QUT). The outcomes of these processes informed the formulation of new course objectives, formerly a set of value-centred principles, to ones of a student centred framework. The framework's graduate capability statements were developed in a manner encompassing Engineers Australia's requirements, and QUT and Faculty teaching and learning objectives, in consultation with academic staff from within and beyond the disciplines. They relate discipline specific knowledge and skills, critical, creative and analytical thinking abilities, abilities to communicate, life long learning capacity, independent and collaborative working abilities, responsible professional practice, and self-reliance and leadership capabilities. The three engineering degree courses were examined on a unit-by-unit basis in terms of developing students' graduate capabilities, both discipline specific and generic, and linking these against the framework's objectives. This structure allows units to be refined and better integrated to improve the course's development of student graduate capabilities, and facilitates an investigation into elements of the course that could be enhanced, or better achieved, through an enhanced work integrated learning program.*

Keywords*: AAEE2004, work integrated learning, learning outcomes, graduate capabilities*

Introduction

The Faculty of Built Environment and Engineering (FBEE) at the Queensland University of Technology (QUT), in Brisbane, is currently engaged in a University Large Teaching and Learning Grant entitled, *Integrating Workplace Learning and Professional Education: Implementing a Student Centred, Objectives Driven and Outcomes Focussed Framework* (Boles et al, 2002). The following section of the introduction outlines the objectives of the project and establishes the foundation for the topic being presented in this paper.

The QUT-FBEE Work Integrated Learning (WIL) project addresses the objectives, structure, development and evaluation of workplace learning, focussing on integrating workplace learning with the academic curriculum. The intended framework and implemented system purposely centres on the students, their learning environment and outcomes, and utilises the flexibility provided by the advances in educational technologies in an increasingly knowledge based and learning economy (Lundvall et al, 1994).

The most important goal of this project is to enhance students' learning outcomes from the workplace components of their courses. This will be enabled by the identification of workplace learning objectives specifically linked to, and derived from, the learning objectives of the targeted courses. The achievement of the project's goal will also be facilitated by the design and integration of assessment approaches targeting the evaluation of students' attainment levels of the set objectives.

The project focuses on the three large engineering courses offered at QUT, but with a view to facilitate its extension to other courses in the Faculty. On the operational level, the achievement of the project's goals requires, for each course, the identification of specific objectives that are best achieved through workplace learning and the integration of appropriate assessment with the teaching and learning. The project team, in conjunction with QUT's Teaching and Learning Support Services (TALSS), will complement the components developed through other Faculty projects by building a web-based package that provides and facilitates linking of these components, and enables their integration within the framework targeting the specific objectives of this project.

The distinctive goal of the project is to enhance students' learning outcomes from the workplace components of their courses, thus supporting a change in students' position from detached observers to involved performers. This paper describes the process engaged in to extract and articulate components of course objectives that are best achieved through work based learning. The process is broadly summarised as follows.

1. Examination and alignment of course objectives with Faculty, University and professional body objectives, and QUT graduate capabilities.
2. Distilling discipline-specific objectives for each course and mapping the progressive development of such towards attaining the published objectives.
3. Mapping the contribution and progressive development of objectives and graduate capabilities from specific units within each course. (*Units* are the fundamental academic teaching entity at QUT and are generally equivalent to *subjects* at other institutions.)

The following sections describe the processes and outcomes of these stages in the context of the WIL project with general implications in course continuous improvement cycles.

Examination and Alignment of Course Objectives

The identification of graduate engineer workplace skills, which provides a basis for the structure of the undergraduate course curriculum in the Faculty of Built Environment and Engineering, can be found from a number of sources. Both the technical and generic skills required in the workplace are defined by the Engineers Australia (EA) in general terms and also in specific terms for different engineering disciplines (The Institution of Engineers Australia, 1999). Similar competency standards have been adopted at various levels throughout the University. These are the: *QUT Graduate Capabilities* document (QUT, 2001); *Faculty of Built Environment and Engineering Teaching & Learning Philosophy*; *Course Objectives* for each course within the Faculty; and *Employability Skills* framework developed by the Department of Education Science and Training (DEST) and the Australian National Training Authority (DEST, 2002).

While the workplace generic skills expected of a newly graduated engineer are very well and fully described in all frameworks and standards referred to (although not necessarily articulated the same way), engineering technical skills tend to be more discipline aligned and their articulation typically less pronounced other than course level objectives and capabilities. However, in reviewing or developing new course curricula, it is important that the full gamut of relevant technical and generic skills is defined and integrated within the course structure.

The EA "National Generic Competency Standards" provides a good starting point for obtaining both generic competencies and fields of technical competencies in different discipline areas.

EA Generic Skills	QUT Graduate Capabilities (MOPP)	BEE T&L Philosophy	Employability Skills Framework	Course Objectives BE(Elec&CompEng)
Ability to apply knowledge of basic science and engineering fundamentals.		Provide our students with opportunities to develop knowledge and skills that are relevant and applicable to current and future real world situations.		To ensure that all graduates are provided with a sound appreciation of the fundamentals of their discipline as well as a knowledge of "state of the art" techniques so that they may adapt themselves to scientific, technological and social changes.
Ability to communicate effectively, not only with engineers, but also with the community at large.	Effective communication in a variety of contexts and modes; written and oral with discipline specialists and on-specialists in cross cultural contexts.		Communication skills that contribute to productive and harmonious relations between employees and customers: oral, written, negotiation, numeracy, persuasion, network, share information, LOTE.	To develop the ability of students to communicate at al levels with their colleagues, in industry, and with other professionals, verbally and in writing.
In-depth technical competence in at least one engineering discipline.	Knowledge and skills pertinent to a particular discipline or professional area: theoretical and practical knowledge in at least one discipline, and technological skills appropriate to the discipline.	Offer courses that are at the forefront of technological advances, flexibly delivered, responsive to the varied backgrounds of students and to the needs of society.		To produce technically competent graduates with an awareness of the "managerial" requirements of industry who can take their place within the profession initially in junior positions with a foundation necessary to progress to senior positions.
Ability to undertake problem identification, formulation and solution.	Critical, creative and analytical thinking, and effective problem-solving: critique current paradigms and contribute to intellectual inquiry; exhibit creative and analytical		Problem-solving skills that contribute to productive outcomes: develop creative and practical solutions, show independence and initiative, solve problems in teams, apply a range of strategies to problem solving, use mathematics	To develop in students a creative problem-solving approach to practical engineering situations, including the investigation, design, construction and operational phases, working either as an individual or as a

EA Generic Skills	QUT Graduate Capabilities (MOPP)	BEE T&L Philosophy	Employability Skills Framework	Course Objectives BE(Elec&CompEng)
	ways of thinking; identify, define and solve problems.		including budgeting and financial management to solve problems, test assumptions relative to context of data and circumstances.	member of a specialist or multi-disciplinary group.

Table 1: Generic skills and capabilities associations (extract)

Distilling Discipline-Specific Objectives

Whilst a number of course objectives are relatively generic and can, to some extent, be decoupled from specific engineering disciplines, it is recognised that a number of objectives will be discipline specific and, in-part, provide a distinction between the three engineering courses examined. The following descriptions outline the approaches used in distilling the discipline specific objectives of the three engineering courses. The approaches do vary and, in doing so, illustrate a richness of historical, cultural and philosophical underpinnings used to achieve a common outcome.

Course Objectives Framework

Following the “whole of WIL” examination and alignment of course objectives with each organisations’ criteria, discussed above, the requirements of a BE(Civil) course objectives framework were identified.

Prior to the WIL project, a set of 10 broad objectives existed for the BE(Civil) course. Examples of these objectives include:

- To produce competent and effective Civil Engineering graduates of national and international standing, capable of adapting to and meeting the challenging demands of the future community;
- To maintain high quality teaching and develop and implement innovative teaching approaches;
- To foster a safe and equitable working environment for all students;
- To produce graduates who are technically competent in the fundamentals of civil engineering with an opportunity for specialization…

Upon reflection, and in the context of the WIL project, this set of objectives was considered a blend of organizational objectives for the School itself, and student-related objectives that were not focused towards an audience of students or external stakeholders such as employers. It became clear that the existing set was inadequate to serve the needs of the WIL project and further development was required in relation to defining teaching and learning outcomes.

To inform development of a student-centered course objectives framework a “skills matrix” was first developed, which mapped each unit and the development of capabilities across the course. A “1 to 4” scale was used, which broadly reflected the year of study or depth of skill development. Although extremely informative to the project and academics, this skills matrix was not suitable as a new course objectives framework, as it was too detailed to be informative to students or outside stakeholders, and was not readily comparable to frameworks of other courses of QUT or other institutions.

Providing coverage across seven sub-disciplines, the BE(Civil) course is considerably broader than the other two engineering courses, and many other courses offered at QUT. A model course objectives framework was sought, which would suit this broad disciplinary nature while satisfying each organisation's criteria, in particular QUT's graduate capabilities framework. This meant that the framework could not be too technically specific; rather, it needed to cater for technical breadth but leave the sub-disciplinary specific depth to a lower layer of articulation as discussed later.

These graduate capabilities were adapted in order to re-define BE(Civil) course objectives as summarized in Table 2 below. For brevity some criteria pertaining to some of the capabilities have been abbreviated.

Demonstrate that they possess the **knowledge and skills pertinent to the Civil Engineering discipline**, sufficient for entry to the profession, including: • Sound theoretical and practical knowledge across the discipline • Comprehensive theoretical and practical knowledge in one or more areas of specialization… • Ability to adapt to, and apply, technologies and processes used routinely in the discipline area
Demonstrate that they possess **critical, creative, and analytical thinking abilities** pertinent to the Civil Engineering discipline, including: ▪ the ability to effectively identify, define, and solve novel problems using the disciplinary knowledge and skills.. ▪ the ability to critique current paradigms and contribute to intellectual enquiry in the discipline area
Demonstrate that they possess the capacity to **communicate effectively and appropriately** with Civil Engineering discipline specialists and non-specialists in professional contexts, and in a variety of modes, including: written documentation, graphical presentation, oral conversation, oral and visual presentation
Demonstrate their capacity for **life-long learning** in context of the Civil Engineering discipline, in particular the ability to: ▪ search and procure pertinent information… ▪ critically evaluate information for application… ▪ appreciate the importance of participation in continuing professional development activities… ▪ set and maintain their career goals; and plan and act to enable development of their career…
Demonstrate their ability to work **independently and collaboratively** in a multi-disciplinary context, in particular the ability to: ▪ set goals and objectives for their activities, and observe them during the course of those activities ▪ define and prioritise tasks and manage time and resources to achieve stated objectives of an activity ▪ define and address resource implications in the consideration of problems and their potential solutions… ▪ work cooperatively and productively as a team member, or leader, in order to achieve activity objectives…
Demonstrate that they **act responsibly in their professional practice** towards environmental, social, cultural and ethical aspects, in particular: ▪ possessing an understanding and appreciation of perspectives of those from varying cultures… ▪ the capacity to identify, and be considerate of, all members of the community who may be affected… ▪ the capacity to identify, and be considerate of, realms of the physical environment that may be impacted… ▪ the propensity to value and promote truth, accuracy, honesty, accountability, and codes of practice… ▪ the capacity to contribute to intellectual, social and cultural endeavours
Demonstrate that they possess characteristics of **self-reliance and leadership** including: ▪ the propensity to take the initiative ▪ the capacity to embrace innovation in a responsible manner ▪ the ability to manage change productively

Table 2: Graduate capabilities from BE(Civil) course objectives framework

The model course objectives framework selected was the *graduate capabilities development* model developed by the School of Design and Built Environment at QUT for the Bachelor of Architecture course, as it enabled all organisations' criteria to be encapsulated, and provided the ability to map development of professional capabilities over a year-by-year course structure. This Architecture framework is a two dimensional matrix, with each row representing a QUT graduate capability and each of three columns a course stage. Stage A represents a foundation level (year 1), Stage B a sub-professional level (years 2 and 3) at the end of which para-professional graduation occurs, and Stage C a professional/ graduate level (years 4 and 5) which includes an industrial practice year (Table 3). It is noted that the graduate capabilities development incorporated technical skills and knowledge as well as those capabilities widely considered to be professionally generic.

A four-year staging of professional capabilities development was defined for the BE(Civil) course objectives framework, as is presented in Table 2. This table is an excerpt of the full framework documenting development of the first mentioned graduate capability over the four years of the course.

Graduate Capability	Foundation Year (Engineering)	Foundation Year (Civil)	Sub-specialist Year (Civil)	Specialist Year (Civil)
Demonstrate that they possess the knowledge and skills pertinent to the Civil Engineering discipline, sufficient for entry to the profession, including: • Sound theoretical and practical knowledge across the discipline • Comprehensive theoretical and practical knowledge in one or more areas of specialization within the discipline • Ability to adapt to, and apply, technologies and processes used routinely in the discipline area	Demonstrate awareness of the range and scope of knowledge and skills pertinent to civil engineering across a range of core curriculum areas: • materials • physics • eng maths • elec/computer eng • eng drawing • eng communication Demonstrate basic theoretical and practical knowledge within a civil specialization area: • structures	Demonstrate basic theoretical and practical knowledge within a limited range of civil specialisation areas: • structural • geotechnical • environmental • municipal • transport • construction practices • construction eng mgt • hydraulic • eng surveying • U&R planning Demonstrate basic ability to use a limited range of technologies and processes used in the discipline area	Demonstrate sound theoretical and practical knowledge across a number of civil specialisation areas: … Demonstrate sound theoretical and practical knowledge across core curriculum areas: … Demonstrate ability to apply technologies and processes used routinely in the discipline area…	Demonstrate sound theoretical and practical knowledge across a number of civil specialisation areas: … Demonstrate comprehensive theoretical and practical knowledge in at least one area of specialization: …

Table 3: Row excerpt from BE(Civil) course objectives framework

Unit Formation of Graduate Capabilities

It is recognised that graduate capabilities are formed and developed in units as students progress through their degree. Further to the broad course objectives framework established for each of the three engineering courses examined, and illustrated with BE(Civil) above, units that contribute to the development of each capability are linked within the framework. It is not necessarily an expectation that any one unit contributes solely to a particular capability or learning outcome. More typically, units progressively engage in the development of a number of capabilities such that a sequence of units develops capabilities throughout the four year courses. Of further note, it is significant that capabilities to which units contribute, are embedded within the curriculum of each unit and form part of the assessment process.

For efficient mapping across the course objectives framework, the code of each unit that addresses each objective is displayed adjacent to that objective. Table 3 illustrates this mapping and how units contribute toward the formation of each graduate capability and discipline-specific technical capability in the case of BE(Elec&CompEng) (as an example). Unit codes are given which are not expected to have particular significance to the reader per se, however they do illustrate the sequencing and formation of graduate capabilities.

In the case of the BE(Elec&CompEng) illustrated, generic and broad technical capabilities are developed through units in the *Foundation year [Engineering]*, *Foundation Year [Electrical]* and *Sub-specialist year [Electrical]*, and the *Specialist year [Electrical]* units largely align with EA published electrical engineering sub-disciplines (eg, Instrumentation and Control as shown in Table 3.

This auditing process, applied to the three engineering degrees, provides deeper insight into certain areas of the course structure, which provides a basis for iterative refinement of the course objectives framework. Conversely, it provides insight into shortcomings of certain unit outlines in how their stated objectives address the graduate capabilities being developed in that unit.

<table>
<tr><th colspan="2">Graduate Capability</th><th>Foundation Year (Engineering)</th><th>Foundation Year (Electrical)</th><th>Sub-Specialist year (Electrical)</th><th>Specialist Year (Electrical)</th></tr>
<tr><td colspan="6">GENERIC GRADUATE CAPABILITIES:</td></tr>
<tr><td colspan="2">Ability to apply knowledge of basic science and engineering fundamentals</td><td>All 1st year units</td><td>All 2nd year units</td><td>All 3rd year units</td><td>All 4th year units except EEB781</td></tr>
<tr><td colspan="2">Ability to communicate effectively, not only with engineers but also with the community at large</td><td>CEB109,BNB007</td><td></td><td>EEB584,EEB612, EEB684,EEB686</td><td>EEB781,EEB889, various electives</td></tr>
<tr><td colspan="2">Ability to undertake problem identification, formulation and solution</td><td>All 1st year units</td><td>All 2nd year units</td><td>All 3rd year units</td><td>All 4th year units except EEB781</td></tr>
<tr><td colspan="2">Ability to utilise a systems approach to design and operational performance</td><td>CEB109,BNB007</td><td>EEB411</td><td>EEB511,EEB584, EEB612,EEB682, EEB686</td><td>EEB781,EEB889</td></tr>
<tr><td colspan="2">Ability to function effectively as an individual and in multi-disciplinary and multi-cultural teams, with the capacity to be a leader or manager as well as an effective team member</td><td>CEB109,BNB007</td><td>EEB311,EEB312</td><td>EEB512, EEB584, EEB612, EEB684, EEB686</td><td>EEB889</td></tr>
<tr><td colspan="2">Understanding of the social, cultural, global and environmental responsibilities of the professional engineer, and the need for sustainable development;</td><td>BNB007</td><td>EEB311</td><td>EEB650,EEB686</td><td>EEB781</td></tr>
<tr><td colspan="2">Understanding of the principles of sustainable design and development;</td><td>BNB007</td><td>EEB311</td><td>EEB650,EEB686</td><td></td></tr>
<tr><td colspan="2">Understanding of professional and ethical responsibilities and commitment to them;</td><td>BNB007</td><td></td><td>EEB684,EEB686</td><td>EEB781</td></tr>
<tr><td colspan="2">Expectation of the need to undertake lifelong learning, and capacity to do so</td><td>BNB007</td><td></td><td>EEB584,EEB612, EEB684,EEB686</td><td>EEB781,EEB889</td></tr>
<tr><td colspan="6">TECHNICAL GRADUATE CAPABILITIES:</td></tr>
<tr><td colspan="2">demonstrate that they possess the knowledge and skills pertinent to the Electrical Engineering discipline, sufficient for entry to the profession, including:
• sound theoretical and practical knowledge across the discipline
• comprehensive theoretical and practical knowledge in one or more areas of specialisation within the discipline
• ability to adapt to, and apply, technologies and processes used routinely in the discipline area</td><td>• demonstrate awareness of the range and scope of knowledge and skills pertinent to the foundations of Electrical engineering across a range of core curriculum areas</td><td>• demonstrate basic theoretical and practical knowledge within a limited range of Electrical specialisation areas
• demonstrate basic ability to use a limited range of technologies and processes used in the discipline area</td><td>• demonstrate sound theoretical and practical knowledge across a number of Electrical specialisation areas
• demonstrate ability to apply technologies and processes used routinely in the discipline area, to which they are introduced, to undertake basic tasks</td><td>• demonstrate sound theoretical and practical knowledge across the discipline
• demonstrate comprehensive theoretical and practical knowledge in at least one area of specialization
• demonstrate ability to adapt to, and apply, technologies and processes used routinely in the discipline area</td></tr>
<tr><td rowspan="12">Instrumentation and Control</td><td>Process Plant</td><td></td><td>EEB311</td><td></td><td></td></tr>
<tr><td>System Engineering</td><td></td><td>EEB311,EEB411</td><td>EEB511</td><td></td></tr>
<tr><td>Mathematical Modelling</td><td>EEB212,EEB340</td><td>EEB411,EEB440</td><td>EEB511,EEB584, EEB640,EEB650</td><td>EEB961,EEB976</td></tr>
<tr><td>Computer Engineering</td><td>EEB112,EEB212</td><td></td><td></td><td>EEB976</td></tr>
<tr><td>Communication Engineering</td><td></td><td>EEB340</td><td>EEB560,EEB641</td><td>EEB961,EEB976</td></tr>
<tr><td>Control Systems</td><td></td><td>EEB311,EEB411, EEB412</td><td>EEB511</td><td>EEB911,EEB976</td></tr>
<tr><td>Energy Conversion</td><td>EEB212</td><td>EEB311,EEB411</td><td></td><td>EEB911,EEB976</td></tr>
<tr><td>Software Techniques</td><td>EEB112,EEB212</td><td>EEB411,EEB412</td><td>EEB511,EEB560</td><td></td></tr>
<tr><td>Computer Interfacing</td><td></td><td>EEB412</td><td>EEB512</td><td>EEB976</td></tr>
<tr><td>Digital Signal Processing</td><td></td><td>EEB440</td><td>EEB511,EEB640</td><td>EEB941</td></tr>
<tr><td>Transducer and Activator Engineering</td><td></td><td>EEB311</td><td></td><td></td></tr>
<tr><td>Local Area Network Engineering</td><td></td><td>EEB311</td><td>EEB560</td><td></td></tr>
</table>

Table 4: Unit formation of graduate capabilities (excerpt)

Levels of Capability Development within Units

Having established the broad framework in which units contribute toward satisfying course objectives, and developing graduate capabilities, an extensive audit was conducted to identify how particular units contribute to such.

As discussed earlier, the graduate capabilities as listed in the framework and contained within the objectives section of each unit outline broadly cover technical skills and knowledge development. Generally, this is limited to stating the depth and development of coverage by sub-discipline. They do not detail specific technical skills or knowledge pertaining to the sub-discipline, which may be covered in the unit, such as "shear force and bending moment diagrams of simply supported beams". This deeper layer of detail is left for stipulation as *technical objectives* within each unit outline.

Prompted by an audit of units within the BE(Elec&CompEng) course during a regular course review process, it was possible to establish unit-by-unit contributions toward the progressive development of graduate capabilities, both technical and generic. The audit identified the expected skills and levels expected of students entering the unit, the topics studied to further develop those skills and the expected skill level outcomes for students having successfully completed that unit. The skill levels used are adopted from Blackketter (2002), developed to address ABET 2000 criteria at the University of Idaho, and are summarized in the following extract (Figure 1).

PERFORMANCE LEVELS - DEFINITION

Level 1: INFORMATION
This level is typical of 1st year students. This level person has developed a knowledge base, with specific skills within a specific context. Can be referred to as a **Trained Individual or Engineer in Training.**
Attitude: Must have explicitly defined rules, procedures, and policies
Cognitive: Need to be told what to do
Social: Need constant supervision and monitoring of performance

Level 2: COMPREHENSION
This level is typical of 2nd and 3rd year students. This level person has acquired a broad base of general knowledge and can apply it in related contexts. Can be referred to as a **Learned Individual or Engineering Intern.**
Attitude: Are willing to accept challenges within their areas of expertise
Cognitive: Can perform low level problem solving within base of experience
Social: Accept feedback better on "what they produce", better than "how they perform"

Level 3: APPLICATION
This level is typical of 4th year students. This level person has developed skills and motivation to apply and self-direct learning in limited contexts. Can be referred to as a **Lifelong Learner or Entry Level Engineer**.
Attitude: Seek out new challenges in related areas of knowledge
Cognitive: Are able to apply previous problem solutions to new situations
Social: Accept and use feedback based on their performance

Level 4: PROBLEM SOLVING
This level is typical of those in, or beyond, graduate school. This level person has highly developed skills and actively seeks knowledge and opportunities for application. Can be referred to as an **Enhanced Learner or Project Engineer.**
Attitude: Seek to push the boundaries of their performance
Cognitive: Seek out greater challenges, responsibilities, and problems to solve
Social: Are willing to manage a team effort and mentor fellow team members

Figure 1: Definition of Expected Student Skill Levels

It would then be expected that one could follow how the skill developments connect and grow through threads of units studied. An example of technical skill development is given in Table 5 below for a single unit *Introduction to Telecommunications*.

Unit	Expected Technical Capabilities	Level	Broad Topics	Developed Technical Capabilities	Level
EEB340 - Introduction to Telecommunications	Complex Arithmetic	1	Classification of Signals	Mathematical Description of Signals	2
	Differential Equations	1	Fourier Series & Transform	Fourier Analysis	2
	Integrals	1	Impulse Response & Transfer Function	Relationship Between Signals & Systems	2
	Fourier Series	1	Convolution	Understanding of System Response	2
	Basic Signal Theory	1	Frequency Response, Filters	Design of Basic Filters	2
	Basic Circuit Theory	1	Components of a Communications System	Reasons for Matching to Channels	1
	Matlab Fundamentals	1	Amplitude Modulation(AM)	Spectrum, Shapes Bandwidth	1
	Operation of Desktop Computer	1	Angle Modulation (FM, PM)	Spectrum, Shapes Bandwidth	1
			Simple Modulation Circuits	Circuits for Modulation & Demod	1
			Introduction to Noise	Sources & Effects of Noise	1

Table 5: Technical Skill Development

Outcomes

The processes engaged in and described above produced a number of outcomes relevant to this paper.

Work Integrated Learning

The initial and primary goal of the course level objective distillation and unit audits was to identify opportunities in which WIL could be used to maximise learning outcomes. The most intricate mapping produced from the previous processes provides the ability to articulate the precise developmental stage of a student undertaking one of these three courses. Students can identify where they are within the developmental path of stated graduate capabilities, and to what depth they have developed these capabilities. This allows them to, firstly, articulate their skill level to a prospective employer/industry mentor, and secondly, to identify particular capabilities that can be targeted and developed within a workplace environment in agreement with both academic and industry supervisors. To facilitate such a process, a web-based interface is to provide support mechanisms as discussed below.

Web-Based Integrated Learning

A web interface is being designed based on constructivist principles which engage students in ways which requires reflection and demonstrated knowledge construction. The project team has a clear goal of creating a flexible, web based system applicable across a range of courses and work based experiences from site visits to work placements. The web interface is planned to offer students access to a range of resources while also providing self-paced training for both academic and industry staff in the areas of consultation and negotiation; experiential learning design; supervision and mentoring; and workplace assessment. This work has been presented in another paper submitted to AAEE2004.

Objective Course Linkages

A secondary benefit of the course objectives distillation and unit audit processes is that it provides a process for quality control for course development and revisions. Capabilities should be seamlessly and progressively developed towards fulfilment of graduate capabilities. Any gaps or deficiencies can be readily identified through these processes.

This process coincides with course reviews soon to be embarked on, for instance, BE(Mech). The opportunity was seized upon to draw upon this course objectives framework to a more student centred perspective. An example of a suitable course objective would be:

> *The Bachelor of Engineering (Mechanical) aims to produce graduates:-*
>
> > *"who can demonstrate a sound knowledge of the fundamentals of science and engineering, and their applications, understanding the principles of sustainable development while valuing ethical and professional responsibilities"*

Conclusions

The primary motive for the work presented in this paper was to provide a mechanism whereby students' skill levels and capabilities could be identified at any point within their course and targeted for further development in a workplace environment. They could then enter into a workplace learning agreement established in consultation with their prospective industry supervisor and faculty. This prompted an in-depth examination of course objectives and testing of their alignment against institutional objectives and desired graduate capabilities. A process was then developed which systematically mapped and facilitated the alignment of unit (or subject) level contributions to the progressive development of student graduate capabilities. Whilst some of the outcomes achieved were engineering discipline specific, the overall process is applicable to any course in any discipline. This process has application in students pursuing workplace integrated learning opportunities and a quality control mechanism for course development and continuous improvement

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