

Comparison of the Australian and South African Mining Engineering Courses to the Competency Requirements for Mine Managers

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Abstract

The mapping of the undergraduate mining engineering courses at 5 Australian and 3 South African universities was completed to provide the mining industry with information about the relationship between current undergraduate courses and the requirements of the mandatory competencies in the National Training packages for mine managers in both the coal and metalliferous sectors.

The structure of the university courses is considerably different to the set-up used in the AQF6 competency unit and a specialised template was developed to allow a meaningful comparison base on the required knowledge and the required skills.

There were many similarities between the different courses but also some important differences. The analysis of the content of the courses resulted in a series of recommendations for the Board of Examiners, the Universities and the Industry. These recommendations were made to assist in the development and integration of the competency requirements for individuals and companies.

1. Introduction

The mapping of the undergraduate mining engineering courses at Australian and South African universities was completed to provide the mining industry with information about the relationship between current undergraduate courses and the requirements of the mandatory competencies in the National Training packages for the mining industry at the Australian Qualification Framework level 6 (AQF6).

The mapping was completed at the following universities:

Australia	South Africa
The University of Queensland	Pretoria University
The University of New South Wales	The University of Witwatersrand
Curtin University of Technology – The Western Australian School of Mines	The University of Johannesburg
The University of Ballarat	
The University of Wollongong	

The mapping exercise could not have been completed without the co-operation and assistance of the staff of the universities involved. Information and time were generously and freely provided. The project personnel acknowledge and thank the university staff involved in the project.

2. Methodology and outcomes

The following methodology was used.

2.1 Compilation of competencies

The mandatory competency units at AQF6 level for management were identified from the following National Training Packages:

- Coal Training Package – MNC04 - May 2004;
- Metalliferous Mining Training Package – MNM99 - Review Dec 2003 (Reviewed competencies included);
- Extractive Industries Training Package – MNQ03– Review Feb 2003.

The competencies were compared across the packages and it was identified if they were equivalent or similar and the differences were detailed. Only the mandatory competency units were considered for the mapping exercise. 15 competency areas were used. These were:

1. Risk assessment and control system
2. Environmental management system
3. Statutory compliance management system
4. OH & S management system
5. Quality system
6. Mine emergency preparedness and response
7. Mine services System
8. Mine infrastructure and plant systems
9. Haulage, transport and production systems
10. Blast system
11. Ground control and mining systems – surface mines
12. Ground control and mining systems – underground mines
13. Ventilation
14. Spontaneous combustion management plan
15. Gas management system

2.2 Mapping Requirements

The structure of the university courses is considerably different to the set-up used in the AQF6 competency units. The elements and performance criteria of the competencies do not relate to the course and subject structure of the tertiary courses in a straightforward manner and attempting to map to the elements and performance criteria would be an extremely difficult process.

After consultation with the QMITAB and industry representatives, a modified mapping process was established. The university courses were mapped against the **required knowledge** and the **required skills** related to each individual competency unit. The definitions used in the competency units are:

Required Knowledge

Specific knowledge is required to achieve the performance criteria in the unit to the standard of performance required in the workplace, to transfer the skills to other contexts and to deal with unplanned events. Assessment requires evidence of the ability to identify and explain the purpose of the required knowledge areas outlined in the competency unit.

Required Skills

Specific skills are required to achieve the performance in the unit. In addition to the generic skills identified in the key competencies, assessment needs to obtain evidence of the ability to apply the skills outlined in the competency unit.

In addition, for the South African component, the range of variables was also checked.

2.3 Templates

A standard template was developed. The required knowledge and required skills for each competency were used. Where there were some differences in the competency units over the different training packages or industry sectors, these differences were identified and incorporated.

The information to be recorded included the subjects covering and the hours allocated to that topic, the reference materials used, and the assessment processes. Where the range of variables was also included, it was simply identified if the particular variable was included in the course.

It was not intended that any judgement on the quality of the materials would be made. It was expected that the quality of materials and presenters would be managed by the internal quality requirements of the University.

2.4 Interaction with Universities

Each University supplied the written subject and course outlines for the undergraduate mining engineering degrees.

The project personnel used this information to draft a partially completed map. The project personnel visited each University and interviewed the lecturers involved in the subjects completed as part of the course. The University personnel modified the draft map to align with the written, practical and field components of the course. Assessment information was provided. Each visit to the Universities lasted 2 - 3 days.

The completed maps were returned to the University for checking. Given the input from the University personnel, there is confidence that the maps reflect the knowledge expected and skills developed during the courses. Full details of the completed maps are available on request. This is a considerable amount of material and is available on CD.

2.5 Comparison across Universities

After the maps were completed for the Universities, a comparison table was prepared for each competency unit to indicate the areas covered by the individual Universities.

2.6 Areas not covered by University courses

Using the comparison tables, the areas covered and not covered by the University courses were identified. For the Australian Universities, if an area was covered by at least three of the Universities, it was identified as being included. For the South African Universities, if an area was not covered by at least two of the Universities, it was included.

3. Results

3.1 General comments on use of outcomes

The information reported was obtained from the participating Universities based on the courses presented in 2004 and 2005. There will be changes to courses and assessments over time. This report is not intended to be a definitive examination of the undergraduate course and most certainly does not intend to make any value judgements on the quality or suitability of any course.

It is intended that the information contained in this report be used to assist persons in the Australian minerals industry to appreciate the relationship between the undergraduate mining engineering courses and the AQF6 competencies.

In terms of considering the knowledge and skills across the different competencies, some comments on the differences and similarities can be made:

- Risk Assessment – generally covered by all courses;
- Environmental management – not well covered;
- Statutory compliance – covered more comprehensively in South Africa;
- OHS management systems – covered more comprehensively in South Africa particularly in terms of the general management skills;
- Quality systems – similar comments to OHS;
- Emergency systems – not well covered in any course;
- Mine Services - similar requirements in both countries;
- Infrastructure and fixed plant – South African courses include more management skills;
- Haulage and transport – similar requirements in both countries;

- Blast systems – similar requirements in both countries;
- Ground control, surface and underground - similar requirements in both countries;
- Ventilation, gas management and spontaneous combustion - similar requirements in both countries.

3.2 Australian Courses

Due to the differences in legislation and regulation between States, the specific legislative requirements were not emphasised at each University. There was a greater emphasis on being able to find, identify and interpret the legislative requirements as needed.

The technical aspects of the competencies are generally well covered. There are some differences in the depth of cover of some of the technical aspects between the University courses due, at least in part, to the type of mining and minerals industry in the region serviced by the University and the expertise of the staff.

There were also differences in the emphasis placed on management and systems. Generally these areas were not covered as comprehensively as the technical areas.

Although practical work experience at a mine is required for completion of the course, there did not seem to be an emphasis on defining or monitoring the range of experience considered appropriate during this work experience.

3.3 South African Courses

In general, the comparative comments between Australian Universities contained in Section 3.2 apply for South African Universities. Correlation and comparison of the various South African and Australian mining degrees indicates a general similarity between the qualifications.

The technical content of the South African courses was very similar to the Australian courses. There was a stronger emphasis on management processes and more detailed practical programs. Legislative requirements were covered in more detail than the Australian courses. The mines in South Africa work under a common legislative framework.

There are three types of qualifications by which a student in South Africa will gain recognition for achieving a statutory certificate. They are:

- Bachelor of Engineering as granted by the Universities of Witwatersrand and Pretoria;
- Bachelor of Technology as issued by the University of Johannesburg (previously National Higher Diploma from Technikon Witwatersrand, but with elevated requirements in the academic area for achievement of degree status);
- National Diploma as issued by the University of Johannesburg – equivalent to the previous National Diploma issued by the Technikon Witwatersrand.

In particular the issue of skills acquisition needs to be thoroughly addressed for all recipients of Bachelor of Engineering degrees, by the employer organisation. This holds similarly for the Bachelor of Technology qualification, however, due to the mandatory practical component of this qualification (two 6 month semesters of practical experience), it is likely that a greater proportion of the competence required for Mine Managers would be obtained during the B.Tech program.

South African Mine Managers Qualification

As in Australia, there are a number of options available for obtaining qualifications for the statutory position of Underground Coal Mine Manager. The current South African system is most similar to that operating in NSW. The options are laid out in the South African Mine Health and Safety Act and have been summarised as follows:

Graduate with a BE (Mining) or BTech(Mining)

Must:

- be at least 23 years of age;
- hold a permanent blasting certificate;
- have a minimum of two years experience employed in the workings of a mine, including six months at the working face and six months in the workings appropriate to the certificate of qualification; and,
- pass a written examination in legal knowledge

Graduate with a National Diploma in Mining Engineering

Must:

- be at least 23 years of age;
- hold a permanent blasting certificate;
- have a minimum of five years mining experience (with some scope for exemption); and,
- pass a written examination in legal knowledge, mining, mining technical services, mine management and industrial law.
- NB: The National Diploma qualifies for exemption from surveying, geology and mechanical and electrical engineering.

4. Recommendations

4.1 Recommendations for the Queensland Boards of Examiners

A mining graduate from an Australian university is required to obtain certain practical skills and experience from the mining sector in which he/she intends to gain statutory qualification. This experience is required particularly for the AQF competencies as listed by the Advisory Councils. It is recognised that university education provides an acceptable academic component, but the skill component must also be achieved in a similar fashion to vocational competencies.

An Australian candidate for a First Class Coal Mine Managers Certificate must have, amongst other qualifications, a BE (Mining) or the competencies as listed by the Coal Mining Advisory Council, three years experience and be either trained in mines rescue or have obtained the emergency preparedness competency. They must also have obtained (MNCG1003A – Establish the risk management system) prior to appointment as mine manager.

The South African qualifications can be viewed similarly.

The **Bachelor of Engineering (Mining)** from the Universities of Pretoria, and Witwatersrand, and the **Bachelor of Technology** from the University of Johannesburg are considered to be similar in standard and content to the Australian mining engineering degrees. This supports the precept of the Washington Accord.

The **National Higher Diploma** as delivered by the University of Johannesburg (or previously Technikon Witwatersrand) is similarly considered to satisfy the AQF competencies as listed by the Coal Mining Advisory Council required for a Mine Managers statutory qualification.

The **National Diploma** as issued by the previous Technikon Witwatersrand enabled a candidate exemption from the Part A written exams for the Mine Managers Certificate (Surveying, Geology and Electrical and Mechanical Engineering). Candidates are still required to sit additional Part B written exams in Mining Technology, Sustainable Development, Environmental Eng., Risk Management, Rock Eng., Infrastructure, Mineral Resource Management, Coal Preparation, Mining Management and Industrial Law and Part C Act and Regulations. They are also required to have undergone a structured process of skill and operational experience.

An assessment of mining operations and discussions with mine operators, trainers and educators in South Africa revealed that the depth of knowledge in the areas of spontaneous combustion, risk management, Australian emergency response procedures and mine gases would not be adequate to meet the relevant AQF6 competence standards. Further qualifications would be required.

Recommendation 1

An applicant for a Queensland statutory coal mining certificate with either a BE or BTech (Mining) or National Higher Diploma in Mining should have the academic qualification recognised as for an Australian applicant but also obtain the competencies MNCU1102A– Establish the spontaneous combustion management plan, MNCU1151A Establish mine emergency preparedness and response systems or mines rescue training; and attend a course in mine gas awareness. They must also gain a minimum of three years practical experience with at least six months at an Australian underground coal mine.

Recommendation 2

An applicant with a BE (Mining), National Higher Diploma or National Diploma together with a South African Mine Managers Certificate should be required to obtain the competencies MNCU1102A– Establish the spontaneous combustion management Plan, MNCU1151A Establish mine emergency preparedness and response systems or mines rescue training; and attend a course in mine gas awareness. They must also gain six months experience at an Australian underground coal mine.

Recommendation 3

An applicant with the National Diploma (only) should not be accepted to sit for the First Class Certificate of Competency. They will need to obtain an Australian qualification.

4.2 Comments to Tertiary Institutes

Engineers Australia and the Engineering Council of South Africa (ESCA) are both signatories to the Washington Accord – a multination agreement that involves:

- The recognition of the substantial equivalency of accreditation systems of organizations holding signatory status, and the engineering education programs accredited by them.
- Establishing that graduates of programs accredited by the accreditation organizations of each member nation are prepared to practice engineering at the entry level.

The substantial equivalency of the undergraduate mining engineering degree programs in both countries is supported by the evidence from the mapping process.

There are limitations in terms of the knowledge and skills in the undergraduate degrees when compared to the expectation of the AQF6 competencies for mine managers. This is to be expected as competence as a manager is developed with time and experience. This is not a shortcoming of the undergraduate course that intends to develop a mining engineer.

4.2.1 Recommendations to Tertiary Institutes

There are areas where some of the aspects of management competencies are covered for particular subjects but are not more widely applied (eg auditing under environmental management). Where knowledge and skills are incorporated in one subject, the applications of these should be included in other areas.

Planning and monitoring of the work experience of undergraduates would benefit the process and allow identification of some of the skills acquired during the work programs.

4.3 Recommendations to Industry

The results of the mapping project demonstrate the limitations of the undergraduate programs in a number of areas relating to systems and people management knowledge and skills.

The results of the mapping project can be used to plan appropriate graduate development programs that address these limitations. These development programs need to be adequately monitored to ensure completion.

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