Building long-term capability in the Australian minerals industry – The MINAD project

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Structured Abstract

BACKGROUND
The minerals industry in Australia, as in many other countries, has a history of fluctuating between boom and bust scenarios. In the boom times the industry experiences severe shortages of skilled labour, whilst demand is considerably reduced in the lean times. In 2011 the Minerals Council of Australia (MCA) received Federal Government funding to foster the development of two new Associate roles within the minerals industry in the disciplines of Mining Engineering and Geoscience, in order to build long-term capability.

PURPOSE
The purpose of the Minerals Industry National Associate Degree (MINAD) project was to develop nationally the role of Associate within the Australian minerals industry and to ensure adequate educational programs and pathways for student articulation.

DESIGN/METHOD
The MINAD project commenced in 2012 as a partial solution to the long-term shortage of graduates from professional level Mining Engineering and Geoscience programs in Australia. The project involved educational providers, mining companies and other organizations in order to establish suitable educational programs and to engage mining companies in Associate training. The MINAD Project was guided by an Industry Advisory Panel (IAP), and utilised a structured approach for contributions from educational providers (VET and HEd) and mining companies.

A systematic curriculum development process was used to develop the structure and content of the two national educational programs. The process involved: (1) the definition of graduate outcomes; (2) the definition of a body of knowledge for each program; (3) the development of the learning outcomes and content for each course. The first two stages were undertaken nationally as part of the MINAD project. The third stage will be undertaken by each provider so as to meet contextual and institutional requirements, while delivering the required MINAD outcomes.

RESULTS
MINAD educational program models have been established for mining engineering and geoscience and a number of mining companies have expressed interest in integrating Associate training into their workforces. Two universities introduced MINAD program models in 2014 and a number of other educational providers have expressed interest in developing MINAD programs for introduction in 2015 or beyond.

CONCLUSIONS
The two pilot programs are progressing successfully and have been well received by students and the mining industry. Active recruitment campaigns sponsored by the minerals industry are underway, both in the general media and within the mining companies themselves. Recruitment through mining companies has however been difficult, as the industry continues to struggle with the concept of long term capability building during a period of industry downturn.

KEYWORDS
Mining, Geoscience, Associate Degree, Industry Collaboration

Introduction

The Australian Government in 2011 released its findings on the workforce needs of the Australian Resources sector, as articulated in the *Resourcing the Future* report of its National Resources Sector Employment Taskforce (NRSET). The Executive Summary of the document noted:

> *"[t]here are emerging shortages at present—mainly engineers and other professional staff with more than five years' experience. The domestic supply of mining engineers and geoscientists will not be sufficient to meet demand over the next five years with a shortfall of around 1,700 and 3,000 respectively. However, there are large numbers of people with these qualifications currently working in other occupations."*

In response to Recommendation 3.2 of the report, the Minerals Council of Australia (MCA), through its Higher Education division, the Minerals Tertiary Education Council (MTEC), commenced work on the Minerals Industry National Associate Degree (MINAD) Project. The MINAD Project was designed to help address the potential long-term shortage of mining engineers and geoscientists in the minerals industry, by developing the para-professional level of these disciplines, and by developing, piloting and evaluating nationally consistent Associate Degrees. The MINAD Project was sponsored by the Department of Industry, Innovation, Science, Research and Tertiary Education (now the Department of Industry) of the Australian Government.

The MINAD Project

The Project Scope

The scope of the MINAD Project included the planning, design, development, piloting and evaluation of the Associate Degree program in the disciplines of mining engineering and geosciences through to 2014. Key deliverables articulated at the commencement of the Project included:

- The articulation of paraprofessional roles that share the workload with traditional four-year, bachelor degree graduates;
- A formalized national collaboration by a consortium of VET/dual-sector/higher education institutes to develop and deliver the Associate Degree program;
- Two industry supported Associate Degree programs in the mining engineering and geosciences disciplines with a high completion rate;
- Partner mining companies supporting their existing employees to be up-skilled by way of the Associate Degree program;
- Expanded career and articulation pathways for mining engineering and geosciences; and
- An Associate Degree program model and marketing strategies for education institutions and employers in the resources and other sectors.

Facilitation of Project

The MINAD Project was unusual in the Australian context in that a representative industry group sought to establish a para-professional level workforce supported by Associate Degree level programs, introduced with conventional VET and Higher Education providers. A 2012 study (Tuckwell, 2012) had found that the Australian minerals industry had traditionally relied upon four-year trained professional engineers and scientists produced through the higher education system and that little effort had been directed on the two-year trained paraprofessional engineer and geoscientist.

The MINAD Project was under the control of the MCA, through MTEC, and the Project Manager was the Executive Director of MTEC. The Project was funded by the Australian Government through the Workforce Innovation Program.

The Project Manager was guided by an Industry Advisory Panel (IAP) which was convened at key stages of the Project (approximately 6 monthly intervals). The IAP consisted of 15 members, predominantly representatives from mining companies, but also including representation from professional organisations and educational institutions.

Educational design and consultation was guided by a specialist Education Management Consultant (EMC), involved from Stage 2 through to completion of the Project. The EMC was responsible for developing and piloting the MINAD Program Model, and preparing and implementing marketing strategies to educational institutions and the mining industry. Coordination and organisation of meetings and workshops, report preparation, etc were progressed by the MINAD Project Coordinator.

Project Process

A review of para-professional education in Australia by Dowling (2010a, 2010b and 2011) showed that the educational goals of para-professional engineering programs are often not well understood by either students or employers. Whilst industry has a role to play in developing and supporting programs at this level (Sung 2010, Blacker *et al*, 2011, Dowling, 2011, and Moodie *et al*, 2013), industry involvement in the development and delivery of curriculum is often ad hoc and overall is fragmentary (King, 2008, Paez *et al*, 2010).

An approach around articulation pathways and their linkages between industry, vocational education and training (VET), and higher education sectors has been presented by Blacker *et al* (2011). This is designated as a Workforce Driven Engagement Model (WDEM) and is shown in Figure 1.

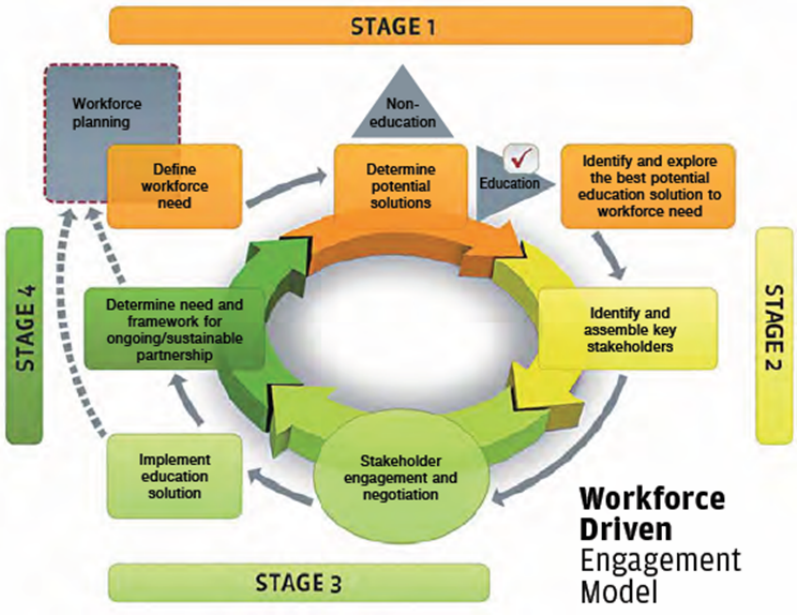

Figure 1: Workforce Driven Engagement Model (Blacker et al, 2011)

The MINAD project has been mapped against the Workforce Driven Engagement Model (Table 1). This paper focuses mainly on the linkages employed in the project and the development of the MINAD Education Model (i.e. stages 2 and 3).

Table 1: MINAD project activities against the Workforce Driven Engagement Model

Stage	Description	MINAD Project
1	Workforce planning helps define the workforce need and determine potential solutions. Potential education solutions can then be explored.	MCA determines need for alternative training pathway in mining engineering and geoscience. MTEC project raised.
2	Stage 2 involves identifying and assembling the key stakeholders.	An Industry Implementation Committee formed. A working group of HE and VET providers established.
3	Stage 3 involves stakeholder engagement and negotiation and the implementing the education solution	Design Your Discipline (DYD) Stakeholder Consultation undertaken to create MINAD Education Model
4	Stage 4 is about determining the need and framework for maintaining an ongoing and sustainable partnership.	MINAD Business case determines need for ongoing sustainable partnership.

Setting up of the Project in Stages 1 and 2 included the recruitment of a Project Coordinator the establishment of the IAP, the commissioning of a baseline critical review of available associate degree programs, and the appointment of the Education Management Consultant.

Stage 3 involved the development of a MINAD Associate Degree Program Model. Initially a Roundtable for MINAD Providers and Partners was held over two days in Brisbane. This Roundtable in September 2012 involved 24 participants, mainly from TAFEs and universities around Australia. The purposes of this Roundtable were to gain a shared understanding of the MINAD Project amongst participants, to identify the key issues to be addressed during the design of the national models, and to explore possible solutions. A further Roundtable for MINAD Industry Partners was held in Melbourne in early November 2012 and involved 18 participants, mainly from mining companies. This Roundtable was able to provide industry's perspective of the potential role of the paraprofessionals, and the issues which might occur in the educational training of these people.

The MINAD Project then held a series of one-day 'coal-face' workshops to identify the occupational outcomes of Associate Degree trained paraprofessionals in the mining engineering and geoscience fields. Workshops were held in Rockhampton, Perth (three), Kalgoorlie (two) and Newcastle during January and February 2013. These workshops utilised the Define Your Discipline (DYD) process which had been developed by Dowling and Hadgraft (2013a; 2013b; 2014). The workshops involved mainly 'coal-face' workers including recent graduates, operational supervisors and technical on-site personnel. The DYD process allowed the MINAD Project team to better understand how a paraprofessional might meaningfully form part of the professional mining workforce and in doing so create value for the participating organisation and the minerals industry.

The information garnered from the DYD process allowed the Education Management Consultant to develop MINAD Models for both the mining engineering and geoscience disciplines. These Models were introduced at a one-day Pilot Model Roundtable held in Melbourne in April 2013. The meeting had 26 attendees and there was a mix of mining industry and educational provider representatives. Feedback from the meeting indicated general support for the proposed models but several aspects of detail were identified. In order to progress the Project, an Education sub-committee was formed in order to resolve outstanding issues and move the Project towards the pilot role out phase. This sub-committee was active from May to November 2013. The Education Sub-Committee assisted in the refinement of the Models and addressed issues of curriculum detail, entry pathways, professional accreditation, etc.

A parallel Industry Sub-Committee in Stage 4 focussed on the preparation of a Business Case document which would provide a 'how to' guide for workforce development, mining companies interested in upskilling workers or creating new job roles for paraprofessionals, and educational providers interested in piloting MINAD programs.

The final phases of the MINAD Project constituted the marketing activities, the role out of the Associate Degree pilot programs and the evaluation of the Project. The majority of this work was undertaken in 2014 and mainly involved direct negotiations between MINAD Project team members and individual education providers, mining companies and individuals interested in pursuing minerals industry careers.

The MINAD Models

Design Considerations

Several major problems confronted the MINAD Project team during the Project. One of these was the need to balance ideological and pragmatic goals in the development of the MINAD Program Models. Ideologically there was a desire to provide the 'best' education for both the students/graduates of the programs and for the minerals industry. Pragmatically, there was a need to design national programs which could be implemented at minimum cost to educational providers in a climate of declining public funding for education. A realistic balance between competing ideological and pragmatic pressures was therefore needed.

The models proposed adopted the following design approaches:

(a) Program duration and structure. A full time 2 year program model of 16 courses was adopted for the basis of the MINAD Project educational programs, a common model for Associate Degree programs at Australian universities.

(b) Mode of offering. Entrants to the Associate Degree programs were anticipated to come from a wide diversity of backgrounds and situations. The two major groups of Australian entrants for the MINAD programs predicted to be:

- Secondary school leavers wishing to gain a tertiary education qualification prior to entering the full time workforce.
- Existing workers in the mining and associated industries seeking to enhance their progression opportunities in the industry.

Secondary school leavers will probably be more inclined towards full-time, on-campus study at a university or TAFE whilst existing workers will, in the main, be seeking to undertake part-time on-campus or off-campus study while remaining in paid employment in the industry. The MINAD program offerings were therefore designed with a range of offering modes in mind.

(c) Professional organisation accreditation. It was considered essential for graduates that the programs in each area receive recognition from the relevant industry professional organisation. Several professional organisations had shown interest in the MINAD project and some of these organisations had defined program accreditation requirements. The MINAD program model developed for mining engineering was designed to be acceptable for Engineers Australia accreditation. However, as the Models are flexible, each educational provider that delivers a MINAD mining engineering program has to seek EA accreditation independently, as the process considers institution specific factors such as teaching, assessment, staffing and resources.

(d) Articulation into a program from lower level educational programs. The Australian Qualifications Framework (AQF) states that providers must *'ensure that pathways into and between qualifications are available to all students for all relevant qualifications'* (AQF Qualifications Pathways Policy, Second Edition, July 2013, Clause 2.1.2). Considering the wide range of lower level programs that are available, it was not possible to specifically consider this factor in the MINAD design but it is a factor needing to be considered by individual educational providers as they move into Associate Degree delivery.

(e) Articulation from MINAD programs into higher level educational programs. A further consideration for the development of MINAD programs was articulation of graduates into professional degree programs via efficient and effective pathways. A key aspect of this was the provision of suitable distance education pathways. Again, due to the flexible nature of the MINAD Models it was not possible to consider this aspect in detail in the development. However discussions with possible pathway institutions indicated that a minimum of the equivalent of at least one year of full time study will be available for articulation into professional degrees in the same discipline area.

(f) Flexibility in program development. The offering of a totally new program by an educational provider is a costly exercise, particularly in science or engineering where instructional technology needs to include access to specialised equipment. Establishment of a new program is an exercise in risk management as the provider must seek to ensure that returns from the program will lead to economic feasibility within a reasonable timeframe. In the case of MINAD it was considered that while some providers may be willing to consider program establishment from a zero base position, most would be looking to evolve a MINAD program from existing program offerings and interests. It was therefore considered that some flexibility in program requirements was necessary to foster evolution of MINAD programs within the required timeframe.

Establishment of the MINAD Models

The development and utilisation processes for the MINAD Models are shown in Figure 2.

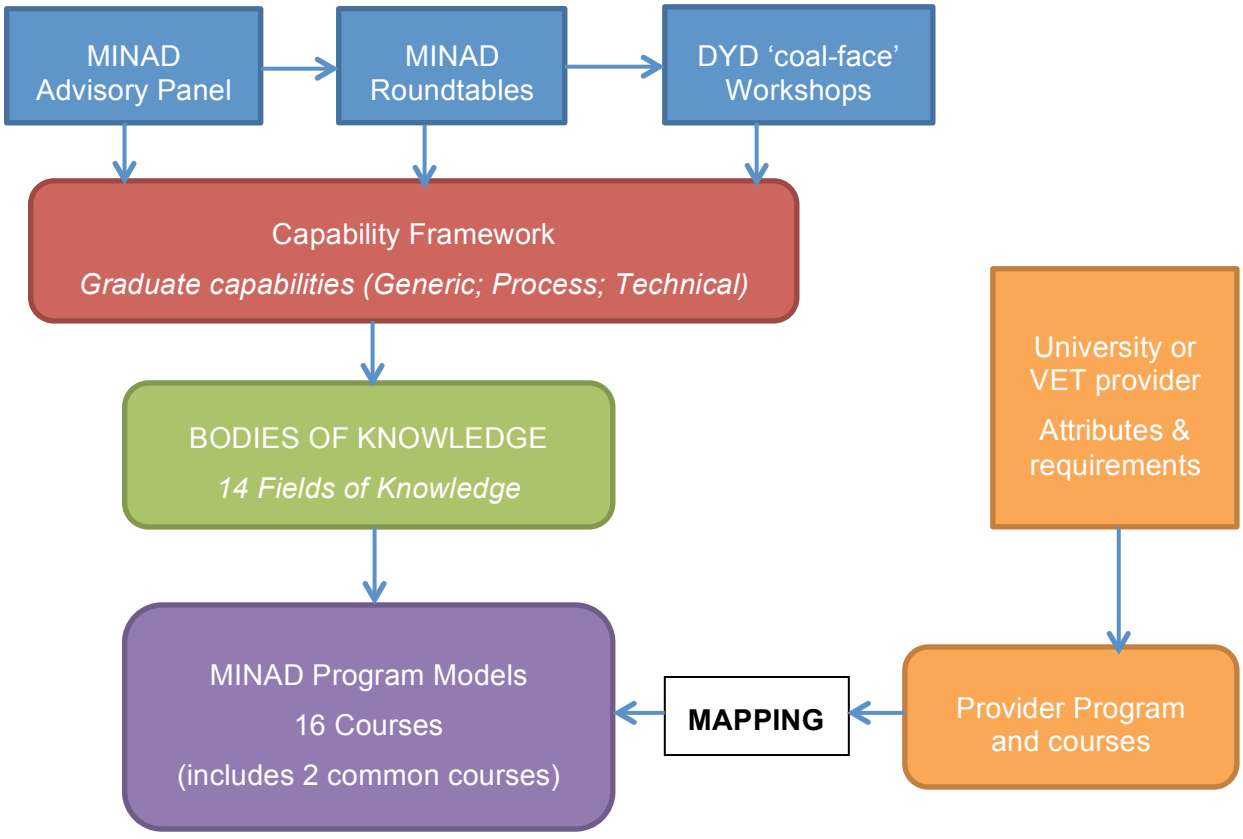

Figure 2: MINAD Model Development and Utilisation Processes

The conduct of the DYD 'coal-face' workshops across a range of geographical locations, and involving a range of stakeholders from the resources industry, yielded outputs which were

arranged into Graduate Capability Framework documents. An overall Body of Knowledge (BOK) document was then derived at the para-professional level for each of the mining engineering and geoscience areas. In order to provide a usable encapsulation of the BOK information for MINAD educational program design, and to achieve a flexible MINAD Model, the BOKs were subdivided into "Fields of Knowledge". For each BOK, fourteen Fields of Knowledge, often further subdivided into sub-fields, were used to provide a relationship to the fourteen Core and Major courses in each Associate Degree program structure. The term Field of Knowledge was used in preference to "course", as it was envisaged each educational provider would design their own courses for their MINAD program. However, the Fields of Knowledge provide a basis for the program design process and a checklist for total program coverage. Representative tasks from the Graduate Capability Framework documents have been used in several of the Fields of Knowledge to illustrate the level of learning which might be expected. Not all Fields have been illustrated in this way as several of the Fields deal with basic science or engineering knowledge and skills which were not directly reflected in the task identification exercise at the 'coal-face' workshops. The Tasks from all three sets of Graduate Capabilities (Generic, Process and Technical) were distributed into a relevant Field of Knowledge. Figure 3 shows typical capability tasks for two of the six sub-fields in the *Project Management & Professional Practice* Field of Knowledge in the mining engineering discipline.

FIELD OF KNOWLEDGE: 6. PROJECT MANAGEMENT & PROFESSIONAL PRACTICE	
Knowledge in this field required as a building block for higher level fields such as Planning & Scheduling, Mine Planning & Design, and Mining Methods & Mineral Processing	
Sub-field	**Typical tasks**
Cost Control	Evaluates major purchases of equipment to achieve best economic result
	Reconciles physicals and costs at end of month (EOM)
	Scrutinises & evaluates progress claims from contractors
	Compiles cost analyses
Liaison	Liaises with customers and takes part in customer site visits
	Attends safety induction and training courses
	Mentors other graduates

Figure 3. Typical capability tasks in a Field of Knowledge

After feedback on the original model from industry and educational providers, it was decided to provide two common courses in each of the mining engineering and geoscience discipline areas. These two courses cover material at the top end of the programs and provide assurance that all providers will be teaching similar courses at the 'capstone' end of their programs. The two common courses in the mining engineering discipline are *Introduction to Mining Technology and Minerals Processing* and *Introduction to Mine Planning and Design.* The course *Introduction to Mining Technology and Minerals Processing* is also a common course in the Geoscience discipline and the other common course is *Resource Geology.* Common courses have a set syllabus and study materials.

The proposed Model allows a particular educational provider to build their own program structure and courses. In some cases this may be done from existing course offerings and in other cases from entirely new courses. In some instances a course may closely align with an identified Field of Knowledge, but in other cases a course may incorporate elements from multiple Fields of Knowledge. For example, a coherent course might be designed by placing together sub-fields from two or three different Fields of Knowledge.

Although the MINAD Model defines Fields of Knowledge rather than courses, each educational provider will adopt titles for their own courses in their program structure. To assist in the design process, a linkage has therefore been provided between the Fields of Knowledge and the course categories of Core, Major, and Elective. For example in mining engineering, the six core courses encompass Fields of Knowledge which could be expected in most engineering Associate Degree programs. The eight major courses represent Fields

of Knowledge which are (a) unique to mining engineering, or (b) which might be shared between mining engineering and associated branches of engineering e.g. civil engineering or mechanical engineering. The two electives enable the student to (a) broaden the scope of their university education, (b) pursue specialisations in mining or allied fields, or (c) to pursue individual areas of interest at a tertiary education level. Selection of electives could therefore be made from a very broad range of subject areas but it is expected that most students would pursue elective studies in areas which would enhance their knowledge and job opportunities in the mining engineering area.

In order for a program to be recognised as a MINAD program, an educational provider needs to provide a mapping which shows how their program covers a minimum of 12 of the 14 MINAD Fields of Knowledge to a reasonable extent, and that the common core courses have been incorporated.

Progress in MINAD Program Implementation

At the time of preparing this paper two universities are offering programs in the mining engineering discipline, and one provider is offering a Geoscience program. There has been strong interest from another three providers to either offer programs independently or in partnership with an existing provider. However it is not known if any additional offerings will be available for 2015. The programs currently being offered consist of one program which is a new mining major added to a long-standing Associate Degree of Engineering, and two revised programs (one in mining engineering and one in geoscience) which have been created by a provider who had existing programs which did not meet the MINAD criteria. Student enrolments for 2014 were reasonable but it is anticipated that increased enrolments will occur in 2015 due to much more extensive marketing in the last 9 months.

One of the deliverables of the MINAD Project was to achieve engagement with a number of mining companies to the extent that the companies would seek to set up employee support programs to upskill existing staff into the para-professional workforce level, including undertaking the necessary Associate Degree studies. To date this deliverable has not had concrete outcomes. Companies have expressed support for the overall MINAD Project and have been willing to encourage staff to undertake the necessary study. However the current economic climate in the mining industry has made it difficult for companies to totally embrace the MINAD concept by commitment to full scale support of students.

Conclusion

The long-term objective of the Minerals Industry National Associate Degree (MINAD) Project was to build capacity at the para-professional level, particularly in the discipline areas of mining engineering and geoscience. The Project was first conceived in a period of skill shortage in the minerals industry but was designed and implemented when economic conditions were much more restricted and skill requirements were not as pressing. The Project has however achieved its aim and the infrastructure and capacity now exists to allow the minerals industry to establish the para-professional workforce level in order to grow long-term skill capacity.

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