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Subject

**Australian developments in education**

Sub-division

The attached paper by Jim Galvin and describes the new organisation of the mining programs in Australia. It involves a close co-operation between three of the Universities and the Industry. There are similarities with FEMP and the proposed Distant Learning program (DIMEP). Co-operation in the future looks like a logical step.

Hans de Ruiter

# MINING EDUCATION – DRIVEN BY GLOBAL IMPACTS

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## ABSTRACT

Globalisation and consolidation is resulting in the mining industry coming to be dominated by a small number of very large companies seeking to lever assets and knowledge to create wealth. As an important service provider to the mining industry, the minerals tertiary education sector needs to understand these global drivers and respond to them. However, it is under-resourced and its sustainability is under challenge in all Western countries. Through the establishment and funding of the Minerals Tertiary Education Council (MTEC), the Minerals Council of Australia (MCA) has provided a unique opportunity to build a national, world-class minerals tertiary education environment in Australia that can be sustained in the long-term. This paper reviews how the global changes occurring in the mining industry provide the model for what needs to occur in the minerals education sector and how MTEC is the logical vehicle to facilitate these changes. It concludes by suggesting that the time has come to integrate the minerals tertiary education providers into one business. Furthermore, the vision should be for a global mining education academy based around a virtual university capable of servicing the cultural diversity and continuing education needs of the global minerals industry.

## INTRODUCTION

In the last decade, globalisation and consolidation have had a major impact on mining companies and the suppliers and manufacturers that service them. At the same time, the minerals tertiary education system in nearly all western world countries has found itself struggling to be self-sustaining. The Minerals Council of Australia recognised this situation about 5 years ago and undertook a review of the status of minerals tertiary education in Australia. Its report, aptly entitled *Back from the Brink*, has provided the basis for a unique initiative to reverse the situation and to develop a world-class minerals tertiary education environment to meet the contemporary needs of all stakeholders in the Australian minerals industry. To properly appreciate the opportunities offered by this initiative, one needs to be aware of the changes occurring both in the mining industry and within the minerals tertiary education sector.

## GLOBAL IMPACTS ON MINING PRODUCERS

The past decade has been disappointing for many participants in the mining and resources sector. There has been a continuing decline in real prices of nearly all mineral products, which has lead most companies to earn returns on investment capital (ROIC) lower than their weighted cost of capital (WACC), Figure 1. This has caused a major de-rating of mining shares compared to shares in the banking, technology and media sectors. Nevertheless, the market still rewards successes in mining as evidenced by the strength of Rio Tinto and Alcoa shares.

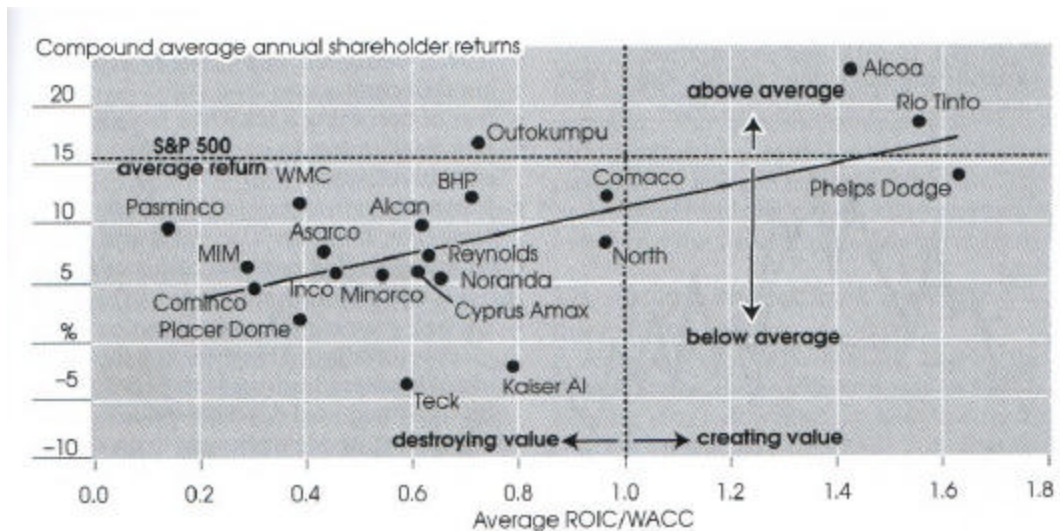


Figure 1. Compounded average shareholder returns versus return on investment capital (ROIC) to weighted cost of capital (WACC) ratio (Stobart 2001).

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Decline in market value has led to many mergers and takeovers which, in turn, has caused the disappearance of well known names in North America, Europe, South Africa and Australia. This decline is illustrated by the combined weighting of all mining and metal stocks in the S&P500 currently being only 0.56, which is less than the weighting of Walt Disney alone (Stobart, 2001). The world has transformed from the industrial age to the information age. The resources sector is now minute in the new economy, with the minerals sector accounting for only 1.5% of the US international sharemarket, Table 1.

Table 1. Relative capitalization of the minerals sector as at December, 1999. (McDonald, 2000)

	<b>Total Market Capitalisation (US\$ billions)</b>	<b>Minerals Capitalisation (US\$ billions)</b>	<b>%</b>
International	19,000	320	1.5
Australia	360	50	14
Canada	500	60	12
South Africa	300	60	20

The harsh economic conditions and the poor economic returns in the minerals sector and the investment attractiveness of the technology and service sectors have caused the money to go out of mining. Capital has gone on strike. This has forced the mining companies to compete for the best assets on a global basis. The mindset of participants is moving rapidly from one of national to one of global.

Miners of course are resilient and do not accept the status quo. Mining companies have responded to the challenge by:

1. Major cost reduction exercises. These, in effect, lowered commodity prices as the cost reductions were passed onto consumers.
2. Consolidation of industry ownership. This changed the market dynamics by balancing supply and demand. In the last 5 years there has been over US\$100Bn of consolidation in the global minerals resources sector. Table 2 lists some of the consolidation that has occurred during this period in the Australian coal sector. Persistent additional capacity from brownfield sites and oversupply from new ventures has kept prices under pressure and handed all the negotiating power to the customer (Gilbertson, 2001). Companies are not investing in new capital unless there is a sustainable return on investment that is significantly higher than the average weighted cost of capital.

In order to capture the gains from consolidation, companies are reshaping mining properties and targeting gains from the integration of mines. The “one business model” approach is replacing standalone business units. They capture the gains from optimizing asset utilization and equipment deployment, improved critical mass of logistics, bulk purchase supplies and services on a global basis using e-commerce and optimized support services. Suppliers are under pressure, therefore, to offer world best practice technology and services on the most competitive and reliable basis.

Table 2. Examples of consolidation of ownership in the Australian coal sector in the last 5 years.

<b>New Owner</b>	<b>Operation</b>	<b>Previous Owner</b>
Coal & Allied (75% Rio)	Lemington	Exxon
	Warkworth	Peabody
	Narama	Peabody
	Bengalla	Peabody
	Ravensworth East	Peabody
	Moura	Peabody
Rio Tinto	Gordonstone	Arco
	Blair Athol	Arco
Glencore	Ulan	Exxon
	Oceanic	FAI
	Liddell/ Glendell	Savage
	Mt Owen	BHP
	Oakbridge	Cyprus
Glencore/Centennial	Springvale	Cyprus
BHP/Billiton	South Blackwater	QCT
Anglo	Moranbah North	Shell
	Capcoal Complex	Shell
	Callide	Shell
	Drayton	Shell
	Dartbrook	Shell

3. Focusing on sustainable development in order to maximize the overall benefits across ecological, economic and social systems. The sustainability of the resources sector depends upon its ability to meet current and future economic challenges. At the same time, it is important for government and community to recognise that the minerals resources sector is vital to the country's industrial prosperity, living standards and quality of life.

Mining is essential and relevant to society. However, the right to mine has to be earned. Heightened awareness of the global pressures of population, poverty and environmental degradation has placed sustainable development of ecological, economic and social systems high on the agenda of international energy policy makers (Cain, 2001). New mining projects depend increasingly on public support. Mining companies must demonstrate that they understand public concern over sustainable development issues and be able to respond appropriately. Clifford (2001) states that this is why Rio Tinto is wholeheartedly behind the Global Mining Initiative. Trade-offs are required.

## **GLOBAL IMPACTS ON MINING SERVICE PROVIDERS**

The three preceding impacts drive significant change in service providers to the producers. Sectors affected include:

- Manufacturing
- Contracting
- Research and development
- Education and training

Table 3 illustrates the trends that are occurring in US manufacturers of underground coal mining equipment. Similar trends can be produced for the hardrock sector and for European manufacturers. Consolidation of equipment suppliers is resulting in reduced research and development by the manufacturers and reduced product range. However, Australia is going against this trend to some extent. AusMINE report a 20% annual growth between 1991 and 2001 in mining goods and services exported from Australia. Exports of mining related goods and services are expected to exceed \$1.7 billion in 2001 and exceed \$3 billion in 2003 (Broome, 2001). Australian mining equipment manufacturers report an average annual expenditure on research and development of some 5% of total revenue.

It is interesting to note in passing that in association with e-commerce and global purchasing, consolidation appears to be turning equipment into a commodity.

The services sector has experienced a major expansion as opportunities have arisen in mining contracting and outsourcing of many minesite services. Minesites are becoming more specialized in their activities, with the focus being on the core function of face production. Increasingly, mine planning, development, maintenance and training are being sourced from outside providers.

Table 3. Trend in US manufacturers of underground coal mining equipment.

<b>1980</b>	<b>1990</b>	<b>1999</b>	<b>2001</b>
Anderson Mayer	Anderson Mayer	DBT	DBT
Becorit	Dosco	Dosco	Eickhoff
Dosco	Eickhoff	Eickhoff	Fairchild
Dowty	Eimco	Fairchild	Fletcher
Eickhoff	Fairchild	Fletcher	JOY Mining Machinery
Eimco	Fletcher	JOY Mining Machinery	Mitsui
Fairchild	Gullick Dobson	Long-Airdox	Stamler
Fletcher	Halbach & Braun	Mitsui	Tamrock
Gullick Dobson	Hemscheidt	Stamler	
Halbach & Braun	Jeffery Dresser	Tamrock	
Heintzmann	JOY Mining Machinery		
Hemscheidt	Klockner-Becorit		
Ingersoll-Rand	Long-Airdox		
Jeffery Dresser	Mitsui		
JOY Mining Machinery	Simmons-Rand		
Klockner	Stamler		
Long-Airdox	Voest Alpine		
Mitsui	Westfalia		
S & S	MECO International		
Thyssen			
Voest Alpine			
Westfalia			
<b>22</b>	<b>19</b>	<b>10</b>	<b>8</b>

The focus and structure of research and development has changed from research institutes to industry driven and funded collaborative research. The Australian Minerals Research Association (AMIRA) and the Australian Coal Association Research Program (ACARP) are examples of organizations that oversee contracted research and development to suit the particular needs of companies. The days of large centralized research institutions, research for research sake and research to satisfy the interests of the researcher have all but gone. This is evidenced by the demise of the following organisations:

- Chamber of Mines Research Organisation (COMRO), South Africa. Now folded into Mining Tech (CSIRO) on a much reduced scale.
- United States Bureau of Mines (USBM), USA. Now folded into NIOSH with a primary focus on OH&S rather than on mining related research.
- National Coal Board/British Coal, UK. Closed.
- Australian Coal Industry Research Laboratories (ACIRL), Australia – exited from coal mining R&D.
- CANMET, Canada – significantly reduced scale.
- Deutsche Montan Technologie GmbH (DMT), Germany – reduced scale.

In Australia, organisations such as AMIRA and ACIRL now provide the capacity and capability for innovation and rapid technology transfer. There is a higher focus on the end product, safety, environment and accountability for the quality and timeliness of deliverables.

The research now has a highly applied focus and is being sourced from a broad range of providers over contracted time frames that are typically of only 2 to 3 years duration. This is yielding significant ‘stay-in-business’ benefits to the mining industry. However, it raises some concerns, in particular:

1. When will the basic research that underpins the applied research and development reach its ‘use-by’ date?
2. Who is funding and undertaking the basic research to support future innovation?

- Where are the next generation of researchers being trained and to what standards? It is doubtful if Australia has produced 5 home grown PhDs in mining engineering in the last decade.

To a degree, ACARP is addressing some of these concerns by moving to ‘landmark’ projects. These are characterised by larger and longer term projects to meet the strategic needs of the industry. However, the projects are still primarily of an applied nature.

## GLOBAL IMPACTS ON MINERALS EDUCATION

Consolidation is resulting in the mining industry coming to be dominated by a small number of very large companies competing for the best assets. Modern mining companies have moved far beyond the single-minded focus on low cost production and embraced instead, an approach driven by the needs of the customers and the markets; one which seeks to lever assets and knowledge to create wealth.

It is unrealistic to believe that the minerals education sector can be relevant and sustainable whilst remaining quarantined from these dramatic developments. As the primary source of knowledge, training and skills, the education sector is effectively another service provider to industry. This is especially the case for the discipline of mining engineering, since no mining industry effectively means that there is no need for mining engineering education. Therefore, mining engineering educators must be aware of the drivers behind globalisation and consolidation of the minerals resource sector and be responsive to these changes. At the same time, they also need to be aware of and responsive to both the global and local drivers within the tertiary education system.

The major global driver in the education system is the information age. This can impact on minerals tertiary education providers in the following ways:

- There is no longer a monopoly on information
- Quality is exposed to global scrutiny
- Competition is global and may come from non-traditional sources

The nett effect is that customers have more flexibility and choice as to time, location, provider, format, pace and cost of learning. Tables 4 and 5 highlight in more detail the impact that the information age is having on the overall education process and on the student learning processes. If these are then combined with the drivers pertaining specifically to the global minerals industry, the following messages emerge:

1. Education, training and skilling are services to the minerals industry
2. The information age provides the opportunity for these services to be sourced globally at the best quality, price, time and location.
3. Consolidation within the minerals industry in association with the information age means that, potentially, some companies are in a position to control who are the major education providers to the global minerals industry.

Table 4 Impacts of the information age on the university education system  
(extension of Watts, 2000)

<b>THE EDUCATION SYSTEM</b>	
<b>OLD</b>	<b>NEW</b>
The student went to the university	The university goes to the student
Government provided	Government are withdrawing Private providers/corporate universities
Imparted knowledge for education sake	Knowledge is a service industry
Education drives economics	Economics and market forces drive education
A right of everyone, arbitrarily distributed	An investment
Little quality assurance	Students behave as customers – demand service and quality
Distinct tiers in education and training	Blurring of boundaries between tiers of education and between providers of education
All learning components from one provider	Mix and match sourcing of program components

Table 5. Impacts of the information age on the learning process  
(extension of Watts, 2000)

<b>THE LEARNING PROCESS</b>	
<b>OLD</b>	<b>NEW</b>
Conducted at fixed locations	Receive in own space
Conducted at fixed times	Receive in own time
Conducted at fixed pace	Learn at own pace
Fixed presenters	Presenters can be sourced globally
Face to face tutoring	Audio visual, chat room etc tutoring
Fixed number of times delivered	Multiple replays
Linear/sequential programs	Non sequential programs
One to many	One to one, many to one, one to many
Practice confined to labs	Practice by labs, simulations, on the job
Students had limited interaction with academics and other institutions	Students have global interaction with learning providers, other students, other institutions, business
Fixed resources - lectures, books	Multi-media resources
Restricted library hours	24 hour access to resources
Class room based assessments	On line assessment
Fixed entry and exit	Flexible entry and exit
One size fits all	Learning tailored to student
Academic as teacher, judge and jury of learning process	Academic as facilitator of the learning process

## **LOCAL IMPACTS ON MINERALS EDUCATION IN AUSTRALIA**

The local challenges facing minerals tertiary education in Australia are not all related to government funding cuts to the university sector. Indeed, many are not unique to Australia. In the past decade, the number of mining engineering programs in the UK has fallen from 10 to 3. In the last five years, the number of programs in the North America has fallen from some 27 to 22, with talk of only 16 in the near future.

Local issue facing minerals tertiary education in Australia include:

1. There has been a significant decline in the number of school students studying subjects which are pre-requisite for entry to tertiary engineering programs. Figure 2 shows that typically, there has been a 25% decline over the last decade in the number of school students studying mathematics, physics or chemistry at university engineering entry standards in NSW. During the same period, there has been an almost 1200% increase in school students studying business studies. Similar trends were reported by British and European universities at the annual general meeting of the Society of Mining Professors in 2001.
2. Fewer of those students with the necessary pre-requisite subjects to study engineering are electing to do so.
3. Fewer of those students who elect to study engineering do so in resource related disciplines (civil, environmental, mining, chemical etc). Instead, they are preferring to study in the Computer Science and Telecommunications Engineering fields.
4. The introduction of student fees. This is causing students to behave more as customers and to demand quality and service. They shop around for value when making course selections. Scholarships have taken on a greater importance in being able to attract good quality students to engineering, especially given the shrinking student pool to recruit from.
5. Government funding cuts, whilst of the order of 6%, have translated to as much as a 15% decline in real funding at a School level over the last 3 years, partly because enterprise agreements have also not been fully funded by government.
6. Academic salary levels are very low by industry standards. In 2000, at least 5 graduates from the School of Mining Engineering at UNSW commenced employment at a higher salary level than the base level for a Senior Lecturer in the School. Market loadings have to be offered to attract talented academic staff. Government funding is not permitted to be used to pay market loadings.
7. Enrolments in mining engineering programs are notoriously cyclic. Under current funding arrangements, a minimum of 40 students in each of the 4 years of a program is required to run a dedicated program in mining engineering. This has never been sustained in Australia. For example, last year the University of New South Wales and the University of Queensland together graduated some 110 mining engineers.

However, they only have a combined total of 38 students in 2<sup>nd</sup> year. Programs which are not viable face closure under current funding regimes.

8. The days of industry champions and 'old boys' networks to sustain tertiary mineral educators are gone.
9. Industry consolidation has significantly reduced the number of sources of external support for Australian tertiary education programs.

The introduction of student fees is considered a most important and under-rated catalyst for driving change internally within the tertiary education sector. Students expect and increasingly demand:

- Well structured and relevant courses
- Expert teaching
- A meaningful learning experience
- Quality learning resources
- Accessible staff
- Marketable skills
- Flexibility in course delivery
- A degree with a strong brand name

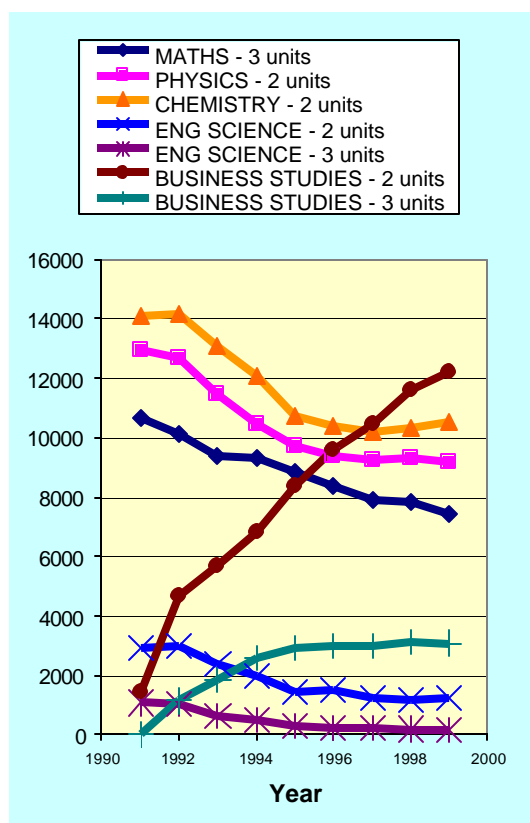


Figure 2. Trends in subjects studied in the final year of secondary schooling in NSW.

Minerals programs have to be responsive to these customer demands. However, they are faced with two serious challenges:

- Changing their internal culture such that they become more customer focused on the needs of students and industry. Minerals programs are fortunate to have a well defined and networked industry to focus on as a customer. However, this strength can also be their weakness, since it is also makes it easy for industry to spotlight the performance of the various educational institutions. If the educators are not relevant or responsive to the needs of this particular customer they can quickly lose both the support of the industry and the market for their product, namely the graduate.
- Recruiting and resourcing quality staff, students and facilities. There are currently 7 providers of mining engineering programs in Australia. The largest program only has 136 students. Some programs often graduate less than 5 students per year. Only three are staffed as dedicated mining engineering programs, that is, they have staff with expertise in the full course program. National demand for mining engineers

has fluctuated in the range of 80 to 140 graduates per annum. Against this background, it is apparent that not all these programs can be properly resourced.

## THE WAY FORWARD

Significant and fundamental attitudinal and structural change is required in the tertiary mineral education sector if it is to be relevant and self sustaining in the long-term. The changes that have occurred within the production sector and the service sectors of the mining industry give direction and provide a model for these changes. Put simply, there is a need for consolidation in the minerals tertiary education sector to achieve a small number of well resourced providers competing, or preferably collaborating, for the best assets.

Fortunately, the Australian minerals industry has become closely involved with tertiary minerals education in Australia in the last 5 years. A national review of the tertiary minerals education sector was completed by the Minerals Council of Australia (MCA) in 1998. This review, entitled *Back from the Brink*, clearly identified the strengths and weaknesses of the various stakeholders in tertiary minerals education.

*Back from the Brink* caused a focus on the education issue for the MCA. The mining industry CEOs took up the challenge and in 1999 funded the establishment of the Minerals Tertiary Education Council (MTEC). MTEC comprises ten invited representatives from industry, academia and government. It is funded with \$15 million over 5 years and is resourced by a full time Secretariat led by an Executive Director. MTEC is charged with leading and facilitating changes necessary to build a national, world-class minerals tertiary education environment to support Australian minerals industry. Specifically, through its Secretariat, MTEC will:

- Lead and facilitate the achievement of the objectives of *Back from the Brink*.
- Assemble and direct resources to achieving agreed objectives including identification and sourcing of new funds.
- Review minerals education outcomes regularly across the whole system and report to industry and academia.
- Represent the minerals industry and provide input to tertiary education policy-making processes at all levels.
- Foster close links between the national minerals industry, professional bodies and the academic community.
- Coordinate work experience placements on a national basis.
- Encourage industry to place more emphasis and priority on the education of its professionals, and demand more of the universities and government in helping to do so.

Action has been swift and MTEC has already caused a significant alignment of interests amongst the various stakeholders. In the case of mining engineering, three universities have been selected to collaborate with MTEC to build a world class tertiary learning environment. These are the University of New South Wales (UNSW), the University of Queensland (UQ) and the Western Australian School of Mines (WASM) under the banner of Curtin University (CU). Initiatives in hand include:

- Recruitment and development of the next generation of academic staff.
- Preparation of course material in a flexible modular delivery format so that the expertise residing within each school can be networked and shared between the three schools.
- Fostering research, consulting and continuing professional development services for the mining industry through the establishment of the:
  - National Centre for Mine Ventilation, and the
  - National Centre for Rock Mechanics.
- The establishment of a National Masters Program to improve the quality, market and relevance of postgraduate coursework.
- The establishment of the Industry Experience for Undergraduate Program to facilitate students gaining industrial training.

As the process is maturing, the barriers between university providers and between universities and industry are being dismantled. Collaboration and innovation are occurring. Examples include:

- The Director of the National Centre for Mine Ventilation (NCMV), Dr Roy Moreby, is appointed as an Associate Professor to the staff of UNSW but operates out of Plymouth, UK. This appointment was not without its challenges for UNSW management but received strong support from both the university and industry as an important first step in establishing a ‘virtual’ and ‘global’ education system.

- A second member of the staff of the NCMV is a shared appointment with UQ. Associate Professor David Cliff is appointed to the Minerals Industry Health and Safety Centre (MIHSC) in Brisbane on a 0.75 basis and to the NCMV at UNSW on 0.25 basis.
- The flexible delivery modules in mine ventilation for undergraduates are being adapted to enable the UNSW Statutory Mine Ventilation Officers Course and the Diploma in Mine Ventilation to be delivered to minesites in a distance format as from 2002.
- The flexible delivery modules in rock mechanics for undergraduates are being developed by the three partners (UNSW, UQ and WASM) under the leadership of WASM.

A close collaboration with industry is essential if minerals tertiary education is to be sustainable in Australia in the longterm. However, universities must be prepared to also help themselves. There are many opportunities for those tertiary providers that are relevant and responsive to their customers. In the case of mining engineering, two examples include:

- Continuing professional development (CPD). Duty of care and business performance dictate that employers must ensure that the education, training and skills of their employees remain current. Schools with appropriate staff profiles and cultures can provide this service to industry. Industry pays well for quality and this can provide a valuable income stream. At UNSW it enables market loadings to be paid to staff. In turn, market loadings attract quality staff who improve the quality of the undergraduate programs whilst growing the CPD business.
- Basic research. Universities have access to government funding focussed on basic research. This can be used to advantage to complement industry funding of applied research whilst, in association with CRCs, developing the next generation of academic staff.

Nevertheless, minerals tertiary education providers face a number of challenges and the seriousness of some of these will increase with time. The authors believe that the future of minerals tertiary education providers, including those MTEC providers, cannot be sustained under the current education structure. The providers are too small in the scale of university departments and in the face of rising costs and falling student enrolments. They do not have the benefits of economies of scale. If the current structure is not addressed then, as the pressures on the tertiary education system increase, minerals related disciplines will either be closed or amalgamated with other small disciplines. History shows that quite apart from quality issues, this later option is also not sustainable in the long-term.

Developments within industry and the university sector suggest that the time has come to apply the 'one business model' as a means to sustain mining engineering education in Australia. In other words, integrate mining engineering education under one umbrella organisation. Each participating university could still maintain its own identity and particular areas of specialisation. However, they would be coordinated under one shopfront in matters such as industry interaction, staff and student recruitment and course development and delivery. One can imagine how this could evolve to a global mining academy (college of educators) that is a virtual university tailored to suit the cultural diversity and education needs of the international minerals industry.

The foundations for achieving this vision are already to be found in the MTEC initiatives; networked course modules in flexible delivery format, a virtual Nation Centre for Mine Ventilation managed out of the UK, shared staff appointments between universities and a national masters coursework program. MTEC provides the logical vehicle and brand name to achieve this best practice vision in mining engineering education.

The reality is that all dedicated mining engineering programs in Australia are faced with some sort of structural change in the near future in order to remain viable. It seems ridiculous that they would elect to merge with other disciplines to gain critical mass when the information age and MTEC provide opportunities for them to form a centre of best practice and critical mass amongst themselves. When companies such as Rio Tinto have a global mining focus that extends to moving experienced equipment operators around the world to demonstrate best practice (Clifford, 2001), they are unlikely to exercise much patience with a tertiary education system that is inward looking and living with a value system of the past.

## **CONCLUSIONS**

The establishment of MTEC provides a unique opportunity to establish a national world-class minerals tertiary education environment to support the Australian minerals industry. Changes that have occurred in industry provide a model and give direction for what needs to occur in the minerals tertiary education sector. Not all institutions will be winners. However, the reality is that if the opportunity is not grasped by some, all stand to be losers in the longer-term.

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