

NEWSLETTER

SOCIETY OF MINING PROFESSORS



SOCIETÄT DER BERGBAUKUNDE

Number 11

May 1998



Editorial

There is a lot going on in mining education in the United Kingdom. Firstly, the crisis that has been going on at the Royal School of Mines, and has been the cause of your Secretary General being less than an efficient operator of the Society's business over the past year, does now seem to be easing. The Imperial College of Science, Technology and Medicine, of which the Royal School of Mines is a part, decided that the real problem was too many small departments.

The Rector therefore instructed the Department of Earth Resources Engineering (of which Mining was a part), the Department of Geology, and the Imperial College Centre for Environmental Technology to merge and form one unit. This unit has been given the almost unmanageable name of the T.H. Huxley School of Environment, Earth Science and Engineering. So mining engineering is now part of the T.H. Huxley School, within the Royal School of Mines, within the Imperial College, which is itself part of London University.

However the real advantage of all this is that the pressure to try and close down mining engineering, which I have been fighting for some time, has eased. It is possible that we will be allowed to recruit new staff in the near future and that mining will be back on an even footing. Certainly the immediate financial pressures that were being brought to bear on us have eased. So we are once again able to look towards a longer term future.

The development of, and the success of, the European Mining Course in conjunction with Delft, Aachen and Helsinki has been a not inconsiderable asset in the battle to remain viable. This course continues well and is believed to have been the reason for the easing of pressure on mining at Helsinki and Delft as well as at the R.S.M.

The next task at the R.S.M. is to restore the initial years of the mining engineering course, which have had their content much eroded in the past couple of years due to the efforts by the department and the College to reduce the financial burden of teaching small classes. The current course is probably a bit light in mining engineering fundamentals in the first few years, and this needs to be addressed. However, it remains strong in basic engineering fundamentals and if you read the paper presented later in this newsletter, there may be some merit in that approach.

In view of this, I thought it a good idea to suggest that I once again undertake the exercise of comparing the current course offerings of our member universities. Later in this newsletter are the forms I would like you all to fill in to update my data base of courses. Please let me have your latest information as soon as you can and maybe I can then have something ready for September.

The second item of interest in the U.K. is that Camborne School of Mines, now part of the University of Exeter, has for some time now been looking for a professor of mining without much success to date. They really do need to find a suitable candidate in the near future if mining engineering education is to continue at a high standard there.

So far of course, being an English language university they have been advertising mainly in the English speaking world. However, there may well be a suitable candidate elsewhere who does not know of this opportunity. If any members know of a person who might be available for the post, and who is able to teach comfortably in English, they should let me know and I can pass the information on to Camborne.

The next meeting of the Society will take place entirely in Carrara. Later on in this newsletter, there is the tentative programme for the meeting. Those who were in Helsinki last year, will recall that the original plan was to be to have a preliminary day or so in Rome and then to move to Carrara. This has proved to be a very expensive option. In addition I am told that Rome is currently a construction site as they prepare to celebrate the millennium in style. So the decision has been taken to have the meeting entirely in Carrara. The people and industry in Carrara are being most helpful.

It remains a joint meeting with Eurominerals, as was planned though. Prof. Badino has done a good job of planning and continues to firm up the proposals. It looks to be a good and exciting programme and I suggest that all of you, if you have not already done so, mark the dates firmly in your diaries. A good attendance helps the Society to maintain credibility, especially it will do so with Eurominerals, and anyway it looks like being a very interesting and good meeting. The social aspects of the meeting look to be fun too. Remember that Carrara is a coastal city and so there is a harbour and some nice bathing beaches too.

The Journal Mineral Resources Engineering continues as you all should know. We can always do with more papers for that though, so please remember it is a refereed journal and so a good place to publish. Please also ensure that your university library subscribes (we would rather you did not pass on your copy to your library to save them having to subscribe in other words) or we may find that once again the low subscription level forces a closure of the journal.

This will probably be the last Newsletter before the meeting. Let there be a wonderful attendance at the latter.



International Joint Meeting

EUROMINERALS and THE SOCIETY OF MINING PROFESSORS SOCIETÄT DER BERGBAUKUNDE

Carrara, Italy - 12 - 17 September, 1998

PROGRAM

Sat. 12		Arrival at Pisa Airport Bus Transfer to hotel (~ 30 min)
	19.00	Welcoming Cocktails
Sun. 13	10.00	Mini-cruise from Marina di Carrara to the Cinque Terre and Porto Venere, including visit to historical marble quarries.
	17.00	Return to hotels
	20.00	Dinner at the Nautic Club
Mon. 14	8.30	Registration of Participants
	9.30	JOINT SESSION WITH EUROMINERALS International Conference
	12.30	Lunch
	14.30	1st. Working Session Society official annual meeting Reports on mining education in Italy Prof. Badino England Prof. Shaw EMC update Mr de Ruiter
	18.30	Close for day
	20.00	Dinner
Mon. 14		for Accompanying Persons
	15.00	Trip to Lerici or Versilia
	20.00	Dinner
Tue. 15	8.30	2nd Working Session Discussion of Mining Education in the 21 st Century Report on Hanover meeting Australian paper, Prof. Galvin Discussion - 'networking' and 'corporatising'
	10.30	JOINT SESSION WITH EUROMINERALS Review "Minetime 99" programme
	12.30	Lunch
	14.00	3.rd Working Session Continue discussions.
	15.00	Visit to open pit and underground marble quarries. (Accompanying persons may participate.)
	20.00	Typical Tuscan Dinner "Istituto Alberghiero"
Wed. 16	8.30	Closing Society Meeting
	10.30	Work and pleasure trip to Pisa. Piazza dei Miracoli: visit to the Pisa Tower stabilisation works. Florence - to be defined
	20.00	Return to hotels
Thur 17		Transfer to airport and flights

All of the working sessions will be held at:

The Internazionale Marmi e Macchine S.p.A. who will be the hosts.

This is the early programme. More detail on the International Conference part of the meeting and the work to be done during the working sessions will follow later. Eurominerals will be involved and it is hoped that Euromines and Eurometaux can also be persuaded to take part. This is one of the most important aspects of this annual meeting. The liaison with Eurominerals which will be developed through this meeting will concentrate on the planning of an international conference, supported by the Society, which will take place with the important minerals exhibition in Hannover in 1999. This could be very important for the future development of the Society. All of this means that it is important that as many members as possible attend this meeting. This is a good programme and looks as though it will be a good meeting to attend.

As a suggested basis for some of the Society's discussions which will take place at the meeting (Monday afternoon) I include in this newsletter a paper by Profs Galvin and Roxborough on what is being done at the University of New South Wales. It seems to me that some discussion at our meeting should be devoted to the changes needed to take us into the future in mining education. This has been discussed before, but we now have the European Mining Course (EMC) in operation, and the New South Wales model seems to be similar but different.

Of course the NSW model assumes that there is a vibrant mining industry willing and able to help. This is not the case in some of the European countries in which our universities operate. However, the networking aspect and what they have called 'corporatising' both seem to me good directions to go (the EMC is after all a model of what seems to be planned for networking). I personally think that there should be a number of interlocking networks set up. The EMC group are already forming some links with Queens in Canada and forming some sort of a link with the Australians seems to me to be a good idea as well.

So I suggest that 'networking' and its implications should be the discussion them for the Carrara meeting, with possibly some papers being given at the International conference on this topic.



Mining Engineering Education in the 21st Century Will Universities Still be Relevant?

J.M. Galvin and F.F. Roxborough

Introduction

The troubles currently facing Australia's universities are not all financial and do not arise from the 1996 budget cuts. There are other major issues of a fundamental nature that go to the question of purpose and function.

Universities may not have been conceived primarily as the training grounds for the professions, but that is certainly what they have become and what they will continue to be. The Cardinal Newman model of the university being there to pursue the noble ideals of scholarship, learning and search for truth has had to make way for more pragmatic objectives such as the supply of doctors, lawyers and engineers. These are not necessarily conflicting objectives, but avoiding conflict has involved compromise.

Society one way or another pays for the universities and so has the reasonable expectation of having a say in what universities do and how they do it. Universities by and large have not liked this and have regarded such outside interference as a threat to independence and an assault on academic freedoms. These are cherished values within the university system and are worth protecting, but universities seem now to be learning and accepting that there is not the risk to these values from the outside that has been long and widely supposed. Universities are probably now more favourably disposed to change and amenable to external influence than they have ever been.

Mining Engineering as a Discipline

Mining engineering sits a little uncomfortably in the traditional university setting. It can be argued that it is not a proper academic discipline, existing solely to serve the industry that justifies its existence. No mining industry means no mining engineering. The same is not the case, however, with the other principal mining related disciplines of geology and metallurgy, neither of which are industry specific and both of which are based on independent and rigorous scientific foundations.

If mining engineering exists uniquely to serve the mining industry, who is to say what mining engineers should learn and know about? Should it be industry? Maybe different sectors of the industry want different priorities. Moreover, the required skills and knowledge base may need to change with time to be in step with rapidly developing mining technologies and industry's embrace of the new ones. So, can an industry which has different and changing requirements be expected to agree on what constitutes the correct mix of topics and subjects in a degree programme in mining engineering and also to specify the depth of knowledge required in each of them? To be quite blunt, probably not. Industry should certainly have influence but not be the arbiter. Most, maybe all, university mining schools would acknowledge the vital role of industry in the development of mining engineering curricula. They would also point out that industry, or some sections of it, has a proclivity to push sectional interests and press for the inclusion of topics that are no more than the whims or momentary fancies often of influential, albeit well meaning, representatives of the industry. The 'flavour of the month' syndrome is a hazard to be guarded against in course development.

In most cases, mining engineering curricula have centred on meeting the academic requirements of the mine managers statutory certificates of competency. In other words the content of mining engineering degree courses has tended to be prescribed, by and large, by legislation governing the granting of certificates of competency to function as a mine manager or as any one of a range of other jobs that require a statutory qualification.

Such statutory provisions in mining education relate primarily to issues of designing and operating mines safely. They say nothing about designing and operating mines as successful enterprises or as businesses. Nor do they require any knowledge of environmental management or of ethics and the professional responsibilities of engineers.

The priority in course development has tended to be the provision of a strong foundation in the mathematical, physical and engineering sciences. This was to provide a basis for the rational understanding of existing and developing mining technologies and to avoid over-reliance on experience as a basis for decision making. The ability to reason soundly and think through the likely consequences of alternative courses of action before making a decision is an essential attribute for an engineer.

Mining engineering education in Australia may be ready for a drastic shake-up. In the process, however, there is a need to preserve and where possible improve the rational and analytical 'think through' capabilities of mining engineering graduates. They also need to be better equipped to apply such skills in a broader operational, economic and social framework.

Why a Degree in Mining Engineering?

The report of the official inquiry into the explosion at Moura No. 2 coal mine (Windridge, 1996) recommended that statutory certificates of competency no longer be granted for life and that persons holding statutory certificates and positions be required periodically to demonstrate their fitness to retain the certificate on the basis of both maintaining the original and developing new knowledge bases appropriate to contemporary needs. In other words it was seen as necessary to impose a statutory obligation on mine managers and other mine officials to keep up to date. Clearly whatever voluntary or corporate process of continuing professional development applied in the mining industry, it was an is not working.

The concept of Continuous Professional Development (CPD) is not new. It has, however, come very much to the fore in recent years in most professions, stimulated by the exponential growth of knowledge and information. Prior to that, certainly in mining, it was fondly assumed that if the employing company did not provide CPD, then people were keeping themselves up to date through private reading, involvement in professional societies and the like. It used to be a reasonable presumption that graduate sin whatever discipline had become, as part of their university education, schooled in the art of learning for themselves. University lecturers lectured; they provided in the classroom, the framework of a subject on which the students themselves were anxious to build through private study and reading. Indeed in some parts of the world the common university phrase was 'reading for a degree'.

Regrettable, that has not been part of the university ethos for a very long time. It got lost and forgotten when different priorities began driving the tertiary education sector. These were such things as imposing productivity



based performance criteria on universities, introducing quantum based output incentives, expanding the university system and its subsequent unification. Several generations of graduates have not been exposed to and inculcated in the self-motivated learning culture that was always supposed to be the hallmark of university education. Rather they have been overwhelmed by and intensity of formal classroom contact and prescribed schedules of academic tasks. Not surprisingly students have tended to view graduation as the successful completion of the education process, as an objective accomplished, as an end in itself and certainly not as the preparation for a lifetime of learning, acquiring new knowledge and developing new skills.

Thankfully, things at last appear to be changing. There is a growing realisation in several quarters that university education is seriously off course and in need of overhaul. Appeals are now beginning to be heard for what could fairly be interpreted as a return to the old values in university education, certainly as far as engineering education is concerned.

A recently circulating draft report from the Institution of Engineers, Australia entitled: 'Review of Engineering Education' (IEAust, 1996) is arguing for a major shake-up involving no less than an entire culture change in engineering education at universities. The following comments, taken from the draft report, illustrate the concerns;

- *Deans should take steps to reduce loading of curricula and the formal class contact time required of undergraduate students in favour of alternative modes of learning and expanded opportunities for extra-curricula activity and engagement with industry.*
- *Students will be more responsible for their learning ... There will be a consequential shift in ownership of education from staff to student, from teacher to learner.*
- *The minerals sector will seek in graduates a broad based education and a good basic knowledge in fundamentals. Detailed skills in the application of knowledge will continue to be learned 'on the job'.*
- *The bachelor degree is just one phase in a lifetime of continuing formal and informal education.*

Significantly the draft report includes the present day engineering students model of the professional engineer AD2010 as follows:

- *The students of 2010 would be enthusiastic lie-long learners with management and interpersonal skills and be holistic thinkers while having core mathematics, problem solving and design skills.*

The message for universities could not be clearer whether got from critical self-examination, from the judgement of professional peers or from lessons of a disaster like Moura. University courses in engineering must not be an end in themselves. They must be liberal and provide a solid grounding in fundamentals. Above all they must be geared to preparing engineers for and inculcating them into a lifetime of learning and professional development. To continue putting the emphasis on teaching current technology in university engineering courses is to inbuild obsolescence and with the pace to technological change, means a progressive reduction of a degree's 'shelf life' to the point of self-extinction.

In other words, engineering education at university level must change or become irrelevant. Correspondingly, industry must revise its expectations of what universities can sensibly deliver by way of graduate mining engineers. For example, it is unrealistic to expect a new graduate to be up to speed with all the latest mining technology or to be

'au-fait' with the newest piece of mine planning software. What they are entitled to expect, however, is a young engineer who has a solid grounding in the basics and a sufficient grasp of the relevant scientific and engineering principles to be able to learn quickly and reason the new technologies and the new ideas and indeed, in due course, to be equipped to contribute to such new developments.

So there is an onus on the mining industry to progress the concept of life-time learning and continuing professional development as essential components of professional life in mining and for industry to acknowledge its central role to the continuing education process. 'Industry is responsible for the provision of specific skills and experiences that develop the graduate into a full functioning contributing professional.'

In 1964, Lord Robens, then Chairman of the British National Coal Board, in addressing a meeting of mining lecturers from universities throughout the country said:

- *You (the university) have them (the students) for four years. We (the mining industry) have them for 40 years. Who then can have the biggest influence on their mining knowledge? All we need you to do is to teach them the three R's of mining engineering but to teach them well. Leave the rest to us.*

Current Status of Mining Engineering Education in Australia and some Implications.

There are six tertiary institutions in Australia presently offering degree courses in mining engineering. They are:

University of Ballarat	Ballarat
Curtin University of Technology	Kalgoorlie
University of Queensland	Brisbane
University of New South Wales	Sydney
University of South Australia	Adelaide
University of Wollongong	Wollongong

In 1995 they collectively graduated 119 mining engineers (Dorricott, 1996) with the estimated figure for 1996 being 165. If this estimate is correct, it will be one of the largest number of graduate mining engineers ever produced in a single year in Australia. In fact, it is about twice the average graduation rate over the past 30 years. Yet, given such high current numbers, it is doubtful if six separate mining schools can be sustained in the prevailing economic circumstances of our universities. The present day and foreseeable economic realities are that 160 graduates per year equates to no more than three adequately resourced mining education centres.

By way of illustration on the issue of resourcing mining education, consider the Department of Mining Engineering at UNSW. The total student population in 1996 was 194 comprising 161 undergraduate mining engineering students and 33 postgraduates. It is thereby among the largest mining engineering departments in the world. Yet, its operating budget for 1996, provided by the university was no more than \$81,000. The department's expenditure profile for these funds is shown in Figure 1. The Department did and does not receive any separate allocation for new or replacement equipment, although it is allowed to make competitive application for centrally administered funds. The indications from other mining schools here and overseas are of similar levels of direct central funding.

The resource issue goes a lot further, however. Again using UNSW mining engineering as a case in point, in 1993 the Department had a full-time academic staff establishment of ten, in 1996 it was eight and by the end of 1997 it will be six. Thereafter, it is expected to remain stable at six, being the widely accepted critical staff mass (including



mineral processing expertise) to operate an accredited worthy degree course in mining engineering. The downsizing from ten to six will have also involved a significant change in staff profile. In fact, the move from ten to six will have involved the departure of six staff and the recruitment of two new staff members.

UNSW Department of Mining Engineering Recurrent (operating budget) \$81,000/annum	
Travel Staff	\$ 3,000
Field Trips (students)	\$ 4,500
Computing	\$11,000
Telephone/fax	\$15,000
Laboratories	\$20,000
Materials	\$20,000

There is no Capital Budget. The Department competes annually against other Departments for centrally administered capital grants provided that:

1. the grant application exceeds \$250,000 and
2. the Department contributes at least \$65,000 of this amount (25% of the grant)

Fig. 1 - 1996 operating budget for UNSW Department of Mining Engineering.

The recruitment of new staff member poses significant problems. Universities are expected to recruit and retain well qualified, experienced and knowledgeable people with a high level of expertise in at least one specialised branch of mining engineering, be it rock mechanics, mine ventilation, mineral economics or whatever. Such people are also in demand by industry and universities cannot compete with industry salaries as is implicit in Figure 2. The starting salaries for new graduate mining engineers are, in many instances, well into the senior lecturer range. Nor can job security, by way of tenure, be an inducement because more academic appointments are now being offered as fixed term contracts.

Academic Salaries (May, 1996)	
Lecturer	\$43,042 - 51,113
Senior Lecturer	\$52,726 - 60,797
Associate Professor	\$63,487 - 69,942
Professor	\$81,780

Fig. 2 - 1996 Academic Salaries in Australia

The resourcing problems being experienced at UNSW in terms of funding and staffing mining engineering are not peculiar to this institution. By all accounts, they are typical of the situation throughout Australia and elsewhere overseas.

It might appear from the foregoing that things would be a lot better, certainly in terms of funding and resourcing mining engineering education, if three of the six schools in Australia were closed and the resources transferred to the other three. The solution is, unfortunately, not as simple as that because other significant factors come into play. For example, the number of students enrolling in mining courses are notoriously cyclic. Figure 3 shows first year enrolment at UNSW from 1948 to present. A national graph shows precisely the same troughs and peaks. It is very difficult to plan the resourcing of a university de-

partment and the delivery of programmes in such rapidly and widely fluctuating circumstances. In periods of economic downturn in the mining industry, enrolments have sometimes fallen to less than required to justify keeping even one mining school open in Australia. And if the experiences with mining schools in North America and Europe are anything to go by, once a department is closed it stays closed.

There is a further and perhaps more compelling factor. It is part of the Australian culture that students attend their local university. Such is true for something like 80% of those attending universities. So to tap effectively into a population resource base, such as say Melbourne, for prospective mining engineers, it is necessary to have a mining school located in or close to Melbourne. Some may be persuaded or financially induced to leave home and attend a university elsewhere, but the majority of potential students will not move and would rather choose some other course of study. This culture will not easily be changed. The fact has to be faced, therefore, that to exploit effectively Australia's population base for the future supply of mining engineers requires that mining engineering education be readily accessible in the main population centres of Sydney, Melbourne, Brisbane, Perth and Adelaide.

The obvious answer to the seemingly conflicting imperatives of the resourcing of and having multiple centres offering mining engineering education is to share resources by networking the centres. Stand alone mining engineering departments fly against the explosion of global information and knowledge sharing. Networking should be viewed as providing mining departments with a golden opportunity to enhance their relevance to industry and to overcome their resourcing problems. Conversely, those who fail to grasp this opportunity stand a strong chance of becoming irrelevant as students 'surf the network' for appropriate courses. The bandwagon is already picking up speed and there is little time left to climb aboard.

The UNSW Model - a Potential for Networking

The BE course in mining engineering at UNSW has embarked upon a process of fundamental change. It started in 1994 and will probably take until 1998 to complete and be fully implemented. It is a process of radical change that aims to come to grips with the issues of:

1. what we should be doing
2. how we should be doing it
3. how to become and stay relevant, and
4. how to get closer to the industry we profess to serve.

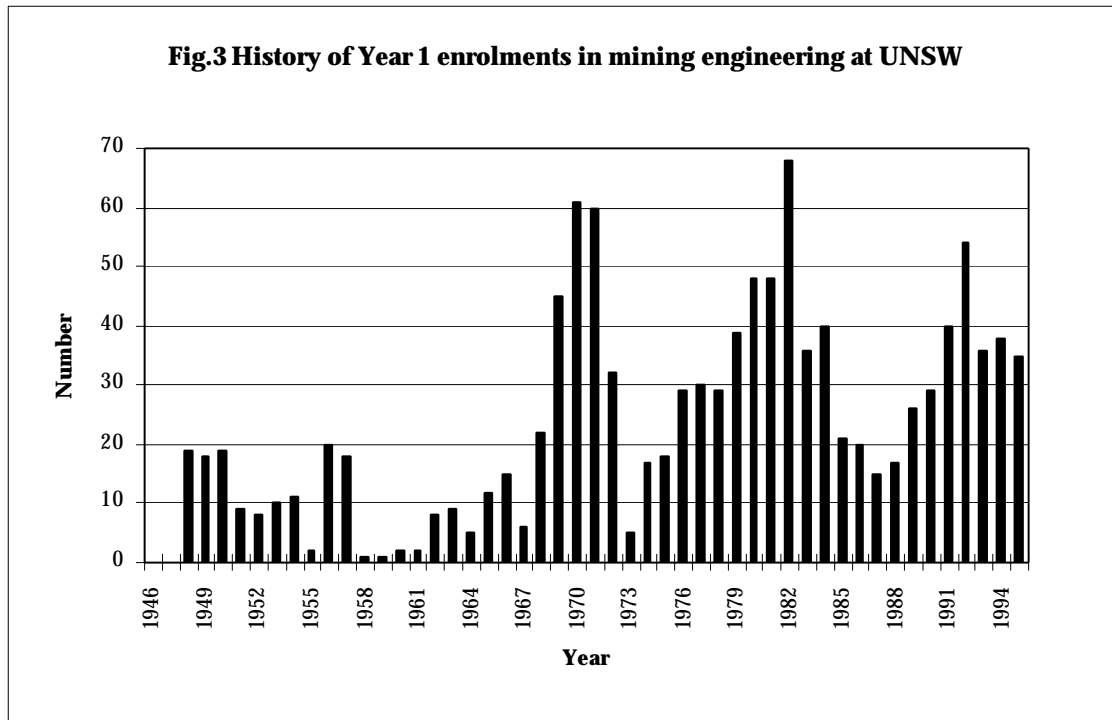
In 1994 the project was awarded a support grant from DEET under the CAUT scheme, a national grant scheme for innovations in teaching.

In essence, the project is based on three closely linked developments:

1. the establishment of Mine Site Teaching Units
2. the development of Networking, and
3. the 'corporatising' of years 3 and 4 of the course.

Mine Site Teaching Units

The concept here is to develop the mining equivalent of the 'teaching hospital'. The first teaching unit has already been established and is located at Wye Colliery on the central coast of NSW and is now operational. It comprises four brick veneer cottages providing self-contained residential accommodation for 40 students and four staff. There are two air-conditioned lecture rooms each housing



40 students. The complex is a secured site with inbuilt recreational facilities and is located immediately adjacent to Wyee Colliery, a modern two million tonne per year underground coal mine.

The facilities, which were formally opened in October 1995, have been provided by Powercoal Pty. Limited and the maintenance and operation of the student houses is financially supported by four mining equipment supply companies.

The establishment of the Wyee mine site teaching unit is providing the opportunity for several major advances in mining education:

- The unit, in conjunction with the revised modular format of the appropriate subjects in the mining engineering degree course, facilitates the use of experienced industry personnel in presenting the course, in keeping course material up to date and in tapping into a state-of-the-art applied knowledge base.
- Mine site teaching is being developed on the basis of self-directed learning and provides a unique learning environment whereby students can better integrate various inter-related components of their coursework (e.g. ventilation, mine design, transport and management structures) and thereby develop an understanding of the overall mining engineering activity.
- The mine site teaching environment provides students and academic staff with access to a broad range of case studies. Wyee operates state-of-the-art methods of both longwall and bord and pillar mining.
- The establishment of an underground section of the mine for student use enables students to undertake, in a full-scale dynamic environment, learning exercises which would otherwise not be as effective or even possible.
- The geographical location of the teaching unit provides ready access to a wide range of surface mining and the underground mining operations. Moreover, it facilitates industry practitioners attending professional development courses and technology transfer workshops,

presented by academic staff and academic research personnel.

It has permitted underground learning exercises to be incorporated into CPD courses and Technology Transfer Workshops.

In summary the teaching unit concept is a means of achieving balance between competing calls for greater emphasis on education in fundamental engineering science principles versus more vocational training in what is a highly applied engineering discipline.

The time honoured quotation from Confucius:

I hear and I forget

I see and I remember

I do and I understand

is especially appropriate to the teaching unit philosophy and is being used as a symbolic maxim of the unit.

In concluding this outline on the development of mine site teaching units, it is worth making some comment on experience with it to date and on future proposals for developing the concept.

The first subject in the BE(mining) course to be modularised and presented at Wyee was 'Methods of Mining Coal Deposits'. This covers both surface and underground operations. It has been presented at Wyee for the past two years using the self-directed learning approach, facilitated by a combination of academic and industry staff. The effectiveness of the method can be judged from the following:

- Over the two years there has been a 400% increase in the number of students gaining a distinction grade and a 75% increase in the number gaining a credit grade.
- No student out of a class of 45 failed the subject in 1996 with 39 achieving a credit grade or higher.
- Student approval ratings for the course structure, presentation and learning outcomes has increased markedly and on average close to 90%.
- Students are now requesting specific courses to be conducted at the mine site teaching unit.

Concerning the future development of mine site teaching it is proposed:



- to extend its use, wherever appropriate to other subjects in the BE(mining) course;
- to make the Wyee Unit available to students and staff from other universities as part of networking;
- to seek to establish at the earliest possible juncture mine site teaching facilities specifically for metalliferous mining and open pit mining;
- to develop fully the potential of the teaching units in Continuous Professional Development for the profession of mining engineering.

Networking

The concept of networking offers an opportunity to address the vital issues in Australian mining education of diminishing resources and maintaining adequate access to the nation's population base. It is expected that UNSW will be both a provider and a receiver of teaching inputs and services to and from other institutions.

Networking provides the opportunity to:

- to exploit synergies with other research, education and training establishments;
- for mutual complementation of strengths between participating mining engineering departments;
- selectively to globalise mining engineering education ; and
- for students to have much greater choice of subjects. Networking also facilitates;
- distance learning and alternative delivery modes;
- the development of CPD programmes in specialist areas;
- the development of implementation of a National Mining Engineering Curriculum and Accreditation System;
- ownership of the learning process being transferred from the teacher to the student and breaking the shackles that everything has to be taught; and
- globalising mining engineering education, through international alliances with 'best practice' institutions.

In this latter regard, UNSW has already established links, with a view to networking, with mining engineering departments at Colorado School of Mines and the University of Missouri-Rolla in the USA, the University of the Witwatersrand in South Africa, Luleå University of Technology in Sweden and Montanuniversität at Leoben in Austria.

A vital element of networking is the development of strategic alliances with other industry stakeholders in mining education and these have to be of mutual benefit. Such an alliance has already been established at the Wyee mine site teaching unit between UNSW, Powercoal Pty Ltd. and the four mining supply companies ANI Arnall, EIMCO (Tamrock) Australia, Joy Longwall Australia and Mine Site Technologies Ltd.

The model that is proposed and being developed at UNSW is shown diagrammatically in Figure 4.

Corporatisation of the BE course in mining engineering at UNSW

One of the strengths of mining engineering being a university based discipline is the fact that the basic sciences and principles of engineering are presented on a collegiate basis. In other words the mining engineer gets the same foundation in engineering education as other engineers and the discipline is thereby established as a genuine part of the professional engineering culture.

At UNSW, as at most other universities, this in effect comprises the first two years of the four year full-time degree course in mining engineering. The final two years are devoted to a mixture of core, specialised and elective mining subjects which are mostly in the province of the mining engineering department.

The plan at UNSW is to completely revise the undergraduate course, not solely in terms of content but most especially in the organisation of years 3 and 4. The third and fourth years will be concerned exclusively with subjects and activities that are mining specific. All service teaching, that which is provided to the mining engineering course by other departments of the University will be restricted to years one and two of the course. This will enable third and fourth years to be 'corporatised' by taking them out of the university calendar and modularising the content such that the more applied components can be delivered at mine site teaching units utilising self directed learning concepts. Other subjects in years 3 and 4 more suited to main campus presentation will also be provided in modular form.

The corporatisation and modular structuring of years 3 and 4 is of course, essential to the effective implementation of self-directed learning and use of the mine site teaching strategy. It does, however, bring some significant additional benefits including:

- the potential to release students for an eight month period of industrial training prior to completing their degree;
- the university being able to recognise prior learning and experience of industry personnel and any necessary upgrading of their knowledge;
- improve the opportunity for industry based personnel to develop their education to degree level;
- facilitate networking with other national and international institutions especially where staff transfers are involved;
- customising programmes to suit the needs and circumstances of a broad cross-section of minerals industry personnel; and
- facilitate meeting budget restrictions by enabling some courses to be presented to combined third and fourth year classes on a biannual basis.

Other significant benefits arise from offering a good range of subjects on a modular basis at mine site teaching units. They can be readily accessed by industry as components for:

- statutory certificates of competence in mining;
- Continuing Professional Development;
- specialist training of industry personnel; and
- attaining graduate qualifications.

It also facilitates the use of industry expertise to achieve:

- more cost effective teaching arrangements by utilising the complementary strengths of and developing synergies between industry and university personnel;
- keeping course material up-to-date;
- flexible staffing arrangement to respond better to fundamental changes in engineering technologies and business management; and
- closer contact with industry and an up to date awareness of industry benchmarks.

Corporatising, in terms of modular teaching and quitting the university calendar is seen as both an essential and highly desirable development in mining engineering education. There seem to be no serious impediments of disad-



vantages in moving in this direction. Indeed much the same approach has long been a cornerstone of medical education where senior students bring together the theory and practice of medicine within the real world environment of the teaching hospital. We can and should be doing the same in mining.

Concluding Remarks

The title of this paper poses the question 'will universities still be relevant to mining education in the 21st century?' The answer is that they can be and that they should be. Mining engineering education, however, is in need of urgent and drastic overhaul if it is not to slide into obscurity and become irrelevant.

No one has the monopoly on ideas for change in mining education. It is known that others recognise and are responding to the critical challenges that are facing the discipline. This paper describes one approach, the one being promoted and developed at UNSW and outlines the reasoning behind it. Significantly there are some striking similarities between what is already under way at UNSW and the advocacy of the recently issued Discussion Paper on Tertiary Education in the Minerals Industry by a Task Force of the Western Australian Chamber of Mines.

References

- Winridge, F.W., 1996, Report on an accident at Moura No. 2 Underground mine on Sunday, 7 August, 1994, 74p, (Wardens, Department of Minerals and Energy, Brisbane, Queensland**
- IE Aust, 1996, Engineers for a Changing Australia. (Review of Engineering, Exposure Draft Report Vol. (Draft 1), Institution of Engineers, Australia, Barton, ACT, June 1996.**
- Dorricott, M., 1996, Mining Engineering in Overview, pp 36-38, Australian Journal of Mining, June 1996**
- WA Chamber of Mines, 1996, Minerals Industry Tertiary Education Taskforce., Discussion Paper 48, The Chamber of Minerals & Energy of Western Australia Inc., Perth, WA, July 1996.**

Comparison of Courses

It is some years now since the comparison of the degree courses offered by member universities of the Society was done. It would be a good idea to update the data base. It would be most helpful therefore if you could fill in the forms below and send them back to me - by e.mail if possible to avoid my having to type everything in again. You can get an electronic copy of the form from the Society's site on the net by downloading the copy of the newsletter there.

COUNTRY	
UNIVERSITY	
Theoretical Duration of Course - Semesters	
Theoretical Duration of Course - Terms	
Weeks per semester/term	
Maximum Timetable Hours/week	
Average Timetable Hours/week	
Years	
Degree Awarded	
Pre-university Industrial Work (Required)	
Practical Training During Course - weeks	
Field Trips - weeks	
BASIC ENGINEERING STUDIES	Hours
MATHEMATICS	
Engineering Mathematics	
Mathematics & Co-ordinate Geometry	
Algebra & Calculus	
Numerical Analysis	
Statistics	
PHYSICAL SCIENCES	
Physics & Technical Mechanics	
Physics	
Fluid Mechanics	
Thermodynamics	
Mechanics/Statics	
Structures & Civil	
METALLURGY & MATERIALS	
Chemistry	
Materials	
Metallurgy	
GEOLOGY & SURVEY	
Geology & Mineralogy	
Geodesy & Surveying	
MACHINERY	
Machinery & Hydraulics	
Electrical Engineering & Electrotechnics	
Engineering Drawing	
COMPUTING & INFORMATION SCIENCE	
Principles of Units	
Computing & Information Science	
MANAGEMENT & ECONOMICS	
Social & Legal Studies	
Economics & Industrial Engineering	
ELECTIVES & LANGUAGES	
Laboratories/Tutorials/Electives	
Languages	
TOTAL	



COUNTRY UNIVERSITY	
DISCIPLINARY STUDIES	Hours
MINING ENGINEERING	
Introduction to Mining/Excavation	
Mining Engineering	
Infrastructure/Foundation Engineering	
Shaft Sinking/Prime Access	
Rock Breaking & Drilling	
Development	
Surface Mining	
Drainage	
Dredging, Alluvial, Unconventional	
Underground Mining	
Energy & Petroleum	
Mining Science/Design	
Mining Management	
Engineering Science	
GEOMECHANICS	
Strength of Materials	
Geomechanics/Soil Mechanics	
Subsidence	
Rock mechanics	
MINE ENVIRONMENT	
Ventilation & Fires	
Safety & Rescue	
MINING MACHINERY	
Mining Machinery	
Pumps and Fans	
Transport Systems	
PROCESSING	
Mineral Processing	
ELECTRICAL	
Electronics	
Electrical Engineering	
EXPLORATION & GEOLOGY	
Economic/Engineering Geology	
Geophysics & Exploration	
MINE SURVEYING & THE ENVIRONMENT	
Surveying	
Ore Reserve Estimation/Geostatistics	
Environmental Studies	
COMPUTING	
Computing/Information Science	
ECONOMICS & MANAGEMENT	
Economics/Mining Economics	
Operations Research	
Project Management	
Colloquia	
Social & Legal Studies	
UNDERGRADUATE THESIS	
Thesis etc.	
ELECTIVES	
Technical	
Humanities	
TOTAL	

The block diagram is also available from the web site as a word file and this too can be downloaded from there. You should then be able to alter it to suit your needs. I look forward to receiving a flood of replies in the near future.

We will be discussing things with Eurominerals and possibly Eurometaux and Euromines in the joint session and it would be good to have up to date ideas on how we are all adapting to the changing mining world of today. From my own point of view too, I am due to give a paper in Hannover in June and I would really like to have at least some of the data updated before then.

It would also help if you could also give me a block diagram of the course of studies to show when various subjects are studied. An example of a complex one from Delft is attached. Please do your best to produce a comparable block diagram for your courses. We should then be able to produce a booklet showing the courses of studies available in Europe and compared with some other universities.