



Examining the skills shortage

BY JOE CUCUZZA

THE basic mechanisms for ensuring a flow of suitable graduates into the minerals industry are relatively well understood – gaining school leavers' interest in, and commitment to, sciences, and offering a career path that will encourage students to study the appropriate disciplines. Co-operation between universities and the industry is critical to ensuring that school leavers are attracted, and that students are equipped with the knowledge and skills they need to pursue that path.

The encouragement and support of suitable research, and the development of skilled researchers is more complex, not least because of the vagaries of research funding and the interdisciplinary nature of the minerals industry. There is the full range of geosciences, mining, process engineering and metallurgy, just to name some of the core disciplines. Many of these are affected by advances in other disciplines, and these create new opportunities.

A number of mineral companies conduct a great deal of research in their own right. But, notwithstanding the impressive record of success some companies have achieved, industry would be remiss if it did not take active steps to harness the intellectual resources that exist in the universities and national research organisations. This is particularly so now that the industry is facing severe global shortages in skilled personnel. There are a number of good reasons, therefore, why industry should be proactive in this regard:

- Bright students need to be encouraged to undertake their degrees in fields that will lead to subsequent careers in the minerals industry and in industry-related research organisations. This means ensuring that there are appropriate scholarships and research grants available. It also means the industry successfully promoting itself to the wider community.
- It provides access to a wider array of ideas than can ever be developed within the industry alone. Mechanisms are required to encourage world-class research by leading academics in these areas and to access such new knowledge as it emerges.
- The provision of highly-trained graduates and postgraduates offers an important mechanism for diffusion of new ideas and innovative technology.

For industry to harness the intellectual resources from the research community, it is assumed that such resources will exist in the future. There are significant pressures on universities to reform along business lines,

In recent years, university enrolments in mining engineering and geology have dwindled in many countries and now, at a time when the minerals industry is experiencing strong supply/demand fundamentals and buoyant commodity prices, it is evident that in some disciplines there is an acute skills shortage

giving rise to closures and amalgamations of departments and to some extent a declining emphasis on the disciplines critical to the minerals industry. As one commentator recently put it: "Only disciplines that pay their way will earn the right to survive in the university of the future."

Amira International compiled data on the number of students who participated at Honours, MSc or PhD level, or equivalent, in projects it managed during the period 1990-2004. A total of 324 projects were completed, of which 191 were university based. The total industry cash contribution to these projects was about US\$170.8 million in 2004 dollars, of which some 72.7% was directed to universities.

This funding does not include matching grants from agencies such as ARC in Australia and THRIP in South Africa which many projects attracted. A total of 430 students, at various academic levels, were involved in the projects. Some 61% of the students were at PhD level. There were 65 post-doctoral fellows engaged in these projects.

The delay in, and cyclic nature of, the commencement/enrolment of new students superimposed on the general decline in enrolments results in significant pressure on the industry when the needs (as currently being experienced) are greatest. It is not obvious to what extent the decline in enrolments is part of the overall trend away from the sciences.

What seems to be generally accepted, however, is that it is contributing to the skills shortages now experienced by industry. In 2001, the UK Government

MURRAY Hitzman, of the Colorado School of Mines, has pointed out recently that "despite the cyclic rebound of the minerals industry during the past 18 months, there has been less of an upturn in student numbers in mining subjects around the world. Although some increase in student numbers is occurring, we still have not reached the student numbers of the 1970s and 1980s. In the US, the rebound in undergraduate student numbers is due more to a robust petroleum industry than to mining".

commissioned a report on the supply of science and engineering skills, focusing on biological sciences, physical sciences, engineering, mathematics and computer science.

The report concluded that "the disconnect between this strengthening demand for graduates (particularly in highly numerate subjects) on the

one hand, and the declining numbers of mathematics, engineering and physical science graduates on the other, is starting to result in skills shortages".

Whereas the numbers of UK students entering higher education rose by more than 10% between 1995-2000, the number studying engineering and technology fell by 7%, and those studying mathematics and the physical sciences by 1%. During the same period, the number of PhD students graduating in the physical sciences fell by 9%.

A recent study by Anglo American, BHP Billiton, Rio Tinto and Xstrata demonstrated that over the past 20 years some 20 mining engineering departments have closed in Australia, Canada, the UK and the US – some 30% of all departments in the countries examined, whilst one has opened in Chile (Davidson, 2004). Government policies have had a tendency to exacerbate the problem because of the use of inappropriate performance criteria to measure the success of courses and departments.

METHODOLOGY

For the purposes of the analysis, the Amira projects have been classified on the basis of four functional disciplines: exploration, mining, mineral processing and

metallurgy, plus 'other'. Projects that were either current or started in 1990 were included in the compilation. The projects were classified as either university-based or non-university based.

Projects that were led by a non-university institution but included collaboration with one or more universities have been classified as university based. Co-operative Research Centres (CRCs), an Australian Government initiative that brings together universities and other institutions under one umbrella focusing on a specific research theme, are classified as university-based since they can involve students.

In some cases, PhD students appeared in more than one project, and such students were counted only once. A small minority of students failed to complete their courses, but these were not deleted from the compilation. Because of the nature of PhDs, many continue after completion of the Amira projects, the majority of which tend to be three years in duration.

In some disciplines, particularly mineral processing and metallurgy, the academic level of some of the participating students is not clear and these were thus placed in the 'other' category. For some of the earlier university-based projects, it was not possible to confirm participation of students, although it is likely that some did. Thus the total number of students reported is likely to be a minimum.

During the period, a total of 324 projects were completed, of which 191 were university based. More than 430 students at various academic levels were involved in the latter. A total of 65 post-doctorates were employed in these projects.

Of the five categories, mineral processing had by far the largest cohort of students, 234. It also had the largest students-per-project ratio, at 3.7. This is due to the fact that mineral-processing projects tend to be much larger in scope requiring greater student participation. Exploration employed the largest number of post-Doctorate researchers. It also had the broadest research provider base.

The low number of students involved in mining projects reflects the relatively small number of projects in this category during 1990-2004. A total of 20 students were involved in the eight university-based projects during the period, and this results in a significantly lower students-per-project ratio than the other disciplines.

DISCUSSION AND CONCLUSIONS

It is interesting to speculate on the investment required to train the students participating in the Amira International projects. Focusing on the PhDs only, and assuming that each student secured a basic annual scholarship of US\$18,600 (the value of the current scholarship offered by the Austral-

OVERALL SUMMARY 1990-2004

	Exploration	Mining	Mineral processing	Metallurgy	Others	Total
Total number of projects	96	37	104	33	54	324
Industry funding in 2004 (US\$ million)	31.1	25.6	75.6	22.4	16.0	170.8
Percentage funding directed to universities	56.4	69.5	77.2	89.4	64.5	72.7
Number of students						
Hons	10	1	3	1	0	15
MSc	23	1	61	6	1	92
PhD	55	18	133	40	15	261
Unclassified	0	0	37	20	5	62
Total number of students	88	20	234	67	21	430
Total number of post-docs	39	0	8	4	14	65
Number of university projects	52	21	63	28	27	191
Ratio students/university project	1.7	1.0	3.7	2.4	0.8	2.2
Number of universities involved	14	8	10	10	26	-

ian Research Council) for an average of four years, this represents a minimum investment of just under US\$20 million in today's dollars.

Despite the substantial intangible benefit that multi-company collaborative projects deliver to Amira members and the industry at large, and their importance in maintaining the research infrastructure to ensure that industry's future human resources and research needs are addressed, the minerals industry is facing a potentially growth-limiting crisis in terms of skills supply. This suggests that other structural issues are also at play.

In the Western world, for example, significant pressure on university training in key disciplines is aggravating the problem; school leavers are opting out of the hard sciences in favour of business and other careers; student enrolments appear to be falling right across the board; and departments are being forced to amalgamate and in some cases close, and are generally unable to provide the necessary breadth and depth of education the industry requires.

Some consolidation of departments has been necessary, but there is a real danger that any further decline can jeopardise the ability of universities to provide the necessary technology and people for the future.

It is not clear to what extent the recent economic resurgence of the industry will cause a slowdown, or indeed a reversal, of these trends. It is also not obvious

AMIRA International describes itself as the global minerals industry's research association. Formed in 1959, the association has some 67 member companies drawn from every continent, including majors such as Rio Tinto, BHP Billiton, Anglo American, CVRD, Phelps Dodge, Placer Dome, Barrick and Newmont, in addition to many medium-sized companies and a few emerging juniors.

The association's main function is to develop, secure funding for, and administer, multi-company collaborative research projects. As part of its mandate, Amira International also identifies key researchers and research work being undertaken around the world that might be of value to member companies, and determines whether collaborative projects can be developed that address issues of interest.

The association manages the relationship between the sponsoring companies (projects are supported by more than one company; frequently a dozen or more may share the cost) and monitors progress, including ultimate technology transfer. There are typically 40-50 research projects under management at any one time and at least an equal number in various stages of development. Since its inception in 1959, Amira International has arranged

funding for more than 650 projects covering diverse fields and commodities. More than half of the funding goes to universities, and the balance largely to other national research providers and other specialist institutions.

This activity is global. Because the Amira model was developed in Australia before being expanded internationally, there remains a residual bias toward Australian institutions – not least because longer familiarity with Amira ensures that they are more likely to bring potential projects to its attention in the hope of attracting funding support.

Notwithstanding this, in 2004 Amira International also supported research work conducted at institutions in the US, Canada, South Africa, Chile, Brazil, the UK and Peru. Approximately 53% of Amira International's new business in 2004 originated from member support outside Australia.

Until now, however, the evidence of Amira International's success in fostering and supporting continued research work among promising graduates (and so creating a pool of talent for the industry) has been less well-documented. An analysis of the student involvement in Amira International projects for the period 1990-2004 was thus undertaken.

to what extent the industry will source its future needs from the emerging economies such as China and India.

There have been attempts at addressing some of these issues in various countries. For example, in Australia, the Minerals Tertiary Education Council (MTEC) was established in late 1999 by the Minerals Council of Australia.

About US\$12 million was allocated over five years, with the majority of the funds committed to the development of undergraduate and postgraduate courses, and the employment of academic staff at selected universities and across earth sciences, mining engineering and metallurgy.

In South Africa, the industry has tackled potential skills shortages in universities by funding the Minerals Education Trust fund, which is directed at geosciences, mining and minerals extraction.

The objective of this initiative is to provide salary support for selected academics to ensure that critical skills are retained in the universities. In 2005, some US\$1.08 million was contributed by companies based on the number of engineering professionals, the majority of this sum being spent topping up academic salaries.

These initiatives are very important and should continue – strategic advantage originates not only from quality orebodies, but also from the quality of the human resources, or intellectual capital (Knights, 2004) – and multi-company collaborative R&D is a proven mechanism for supporting and nurturing the key research centres around the world that provide this intellectual capital.

However, to ensure that the R&D infrastructure is sustainable, industry support of this type must be constant across business cycles. One of the dangers of ignoring this issue at the bottom of the business cycle, when attention is focused on cost containment and efficiencies and so on, is that when the cycle turns, industry's growth may be severely constrained, owing to the lack of skilled people.

Although collaborative R&D through Amira International offers a mechanism for attracting and

training students, and is a necessary part of the overall strategy, this is not sufficient in itself to ensure that an increasing number of bright students are attracted to a career in the minerals industry. Individual companies must do a lot more in providing incentives for students to consider a career in the industry.

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