NEWSLETTER

SOCIETY OF MINING PROFESSORS

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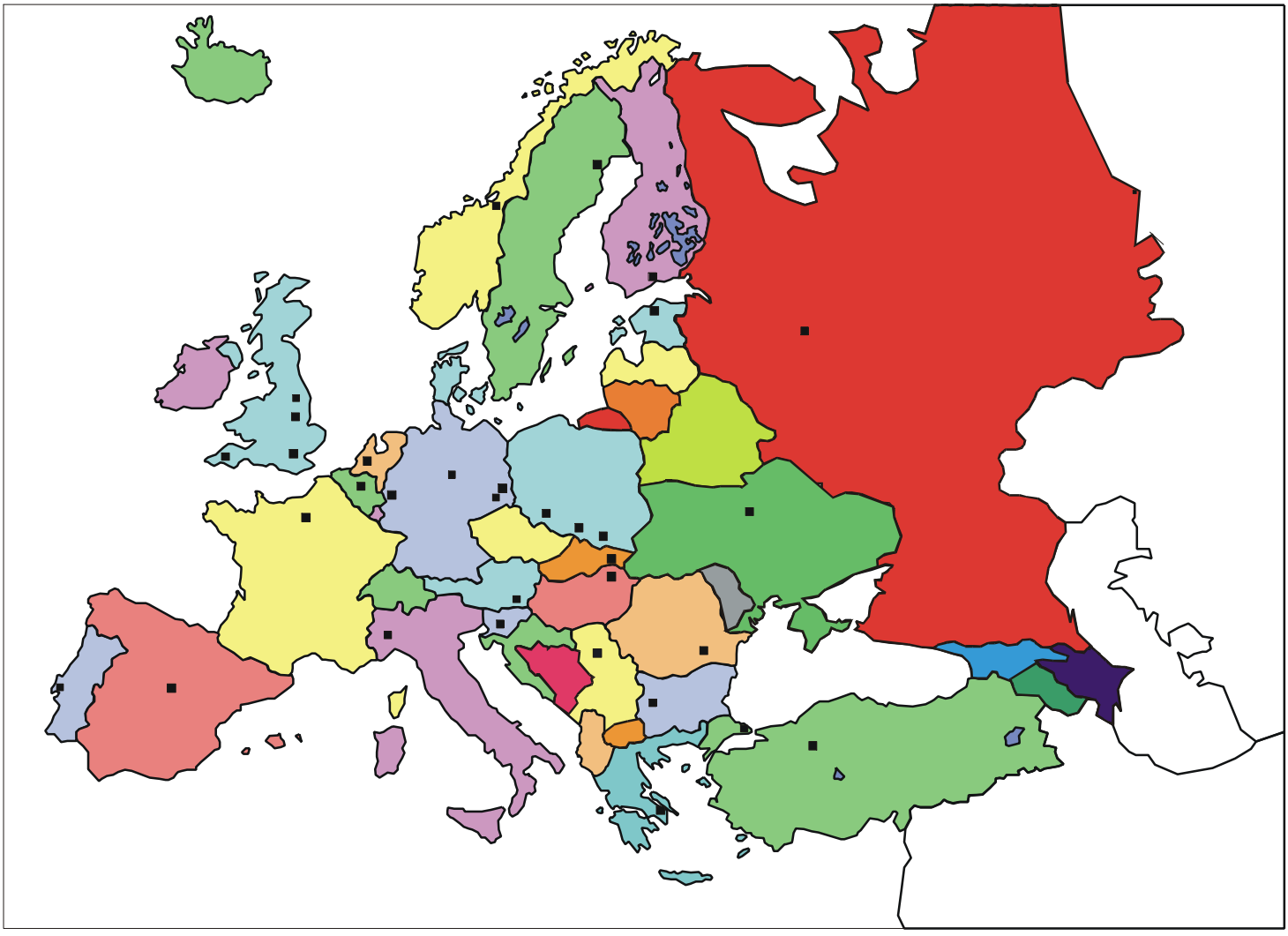

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Editorial

This Newsletter is the third this year, as I am getting back into the swing of running the Society now that Mining Engineering at the Royal School of Mines looks to be more secure for the future. The School has been able to raise a very good level of support from industry and the introduction of European Mining Course two years ago has also made a big difference. Of course, as the delegates who attend the annual meeting in Carrara will hear, the course itself has had to adapt to allow this all to happen. Universities in the UK are no longer prepared to tolerate very small numbers of students in any classroom.

Actually, world wide the debate is still on as to just how mining education should be delivered. In Europe, the area where the mining industry has been most developed for the longest time, there is now a steady decline in the mining sector, with the possible exception of the quarrying industry part of that sector. Europe is of course very heavily populated, and most people (often even including the miners themselves) do not want mines near to where they live. The environmental lobby is very strong in Europe and it is ensuring that, even if new deposits are found, it will be very difficult, if not impossible to obtain permission to mine them. So mining in Europe is reducing and looks likely to continue to do so.

All that said, there are still young people in Europe who wish to become mining engineers, not a lot of them, but still they do exist. In my opinion it is the duty of an educational system to deliver the education that the students wish to receive. Another factor in favour of continuing educating mining engineers in Europe is the fact that there are still large mining companies with their headquarters in one or other of the countries of the EU. It must be assumed that these companies will wish to have at least some of their own nationals working within their operations. So some mining graduates will be probably always be needed within the EU.

A third reason for the continuation of mining education is that there is likely to be in the future increasing use of underground space. As protection of the surface environment becomes more and more important, the move towards building more and more facilities out of sight under ground will grow. In addition to this there is already a strong trend ensuring that more and more hazardous waste is disposed of safely in underground spaces. The persons most qualified to produce such underground spaces as are required for all of these facilities are of course the mining engineers.

At present there are over 30 universities in the EU offering mining engineering degree courses, this is probably far too many. In the UK at least a class size of less than 15 to 20 students is now looked upon as non-viable financially. This would mean if this is extrapolated to the rest of the EU that about 450 to 600 mining engineers would graduate each year within the EU. There is no market for this number of graduates within the industry. So if all 30 universities did in fact attract sufficient numbers of students for their courses to be viable in the eyes of the universities, they would in turn be producing many more graduates than the mining and minerals industries in the EU could possibly need.

In many countries, the UK to an extent included, the mining engineer is looked upon as a good generalist engineer and is in some demand in other industries. In the UK, the financial services industry requires quite a significant number as analysts for example. However, even with this added off-take it is not likely that there would be jobs for as many as 600 mining engineers each year. So if we could attract the students, there would be a problem on the horizon as to where they would find work.

There is little doubt, therefore, that there are too many mining engineering degree courses. Each one of us would naturally like to see his / her particular degree course continuing into the future. This is of course also true of the many universities who are not represented in the Society by one of their professors. So the reduction of course offerings is likely to be a fiercely fought battle.

It may well be that this is an area which this Society will have to address seriously in the future. I do not believe that we should attempt to preserve all courses no matter what. This would probably be self defeating and counter productive. I believe that our approach should be to identify excellence and to do our best to ensure that whatever else happens the excellence does survive. It is also I believe our duty to ensure that we retain the ability to deliver excellent mining engineering education within the EU.

On another note - Hans de Ruiter has now got the Society web page into good shape. Among other things it has the full address list as it currently stands of the Society. I would suggest it is worth a visit and if you find an error in the address list please let us know. Let us know also if you know of the e.mail address of any of the members for whom we do not have their e.mail address listed. The web address is:

http://home.mp.tudelft.nl/mineprofs

I have reproduced here a paper by Prof. Mike Karmis on mining research in the United States. It highlights not only the drying up of research funds which most of us have experienced, but also points out the knock on effect that this will have on the recruitment of academ9ic staff in the universities. It is clear the in the US this is already a problem. This is also true of the UK – those universities which have been allowed to recruit new mining staff have found it extraordinarily difficult to find suitable people to fill the vacancies. The RSM is currently looking for three and I am worried about the chances of finding them. So I believe that this paper is another good one for sparking off discussion in our Society. I have added for good measure some comments made by Prof. Pierre Mousset-Jones in his letter apologising for not being able to come to this meeting. He backs up what Prof. Karmis said.

TOWARDS A SUSTAINABLE MINING RESEARCH INFRASTRUCTURE: AN ACADEMIC PERSPECTIVE

Michael Karmis
Stonie Barker Professor and Head
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"No, I never was lost. But I once was bewildered for three days."

-Attributed to Daniel Boone

INTRODUCTION

The topics of mining engineering education and practice have been discussed in a number of recent publications, meetings and symposia. Issues such as enrollment, curriculum and accreditation of minerals-related engineering departments, and the subjects of post-educational professional training and career development, have been addressed, although not always to the extent that they merit (Karmis, 1990; Karmis, 1998). It is of interest, however, to revisit the future of mining education, and its impacts on the broad mining community, from the perspective of research capabilities and needs. Consequently, the theme of this paper, as well as the predominant message of this workshop, is the case for establishing a sustainable mining research infrastructure. The urgent need to address this topic at this time is apparent to the author, because some of the most fundamental forces to impact the future of mining have largely been ignored in previous debates. These elements include: (a) The Role of Research in the Modern University, (b) The Technological Demands of the Mining Industry, and (c) The Sustainability of Minerals Engineering Departments.

ROLE OF RESEARCH IN THE MODERN UNIVERSITY

The goal of the nation's colleges and universities is to pursue academic excellence in their mandated mission of instruction, research and scholarship. In the case of land-grant institutions, the above mission also includes public service. Research and scholarship, therefore, are important responsibilities of higher education, particularly as the role of the modern University of the 2lst Century is to provide strong leadership to the society.

The research component of the university was not created to solve specific problems, but to expand knowledge; to involve students - the future's explorers in research, in the creative process and the adventure of asking questions; and (paraphrasing from von Karman) to explore what is and create what has never been.

The research university academic system is a bargain. It creates the environment where:

- Undergraduates receive an education with the most current information, from those who make the discoveries and contribute to books and publications. The next generation of leaders is educated in a "state of the art" atmosphere.
- Graduate students work on the frontier of knowledge and technology, and share the responsibility of spreading the word. Society benefits from their energy, their curiosity, their insight before they graduate, and afterwards, as they continue to advance their disciplines and serve in their professions. Graduate students are an important part of the academic cadre and comprise tomorrow's teachers and researchers.
- Basic knowledge and programs are preserved and maintained on a long-term, unbiased basis. The research university develops and creates new concepts, philosophies, arts and technologies. It transfers new concepts and technologies to industries and governmental agencies, playing a primary role in maintaining a competitive position for the United States in the world economy.
- Highly qualified teachers and researchers are attracted to work and develop. Through their efforts, the research university generates supplemental funds and other resources, equipment and facilities to support its education and research missions.
- Research and scholarship conducted at research universities promote and encourage economic development: ideas, new industries, processes, and products that add jobs and wealth to the local, regional and statewide economies.

Often, legislators and government and industry leaders assume that the major product of a university is the student who will be the professional for the industrial complex. Most legislatures primarily support undergraduate education in universities, with research being a distant second priority. It is true that the university has a very important undergraduate educational mission, but this educational function is closely entwined with the research function. The individual who is the educator is also the researcher and when a university employs a person to perform this task they must seek individuals with combined talents.

Today's global marketplace is becoming more integrated and more competitive. In a recent letter, W.M. Phillips, Past-President of ASEE, noted:

> *Innovation will be an increasingly critical component of U.S. efforts to maintain a leadership position in the 21st Century. The capability to innovate and the ability of engineers and scientists to capitalize on innovations depend largely on the vitality of the nation's research enterprise.*

He concluded that federal and private support is the lifeblood of that enterprise, financing cutting-edge work at colleges and universities and the education of future generations of innovators.

THE TECHNOLOGICAL DEMANDS OF THE MIMNG INDUSTRY

The issue of technology, and its impacts on the competitiveness and vitality of the minerals industries, is not new. The National Research Council (NRC 1990), in its report *Competitiveness of the U.S. Minerals and Metals Industry*, urged government, industry and academia to work cooperatively toward achieving the technological breakthroughs required to ensure that our nation can rely on a healthy, secure minerals base for the future. The report also noted that mining and mineral processing are highly dependent on continued technological progress, and new research must be undertaken now in order to meet the future technology needs of the industry.

In an article entitled *Research and Technology Leave a Positive Mark on Mining*, Knebel (1993), then President of the American Mining Congress (AMC, a precursor of the current National Mining Association), wrote:

> *As we continue our march towards the 21st Century, it should be clear to all that we live in an era of tremendous technological change. The wonders of technology have touched all industries, including mining… The great advances of technology in recent decades would not have been possible without an enormous amount of research, which, while costly in terms of time and money, has paid off handsomely in allowing the mining industry to serve the United States and the world in a safer and more productive manner.*

He concluded

To improve upon these achievements it is vitally important to the mining industry that a high level of research activity is maintained. Indeed, the continued health of the modern industry requires the ability to remain competitive. Competitivenes, in turn, demands continual improvement in technology. In the United States, this is especially important because of the prevalence of lower grade ores and stringent safety and environmental regulations.

Interestingly, in the same article, the author praised the contributions of the Mineral Institute Program, conducted at the nation's minerals schools, and the crucial role of the U.S. Bureau of Mines, in the well being of the mining industry. Furthermore, he pledged the support of that industry to maintain these programs. Both of those programs have now been eliminated!

The AMC also developed a position paper entitled *Improving Technology in the Mining and Minerals Processing Industry – An Important National Goal* (1991) to support the findings of the previously mentioned NRC report. In addition to supporting the position of the U.S. Bureau of Mines, the paper expressed its support to *traditional mining universities, both as educational resources and as centers of excellence for the development of new mining technologies* (cover letter by Arthur Brown, Chairman, AMC Board of Directors Technology Committee). The actual report stated the following:

The competitiveness of the U.S. mining and minerals industry depends upon technological advances that can contribute to a healthy economy and a high standard of living. Maintaining this competitiveness is the challenge that confronts the U.S. mining and mining machinery industries… Mining and mineral processing are highly dependent on continued technological progress, and new research must be undertaken now in order to meet the future technology needs of the industry. Due to numerous factors, the industry's R&D capabilities have decreased by approximately 80 percent over the last decade. Therefore, future technological advances will have to be accomplished largely through cooperative efforts between government, industry and the nation's mineral schools… Continuing technological advance depends on an adequate supply of trained scientists and engineers. AMC also is committed to supporting the mining engineering and mineral science programs in the U.S. colleges and universities, and promoting cooperation between industry and the academic community.

But what has happened since then? The continuous decline in mining and minerals research and development is dangerously reducing the stockpile of expertise and knowledge in the field. There is undeniably a direct link between state ownership, political control, or - at least - mere public interest in major mining operations, and government sponsored research organizations. As the political involvement subsides, the sustainability of these centers diminishes, at the very time when they should be contributing even more to the rapid changes required in the mining and minerals producing industries (Hackett, 1966). The demise of organizations such as Bretby, in the United Kingdom, Chamber of Mines, in South Africa, and of course, the Bureau of Mines in the U.S., exemplifies this trend.

Mineral industries undertake, or commission, a range of research and development activities with aims that range from method and process improvements and quality control to diversification and product innovation. These research targets are usually linked to improving both short- and long-term profitability.

Acceptable R&D must make measurable contributions towards improving the performance of a company's profit line (Cohen, 1994). Such requirements are now increasingly influenced by the global integration of world mining and trade. Mining research and development projects are usually the first victims of budget cuts when funds are short. This has happened to such an extent during the latter part of the twentieth century that research and development in most parts of the industry have either disappeared or shrunk to mundane ad hoc tasks. In an interesting commentary, *Reflection on Research Strategy for the Minerals Industry*, Cohen (1994), a noted and well-respected authority in mining and minerals processing, suggested that, apart from some massive increases in the size of equipment and mechanization, if Georgius Agricola was visiting a mine today (more than 500 years after his birthday) he would recognize most processes and would find little change of principle or method in the industry!

Yet, according to Ellis (1998), Chairman of BHP:

The challenge in resources industries is continually to reduce costs and increase margins and returns. This means using advances in technology, both to optimise existing businesses and to develop better ways of finding new resources and delivering the derived products to the marketplace more cheaply. High technology is a prime avenue for adding value in this way. Both depend on people who understand the need for innovation and how to apply it to useful ends. Without an energised and innovative workforce high tech is high risk.

Mineral producers and policy makers should also note that other industries are now undergoing, or exploring, profound changes in their core technologies and work styles. Improved methods of control and automation, rapid developments in information technology, and impressive applications of multimedia, robotics and virtual reality techniques, have begun to alter man-machine interfaces and offer significant reduction and flexibility in workforces and management. Unless the mining community develops an aggressive and innovative research agenda, it is in danger of stagnating in terms of technology and, therefore, preventing itself from exploiting deposits and seams that are uneconomical or impossible to mine with current technology.

In a recent publication (Johnson et al, 1998) a new cooperative research program was described, under the "Industries of the Future" initiative of the U.S. Department of Energy (DOE). According to the article, the U.S. mining industry working through the National Mining Association (NMA) is teaming up with the Office of Industrial Technologies (OIT) of DOE to prepare a long term R&D agenda that will address key technology, market, energy and environmental issues. It is the understanding of the author that currently a technology road map is assembled, which will provide the basis for further discussions, and possibly, funding opportunities under this initiative. At the time of this Workshop, this interesting initiative still remains as a proposal for future consideration and funding.

Returning to the previous article, Ellis (1998) noted in his conclusion:

A high-tech resources company will differentiate itself and be a different and better place to work. It will have a culture of innovation, a global approach, international perspectives and many opportunities. Such a company will expand the earth's resources, operate economically and sustainably, tread softly on the environment and be

based on optimism, not pessimism. Technology will play a big part in this.

The U.S. mining industry must prepare itself for the challenges of a dramatically changing world at home and abroad. In order to face these challenges, the development of innovative mining technology will be an essential ingredient, not only for the continued prosperity of this industry, but also for its capacity to continue as the bedrock support of a strong and secure United States. In the opinion of this author, however, the nation cannot be expected to sustain the R&D necessary for such major and revolutionary innovations without substantial infusion of public and private funds.

THE SUSTAINABILITY OF MINERALS ENGINEERING DEPARTMENTS

The nations minerals-related engineering departments have been challenged, for at least a decade, with severe problems of low undergraduate enrollment and inadequate institutional support. As mentioned earlier, these issues have been addressed in other reports, studies and publications, e.g. Karmis (1990); SME (1998); CONSOL (1997); Grayson (1997). In this author's view, however, the most significant threat, that could even lead to the demise of mineral education, is the lack of research funding. In fact, this is best, and most dramatically, illustrated by the current crunch in attracting and developing mining faculty at the nation's schools, a crisis that is expected to reach even more alarming proportions during the next five years. So, if the educational system is not creating and mentoring a faculty cadre, who will be teaching in the minerals schools in the 21st century?

As of Fall 1997, there were 16 accredited minerals engineering departments in the USA. Rather than looking at the usual undergraduate and graduate populations and student distributions in these schools included in other publications, it is more critical in this paper to review these programs in terms of faculty and graduate student demographics. In doing so, the SME (1998) data were examined, pertaining to Fall 1997, and were further verified by the author through direct communication with individual schools.

In reviewing this information on faculty and graduate students, i.e. the academic mining research infrastructure, the following comments are appropriate:

- Seven departments have a faculty size of less than four. Such strength may be below the necessary critical mass that can sustain undergraduate programs, as well as graduate studies and research activities.
- The actual distribution of faculty, into the various academic ranks is also a cause of alarm. It appears that the current mining and minerals departments had a distribution (as of Fall 1997 of seven Assistant Professors, 29 Associate Professors and 44 Professors. These numbers include minerals processing faculty that are integrated and reported within the traditional minerals engineering departments. The data exclude, however, the minerals processing groups that are in separate, independent, minerals processing programs or departments, as well as the minerals processing faculty that, in some schools, are integrated within metallurgical engineering or even, more general materials sciences programs.
- Looking more specifically at the mining research faculty, i.e. excluding the mineral processing faculty members, the corresponding numbers are six Assistant Professors, 28 Associate Professors and 36 Professors. This is an unbalanced distribution that will, eventually, lead to immense problems in replacing existing mining faculty.
- From the seven Assistant Professors who were in tenure track positions in Fall 1997, less than half will return next academic year, due to resignations and inability to earn tenure. The lack of research funding was quoted in a number of cases as one of the most serious problems in developing this young faculty.
- In reviewing graduate enrollments, particularly those pertaining to Ph.D. candidates, the 16 mining schools list 45 doctoral candidates, which includes only eight domestic U.S. students. It should also be noted that, as of Fall 1997, two of the listed schools had no graduate students at either the MS. or Ph.D. levels and that only 10 schools were active in advising doctoral students. This is a limited pool of candidates for fulfilling the research and education needs of the minerals community and, in particular, the demands of the future professoriat. These figures signify a rapidly decreasing and deteriorating mining research infrastructure.

In an effort to replace retiring or departing faculty (and clearly not to achieve a net gain in faculty size) almost every mining school this year was searching for new faculty. The author counted 13 such vacant positions. Faculty members sought today in engineering, including minerals disciplines, have the following characteristics:

- A Ph.D. degree, preferably from a prestigious university.
- Work in research areas that are "hot" at the time of hiring
- An interest in teaching and undergraduate curricular issues
- An interest in publishing papers and obtaining research grants
- An ability to interact with industry, and
- A desire to work with graduate students.

Academics with the above attributes form the core of most engineering college faculty. According to discussions with colleagues, a number of institutions are experiencing significant difficulties in filling their vacancies, particularly if a priority was placed recruiting promising young faculty members. Furthermore, assume that the academic commu-

nity hires 10 new faculty members at the rank of Assistant Professor. In the current environment, it is reasonable to expect that the cost of developing and establishing research and scholarship credentials of such faculty can be approximated as $100,000 per year, for each such faculty member. What that means is that in order to develop and tenure this pool of 10 Assistant Professors, an external research funding program in the order of $1,000,000 per year will be needed. It should be noted that such funds ignore the funding needs and priorities of the remaining mining faculty.

The author also would like to point out that, during the next five years, 14 additional positions are expected to be vacated because of faculty retirements. This, in his view, will significantly add to the academic manpower crisis and will noticeably weaken all aspects of academic life (i.e. instruction, research, scholarship and service). It could even lead to the demise of the minerals academic community.

A second issue that must be stressed in this paper is the problem of visibility and national prominence of the minerals related programs. Such programs are not listed in any of the respected, and well read, professional or popular surveys, including those conducted by ASEE, U.S. News and World Report, etc. As a result, serious questions are often asked in the academic circles regarding the need of sustaining or preserving such programs. The fact that the established research community (i.e. NSF) has largely ignored technical issues related to minerals exploitation, particularly after the demise of the Bureau of Mines, also raises questions as to whether the nation is willing, or interested, in investing in this field. Within the academic administration system, where the predominant performance measures and outcomes are based on peer rankings and evidence of national visibility, the absence of any recognition of the minerals engineering field could eventually be devastating to those departments.

This is an era where complex technical problems, multidisciplinary approaches, globalization, environmental concerns, ethical situations, public safety issues and national security matters demand unbiased evaluations and new solutions. The mining and mineral programs in US universities deserve the right and the support to be free thinkers and educators, like most of their sister departments, so that the production of all types and levels of minerals professionals can continue.

CONCLUSIONS

The principal benefits of research remain the acquisition of new knowledge, the opportunity for graduate students to train with experts and for undergraduates to be taught by outstanding faculty, in an atmosphere of knowledge in the making. As the need for knowledge becomes more complex and the need to search, apply, and communicate becomes more critical, support for university-based mining research, and graduate education is being seen less as a public obligation and interest. The demise of the U.S. Bureau of Mines, the reduced research budgets of minerals companies and organizations, and the general serious decline in research funding, are all matters of concern.

The universities have to survive as the most stable repositories of intellectual property in minerals and mining, as we move towards the new millennium. It is, therefore, imperative that everything be done to prevent the further attrition of the minerals base and research infrastructure. Government agencies, industry and individuals must recognize the potential intellectual abyss that would result from the continued attrition of minerals research and teaching departments (Hackett, 1996). These programs collectively represent, even now, a sub-critical mass of effort that may deny the industry and the community proper technical support and professional manpower, at least from the home base, within a few short years.

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TABLE 2: ACADEMIC MINING RESEARCH INFRASTRUCTURE(As of Fall Semester 1997, Source: Modified from 1998 SME Guide to Minerals Schools)

	Tenured or Tenure-track Faculty			Full Time Graduate Enrollment	
Accredited Programs	**Assistant Prof.**	**Associate Prof.**	**Professor**	**M.S. (US)**	**Ph.D. (US)**
Alaska-Fairbanks		1	2	4(1)	
Arizona		3		6(3)	4(0)
Colorado School of Mines	2	1	4	11(3)	10(1)
Columbia		1	1	3(2)	4(1)
Idaho		3	1		
Kentucky		5	1	5(2)	1(0)
Michigan Tech		4	1	4(0)	8(2)
Missouri-Rolla	1	2	2	5(2)	5(2)
Montana Tech	1		3	6(5)	
Nevada-Reno (McKay)		1	3	9(1)	
Penn State		2	4	5(0)	
South Dakota		1	2		
Southern Illinois		1	3	13(5)	2(0)
Utah	2	1	2	5(2)	1(0)
Virginia Tech		1	4	4(3)	2(1)
West Virginia		1	3	5(4)	8(1)
TOTAL	**6**	**28**	**36**	**85(32)**	**45(8)**

COMMENTS BY PROF. P. MOUSSET-JONES

Prof. Mousset-Jones from the Mckay School of Mines in Reno, Nevada included the following comments in his letter of apology to Professor Badino for missing the Carrara meeting:

"Mining education world-wide is under severe scrutiny. It will be interesting to see what the Australians do following their 'Back from the Brink' national study of mining education. Recently, the US held a conference on Mining Research. Currently the only available funds are from industry, which, at the present time, is negligible. This makes the problem of how to develop new, competent, industry experienced faculty to teach mining engineering even more difficult, since without research funds young mining engineering faculty will not get tenure at a US university. An attempt is being made to wake up the industry, only time will tell if this happens in time and in a sufficient amount. It is interesting to see that the mining engineering department in the province of Alberta, Canada was saved from imminent death by the local Tar sands mining industry. Perhaps that example will inspire other companies to follow this example."

(*In this respect it is also interesting to note that the mining faculty at the University of Toronto has recently also been resuscitated by a very large donation from an alumnus. CTS.)*

On another point, Professor Mousset-Jones goes on to add:

"In closing may I appeal to you to prevail on the Society to open up its membership to the world mining engineering academic community. This group is shrinking and unless we combine forces and show a united front, I think it will shrink further and may even reach extinction in the not too distant future. I think the society has everything to gain and little to lose from embarking on such a change in the original intent of the society. I hope you can prevail on the membership to think globally in this context."