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THE EDUCATION OF MINERAL PROCESSING ENGINEERS

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ABSTRACT: Mineral processing has been an important academic discipline for more than 200 years because it is an integral part of one of the basic industries. The demand for high quality mineral products is increasing but the ability of universities to train skilled mineral processing engineers İs decreasing. 'Virtual' departments making use of advanced communications technology to link universities with one another and with mining companies can be expected to be an important part of mineral processing departments in the future.

1. INTRODUCTION

The first schools of mines were established during 1760-90. In those days mineral processing was regarded as part of mining and it was included as an integral part of the courses.. The schools had close links with the mining industry and this meant that industrial techniques were presented and discussed in detail. During the next 100 years mineral processing became a discipline in its own right as an understanding of the theoretical aspects of processes started to develop. Small groups specialising in mineral processing were formed in universities for teaching and ore testing.

During the last 30 years there has been a spectacular growth in the size of universities and it has become difficult for small specialist groups to operate effectively in them. The result is that in many countries mineral processing is now fading as an academic discipline. Yet the demand for high quality mineral concentrates, coal and aggregate, and the problems of producing them in high volumes from mineral deposits which may be low grade and complex, continues to rise. Solving tfiese problems requires trained mineral processing engineers. The future of mineral processing education is discussed in this paper.

2. THE HISTORY OF MINERAL PROCESSING EDUCATION

The formal education of mining and mineral processing engineers started in the latter part of the 18th century when schools of mines were established in Freiberg, St Petersburg, Mexico City and elsewhere to solve problems concerned with safety in underground mines and to improve mineral recoveries from the fine grained ores which were then replacing the coarser grained ores which were being mined out. The establishment of the schools by the mine owners was an enterprising step at a time when tertiary education in engineering was almost unknown and the early schools were able to meet the demands of the industry for trained engineers for decades.

By the late 19th century large rich orebodies were being discovered in USA, Australia, South Africa and other countries which were remote from Europe and a network of schools of mines was established in them to meet the demand for trained engineers. This network became part of the international tertiary education system and mining and mineral processing engineers were trained in it for many decades. Papers on education written in the technical journals in the early 20th century indicate that schools of mines frequently encountered difficulties but for many decades there seems to have been a reasonable balance between the supply and demand for mining and mineral processing engineers.

After world war 2 national governments realised that tertiary education was crucial to economic success and university systems were expanded greatly. One result of this expansion was that the funding of academic departments became dependent on the number of students enrolled and this adversely affected small specialist departments, including mining and mineral processing. The result has been a slow decline İn funding and some of the adverse effects have been

i - many mining and mineral processing departments have turned to environmental engineering and their emphasis on minerals has been reduced. Other departments have ceased to exist,
ii - most of the departments which still exist have had difficulty in employing academic staff with industrial experience because of more attractive positions in industry.

These effects are not important over the short term because mineral processing technology, which is capital intensive, does not change rapidly and university departments are fairly stable as far as staff are concerned. But over the longer term of fifteen years a significant number of new staff is always required and changes in technology such as computer based process control do occur. University departments must remain skilled, up to date, and active if the industry is to have the skills it requires. The result of the slow decline in university departments over many years is that there is now a shortage of skilled mineral processing engineers and this is adversely affecting the performance of plants which are crucial in adding value to ores.

The problem is in education but it will not be solved by universities, their priorities are elsewhere. It will only be solved by the mineral industry, in the same way that problems in education which affected industry efficiency were solved by the industry late in the 18th and again late in the 19 century.

Turkey İs an interesting exception to the worldwide trend. There are 22 departments teaching mining and mineral processing in Turkey and there are many excellent students. Some departments rank highly on a world scale in terms of number and qualifications o£ staff. But many departments are small and experience is that a small engineering department *has*difficulty in presenting a high quality course. The concept of finding a mechanism to form larger departments with nodes at several sites which could support strong programs and be attractive to fee-paying students from other countries is interesting in the Turkish context.

3. POSTGRADUATE RESEARCH AND EDUCATION

The mineral industry, like all industries diese days, needs
i - technical specialists to work in plants, research centres and consultancies,
ii - a continuing education system to update the knowledge of engineers on a regular basis after graduation. This highlights the importance of postgraduate research and education which is the main source of training.

Postgraduate work was not common İn mineral processing departments until about 1960 although ore testing had always been important. The problems were that it was difficult to measure the characteristics of mineral particles which have different sizes, shapes and compositions İn such a way that the data accurately reflected some aspect of mineral process behaviour, and to handle size data quantitatively. Flotation was the main topic of research for many years and one reason was that research could be carried out on polished mineral surfaces using pure solutions of reagents.

In the 1950's companies in several countries with strong mining industries recognised the importance of understanding comminution and concentration better and took various initiatives to improve postgraduate research. In Australia the Australian Mineral Industries Research Association Limited (AMIRA) was formed in 1958. One of its objectives was to act as a research broker by setting up and managing projects carried out mainly in university departments and funded on a cooperative basis by companies. The AMIRA approach has been successful both for the research results which have improved plant operations and for the postgraduate training programs which contributed much to technology transfer.

For example in 1961 a project on the modelling of ball mills was sponsored for 3 years at the University of Queensland. The financial support involved initially was small. One research officer and two postgraduate students participated in the project and the modelling and simulation work was based on data collected from plant circuits. The initial project was successful in improving grinding circuit productivity and project extensions have been supported every three years since then. All unit operations İn mineral processing have been covered during the 38 year project life and the economic benefits arising from the research have been very large. Currently about 40 companies sponsor the project which is now international in scope. An important outcome of the project has been the students who have received higher degrees through tlieir research work carried out in plants. After graduation these students are employed by companies and give those companies an excellent knowledge of modern research techniques and of how to apply them to industrial operations and gain maximum economic benefits.

This style of education and research is similar to the style of mining education of 200 years ago when the first schools was set up to train mining engineers. It is funded by industry, it is concerned with plant operations rather than basic studies, and it emphasises the importance of economic outputs. On a broader scale a similar approach to postgraduate research is now being applied widely to government funded science and technology programs in Australia. Government funding for university research has been reorganised and some is now allocated to consortia formed by companies, universities and CSIRO which agree to work on large projects of industrial importance and which provide matching funds. Postgraduate and continuing education teaching programs are an essential part of the work of each consortium. Ten of the 70 consortia which have been formed are involved in mineral industry research.

4. BEYOND 2000

The position has again arisen, as it did in the late 18th and late 19th centuries, that the education needs for mineral processing technology are not being met, this time because the growth of tertiary education has adversely affected small specialist departments. Universities cannot be expected to change their style so the mining industry must decide again, at the end of the 20th century, if its needs for mineral processing engineers are being met and, if not, what should be done about it. The questions are

i - are specialist mineral processing engineers needed ?
ii - what do they need to know as far as formal training is concerned ?
Hi - what can be done to ensure that their training needs are met ?

/ - Are specialist mineral processing engineers needed ?

Opinions vary, particularly about whether mineral processing can be regarded as a branch of some other science or engineering discipline. The important aspect about mineral processing is that İt is closely linked with mineralogy and the geology/mineralogy-mining-processing sequence is an irreplaceable discipline in its own right.

ii- What is needed of mineral processing engineers ?

The list is long but some of the more important characteristics are

a) competency in applied science and mathematics,
b) computer literacy,
c) general knowledge of the mineral industry including
- geology and mineralogy which is relevant to mineral production,
- the main mining, mineral processing, and metal production systems,
- the markets for minerals and metals,

d) good knowledge of the theory and practice of mineral processing, including control and simulation,
e) some knowledge of related disciplines such as biotechnology, instrumentation and remediation,
f) the ability to collect facts fully and without bias, to draw logical conclusions, and to present reports and recommendations, orally and in writing, İn a persuasive and forceful manner,
g) leadership and the desire to improve production operations,
h) some knowledge of public and industrial relations, management and accounting,
i) interest in and knowledge of environmental engineering.

To train engineers so that they are competent in this diverse areas of activity is not an easy task. It highlights the importance of linking small departments into large departments, extending their expertise without increasing the cost of operation, and sharing the teaching load. In this context the role of mineral processing departments in universities now is

a) to provide education at undergraduate level to meet the changing needs of the industry,

b) to present continuing education courses to update the knowledge of graduate engineers who often work in areas which are not easily accessible to universities or centres where courses can be presented to groups,

c) to conduct applied research on topics of importance to industry.

Hi - what can be done to ensure that their training needs are met ?

One way to meet future needs in mineral processing education is to make extensive use of advanced communications technology which includes videoconferencing, email and videotapes. Its advantage is that it enables courses to be delivered wherever and whenever required to classes which may be on university campuses or in centres where continuing education programs are held It removes the limitation of distance, and engineers who specialise in particular topics and live in other cities or countries can deliver lectures without the inconvenience of long distance travel and absence from the normal workplace. A mineral processing education system which utilises modem communications technology would be particularly effective if it includes a worldwide network of universities which specialise in different areas of the topic.

It is possible to envisage the formation of "virtual' mineral processing departments which would have several nodes at different universities, preferably in different countries because the main mining companies now operate in several countries. The 'virtual' departments would have much greater flexibility to specialise than departments do now and they could augment lectures delivered by their staff with courses taken from other 'virtual' departments or from specialists not associated with universities. Costs would be associated with external lectures and diese 'virtual' departments would be expected to receive part of their funds from non-government sources.

The different 'virtual' departments would inevitably produce graduates with different skills, some may concentrate on technical skills and others on a mix of technical and management. There are many possibilities and the result would be a good range of skills available to the mineral industry. This is now occurring in postgraduate study and there İs no reason why it should not occur in undergraduate study.

What are the disadvantages? There are a few. The first is the necessity for access to videoconferencing. A few years ago this was a major problem. Now satellites and high speed cables make it widely available and at a decreasing cost. The second is the necessity for departments in different universities to collaborate. This is where the mineral industry needs to become involved and to make its opinion clear. The Australian Mining Council recently undertook a long investigation into the current state on mining and mineral processing education in Australia and on its needs for the future. It published a report entitled 'Back from the Brink' İn which important changes in mining and mineral processing education were recommended. This report should be of interest to all mining countries and to universities involved in mining and mineral processing education.

5. CONCLUSION

Universities cannot be expected to take the initiative as far as changes in mineral processing education are concerned, other problems have priority. The initiative for change must be taken by Chambers of Mines or professional Institutes and must involve wide ranging changes in the objectives of courses and style of course delivery. The opportunity and incentive exists now to change the style of mineral processing education so that it will meet industry needs for the next 50 years. It is important that this should be taken.

There will be a cost involved but the cost will be much less than the penalty if mineral processing skills are not maintained at the highest level.