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MINING ENGINEERIN EDUCATION IN IRAN AND THE WORLD

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ABSTRACT

Many developing countries have significantly increased the number of tertiary institutions and their students in the past few decades. These rapid expansions, among all the benefits, have drawbacks as well. An example is the status of mining engineering education in Iran. Presently, the number of active mining engineering departments in Iran (27) is more than the sum of similar departments in Canada, Australia, UK and South Africa (23 altogether). Also, the annual mining graduates of Iran (645) are more than the cumulative graduates of USA, Canada, UK and Australia (613). The expansion of mining engineering education in Iran has coincided with the closing or merging of similar departments, as well as a decline in the number of interested students in the industrialized world. The present study shows that the need for development and the excessive number of high school graduates, resulting from of high population growth in the early 80's, are the two prime factors influencing the significant expansion of mining engineering education in Iran.

Key words: Education, Mining Engineering, Iran, Developing Countries

INTRODUCTION

Growth in developing countries depends substantially on the availability of workers with relevant and quality skills. They also show that technical progress is becoming a more important determinant of output growth as economic growth proceeds. Universities can be an important supplier of such skills through the courses offered and an important source of technical progress through their research.

Higher education is a prerequisite for sustainable development (UNESCO 1997, 1998). Each university program should have defined objectives and a system of evaluating its success, which in part reflects the readiness of students for their future involvement in industry. The quality of higher education can be controlled through internal control of academic programs, government regulations, market mechanisms and accreditation. On the other hand, the quality of a higher education institution is determined by its resources (human and material), learning/

teaching process, and the quality of its products (graduates, research and service) (Tadjudin, 2001).

Iran, since its revolution of 1979, has been developing a centralized higher education system. Independent organizations, similar to the US Accreditation Board for Engineering (ABET 1998, 2001) and the Canadian Engineering Accreditation Board (CEAB, 2001 & 1999) have not been active in Iran and almost every aspect of education, ranging from accreditation of programs, to decisions about the number of students, as well as evaluation of universities offering mining, has been planned and supervised by the government.

Different areas of reform have been suggested in recent years, providing incentives for public institutions to diversify sources of funding, redefining the role of government in higher education, and introducing policies unequivocally designed to give priority to the quality and equity objectives. During this time there has been excessive expansion of higher education institutes and a significant increase in the number of mining engineering students and graduates.

State operated mines and agencies of Iran have been the main source of jobs for mining engineering graduates, for the past few decades. Based on the objectives of Third Five Year Cultural and Socio-Economic Development Plan, initiated in the year 2000, the trend to privatization of the Iranian mining industry has been accelerated. In 1999, of the 2436 operating mines, 2027 mines were run by the private sector, excluding sand and gravel, decorative stones, and rubble stone mines (SCI, 2001). So far, most of the private mines are relatively small in size, with no fulltime mining engineer in charge.

The results of a research, carried out for the Ministry of Industries and Mines of Iran during 1999-2000 is presented in this paper. Statistics derived from more than 150 questionnaires completed by mining students and professors of different universities; reveal some of the major pitfalls of mining engineering education in Iran. During the course of this study mining education also has also been studied in ten selected countries (US, Canada, Australia, UK, South Africa, Finland, Bulgaria, Chile, India and Pakistan) and the results have been used to evaluate the state of mining engineering education in Iran (Memarian, 1999).

A database for mining, metallurgy and material education in Iran, has been prepared as part of present research (Memarian, 2000). This database stores a wide variety of information and covers different aspects, such as: details about accredited degree programs, universities and other higher education institutes offering mining and material education, as well as statistics on their academic members and graduates. This database has been used by the Ministry of Industries and Mines of Iran since mid-2001.

HIGHER EDUCATON IN IRAN

So far, higher education in Iran has been free of charge, although a few private universities charge tuition fees. Since the revolution of 1979, Iran has been developing a centralized higher education system, where all the university programs are designed and accredited by the Ministry of Science, Research and Technology (MSRT). The Board of Planning for higher education programs of different disciplines normally consists of university professors, as well as representatives from the mining industry and the ministry. New regulations, which have been introduced recently, are going to give some autonomy to more established universities, which would enable them to modify (diversify) the present programs (MSRT, 2000).

After the revolution of 1979, all the universities and other higher educational institutes of Iran were closed for more than two years during the Cultural Revolution. In 1982, the first post revolution private higher education institution, IAU (Islamic Azad University) opened in Tehran and shortly spread its activities to almost all other cities of Iran. Since 1983 and the reopening of universities, many new state-ruled higher education institutes have been opened and consequently the number of students and graduates have been increasing significantly. The number of Iranian students (175,675 in 1979) has increased more than 80 times in about 20 years. In the academic year 2000-2001, a total of 1,573,322 students registered in Iranian higher education institutes (Table 1). More than half of students are attending IAU University (Table 1). About 21% of these students registered for Associate Diploma degree, 71% for Bachelor degree and about 8% for masters and PhD programs (Table 1).

Admission to post-secondary institutions in Iran is through a nation-wide entrance examination, and only a small portion of the huge number of applicants can pass this barrier. Although all Iranian universities work at full capacity, demands for post-secondary education far exceeds supply. In the year 2000, a total of 178,596 new students were admitted into Iranian universities and other tertiary institutes of the public sector. In this year, for the first time the number of newly accepted female students exceeded the number of males. Since the mid 90's almost 50,000 Iranian post secondary students were studying abroad, of which about 4000 were sponsored scholarship students. Most of the later group, who have returned to Iran, are now teaching at universities and other higher education institutes.

Academic year of Iran consists of two terms and a summer session. Each term is 17 weeks and the summer session is 6 weeks. Each theoretical credit is 17 hours of class, each practical or lab credit is 34 and each training or workshop credit is 51 hours.

ENGINEERING EDUCATION IN IRAN

The establishment of Tehran University in 1934 marks the birth of modern engineering education in Iran. The Engineering Faculty of Tehran University commenced its activity by registering 40 students in four departments of Civil, Mining, Mechanical and Electrical Engineering. A good part of the early academic staff of Engineering Faculty was professors hired from European countries. For a few decades Tehran University remained the only higher education institution of Iran offering engineering programs.

The number of universities offering engineering courses, as well as the diversity of accredited programs has been extensively increased during the past two decades. Presently, more than 20% of Iranian students are studying engineering. The number of graduates of the engineering programs of Iran, in the year 2000, was about 52,000 (Table 1).

The four levels of tertiary engineering education offered in Iran are: a 2 year Associate Diploma (ASs), a 4 year Bachelor of Science (BSc), a 2 year Master of Science (MSc) and a 3-4 year PhD. The courses of ASc and BSc programs are divided into four groups, namely: general, basic science, basic engineering and specialized engineering (Table 3). The general courses, and to some extent the basic science courses, are almost similar for all engineering programs.

MINING ENGINEERING EDUCATION

Different aspects of mining education were considered, namely: institutes offering mining courses, accredited programs, and academic members of mining departments, and students and graduates. These issues are briefly discussed below.

Mining Departments

For almost four decades Tehran University was the only institute offering mining engineering education. In the mid 70's two other universities (Amir kabir Tech. and Esfahan Tech.) started to offer similar programs. The number of higher education institutes, active in mining engineering education has increased significantly in the past two decades (Figure 1). Presently 17 state-ruled universities are offering mining programs. The private IAU university, which has commenced mining education in 1985, is also offering mining in 12 of its branches, which are spread all over Iran (Figure 1). In 2001, mining education was available in almost half of the 28 provinces of Iran. Under a new program, recently released by MSRT, specialized centres (poles), with extra research funds, are going to be established for different disciplines. In this respect, the Department of Mining Engineering of Tehran University was selected as the centres for mining, with research concentrated on rock engineering and mineral processing.

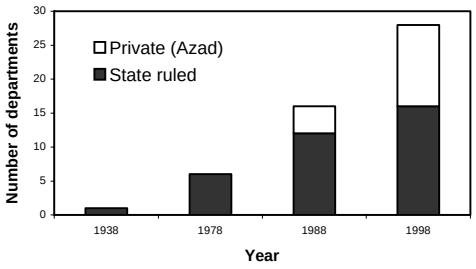

Figure 1. The expansion of Iranian tertiary institutes in mining engineering education

Study programs

Prior to the revolution, each university had the authority to develop its own programs, although one or two other existing mining departments followed the Tehran University curriculum. Since the reopening of universities in 1983 and the introduction of the centralized higher education system, the Mining Committee of the Board of Planning of MSRT has accredited 22 programs, of which 12, 3, 6 and 1 are ASc, BSc, MSc and PhD programs, respectively (Table 2).

The two main accredited BSc level mining engineering programs of Iran are exploration and extraction. A total of about 2900 hours have been allocated to direct education in 64 courses (138 credits) of these programs, of which 70 % are theoretical lecture hours and the rest is practical and lab work (Table 3). BSc students must also pass two sessions (300 hours each) of summer practice in the mining industry.

Exploration, Extraction, Mineral processing, Rock Mechanics, Petroleum Exploration and Exploitation are the six accredited masters programs of Mining Engineering. Mining education at the PhD level has been recently started in Iran and its first graduate entered the job market after the year 2000. Presently the mining engineering curriculum of Iran is significantly influenced by similar programs in Canada, US, UK and Australia. Comparing the mining programs of Iran with what is presently offered in these countries reveales a close similarity between them (Memarian, 1999).

Faculty members

The first teacher of mining engineering in Iran was professor Kock from Austria, who was hired in 1934. Soon, Iranians who had graduated form European Universities (mostly from France and Germany) joined the newly established

department. Presently, about 100 faculty members are teaching in 13 mining engineering departments of public sector. Of these 4% are professors, 6% are associate professors, 40% assistant professors, and the rest are instructors (Memarian, 1999). The new generation of academic members of mining engineering departments are mostly graduates of PhD programs in Canada, Australia, UK and US.

Graduates

The first four Mining Engineers of Iran graduated from Tehran University in 1938. In 40 years of mining education prior to the Islamic Revolution, a total of 454 mining engineers were trained in Iran and they all graduated from Tehran University (Figure 2). In less than two decades after the revolution, the number of graduates increased to 5377 (Figure 2). Presently, about 700 mining engineers graduate annually in Iran, of which 63% are from 17 state-ruled universities and the rest are the graduates of IAU University. About half of those institutes active in mining education, have started offering mining programs in recent years, hence had little output up to year 2000. The graduates of these departments will soon impose another jump on the already ascending curve of mining graduates (Figure 2). Only one woman received a mining engineering degree, prior to 1979. Since the mid 90's and a total removal of the ban on girls studying mining, the number of female graduates of mining engineering is growing rapidly.

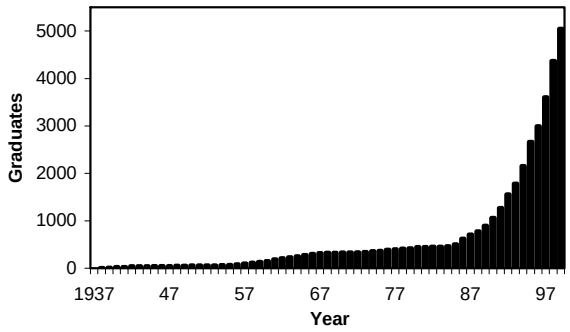

Figure 2. Cumulative diagram of number of graduates since the establishment of Mining Engineering education in Iran

5. DISCUSSION

In the past two decades, higher education in Iran has been experiencing a significant expansion, similar to what some other countries have found in the past. For example in the 1960's, the government of Australia realized that mental capital was the key to future economic success, so they expanded the student population at universities immensely (Lynch, 1998). Comparisons of the state of mining education in Iran with selected countries, from different continents, reveal some interesting points.

In North America 25 universities are offering mining engineering programs. In the US, 16 accredited mining departments, with a total of 80 faculty members (44 Professors, 29 Associate Professors, and 7 Assistant Professors), were active in 1997. The number of BSc, MSc and PhD graduates of these departments, in the academic year 1999-2000 were 153, 21 and 11 respectively (Tables 4, 5). In the US, the majority of postgraduate students are not American. For example, in the year 2000, only 8 of 45 PhD students and 32 of 85 MSc students were originally American. Two current problems of mining education in the US are: decline of research funds and higher ratio of full professors (which soon will be retired) to associate and assistant professors (Kramis, 2000).

In year 2000, nine Canadian universities were active in mining engineering education (Tables 4, 5). The full time and part time academic members of mining departments of these universities are 58 and 38 respectively. In this year 177 mining engineers graduated from these departments (Archibald, 2000). Here again, a good number of graduates are not Canadian. In Canada, the ratio of mining students to full time professors is 11 and considering the full time and part time professors is as low as 7. In recent years, the number of annual graduates of mining departments have exceeded the number of newly registered students (Archibald, 2000) leading to a steady decline in enrollment number.

Only six mining engineering departments, with 30 academic members, are operating in Australia. In 1977, a total of 196 mining engineers graduated from these departments, of which 21 were MSc and PhD graduates (Lawson, 1977). A recent study in Australia showed that only 3 mining departments are sufficient to satisfy the present rate of graduation (Galvin & Roxborough, 1997, Golosinski 2002). Although the Australian job market requires more mining engineers than currently graduate from existing universities, the tendency of high school graduates to study mining is not increasing (Galvin & Roxborough, 1997).

About 90 universities on the European continent and 30 universities in EU countries are offering mining engineering education. The annual mining graduates of EU universities, is estimated to be about 450-600 (SMP 12, 1998). With the introduction of new mining technologies and reduction of mining activities in recent years, the number of mining departments is gradually decreasing in EU countries. For example in the UK, after a period of merging some departments, presently only 4 universities are active in mining education (Shaw, 1998). In the academic year 1999-2000, these departments had 176 undergraduate students, a number of whom were from other countries (Tables 4, 5). In recent years, two major pitfalls of mining education in UK have been the declining number of new students as well as the absence of government founding and the minute amount of funds from industry (SMP 15, 1999).

In South Africa two universities and two other higher education institutes are offering mining education (Table 4, 5). In the past decade, about 38 students graduated annually from these two universities (Phillips, 1999).

And finally from Asia, the example of Iran is presented in this article. Comparing the statistics of mining education in Iran with the above examples shows that the number of active mining engineering departments of Iran (27) is more than combined number of mining departments in Canada, Australia, UK and South Africa (23) (Figure 3). Similarly, the number of annual BSc graduates from Iranian mining departments (645) is more than the total of graduates of US, Canada, Australia, and UK combined (613) (Figure 4).

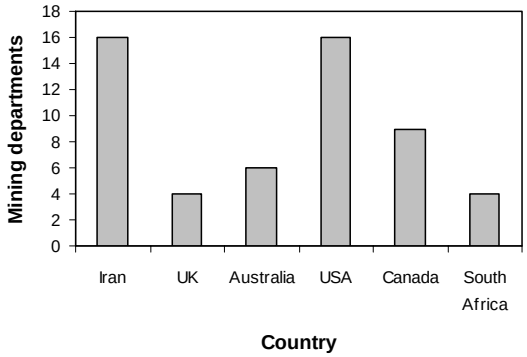

Figure 3. Comparison of the institutions active in mining engineering education in selected countries

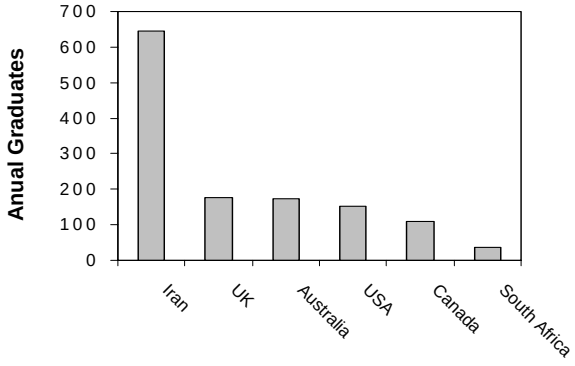

Figure 4. Comparison of the number of mining engineering graduates in selected countries

The obstacles against mining engineering education in a developing country like Iran is different from those of the industrialized world. Declines of first year registration and the lack of funding, especially from government, are the two major pitfalls of mining education in most western countries. The consequences of these trends are the closure of some departments and layoff of faculty members and support staffs. In Iran, in spite of the recent expansion of higher education, the number of applicants far exceeds the available seats. Mining departments are still employing new faculty members, mostly amongst those sponsored scholarship students who had been sent abroad by the Iranian government in the past two decades. On the other hand, a part of untouched allocated research funds of some universities, is retuned to the government at the end of each fiscal year.

The two major factors responsible for the high number of students and graduates in Iran are the determination of the country to expand higher education and the pressure from the ever-increasing number of high school graduates who fail to find a decent job. After the 1979 revolution, the population growth rate of Iran had jumped to a high annual rate of 3.6%, increasing almost 1% from the previous decade (ISC, 2000). Although the population growth has been notably decreased since then, and is presently claimed to stand below 1%, the population wave produced in the early 80's recently hit the Iranian universities and job market. Two consequences of this fact are the long queues of those wanting to enter universities and the 16% rate of unemployment amongst university graduates, which was as low as 4% before the revolution (ISC, 2000).

Soon this bulb of population will have completed university and the declining numbers of applicants, will make it possible to take proper measures to overcome some of the existing problems. Among these relieving measures are: a) reducing the number of available seats in mining departments, b) merging existing departments to create fewer but more powerful centers, c) specializing each department in a specific field, d) correcting the present ratio of students to professors, e) leaving more spare time for academic members to spend on research, and scientific promotion, and f) developing a system of independent accreditation.

CONCLUSIONS

1. The number of active mining engineering departments in Iran (27) is more than the sum of similar departments in Canada, Australia, UK and South Africa (23). Also, the annual mining graduates of Iran (645) are more than the cumulative graduates of USA, Canada, UK and Australia (613).

2. The motivation of the country for development and the excessive number of high school graduates, which are the results of a bulb of high population growth in early 80's, are the two prime factors, influencing the significant expansion of mining engineering education in Iran.

3. Reducing the number of seats for new students, merging smaller departments, and developing a system of independent accreditation, are some of the

main issues that should be considered to make a balance between the needs of industry and the mining graduates.

Table 1. Iran's higher education statistics in 2000-2001 (MSRT, 2001; ISC, 2001).

	Field of study	Higher Institutions	A.A./ A.S.	B.A./ B.S.	M.A/ M.S.	PD	PhD	Total	
Students	All Fields	Public	142,030	512,161	32,287	39726	10,869	737,073	1,573,322
		IAU*	189,362	600,307	34,205	12,375		836,249	
	Technical & Engineering	Public	69,166	74,450	9,323	-	1,251	154,190	352,742
		IAU	69,475	124,793	4,123	161		198,552	
Graduates	All Fields	Public	40,563	69,330	6,866	4,110	1,749	122,618	263,,275
		IAU	31,007	102,288	6,335	1,027		140,657	
	Technical & Engineering	Public	18,790	10,502	1,914	-	68	31,274	51,931
		IAU	7,186	13,004	467	0		20,657	

* Privately owned university

Table 2. Specifications of mining engineering programs (MSRT, 2000)

	A.Sc.	B.Sc.	M.Sc.	Ph.D.
Accredited programs	12	3	6	1
Number of courses	28-97	40-64	12-14	8-10
Number of credits	68-72	130-140	32	44-51
In school educational activities (hours/program)	1600-5747	2134-2980	391-527	357-408
% of practical activities	43-52	36-41	0-7	0

Table 3. Relative activities of the B.Sc Mining Engineering in Iranian universities.

Knowledge area	Number of Courses	Hours of education		% of activities
		Theoretical	Practical	
General (Humanity, …)	10	306	68	13
Basic Science (Math, Physics, …)	13	476	136	21
Foundation Engineering (Static, Dynamic,..)	20	678	323	35
Specialized Engineering (Excavation, Ventilation)	17	459	306	26
Electives	3	102	34	5
Project	1	-	-	-
Total	64	2021	867	100

Table 4. Universities offering Mining Engineering education in selected countries

USA (16)	Alaska (Fairbanks), Arizona, Colorado School of Mines, Colombia, Idaho, Kentucky, Michigan Tech., Missouri (Rolla), Montana Tech, Nevada (Reno), Penn State, South Dakota, South Illinois, Utah, Virginia Tech, West Virginia.
Canada (9)	British Columbia, Alberta, Laurentian, Toronto, Queen's, McGill, Ecole Polytechnique, Laval, Dalhousie.
Australia (6)	Ballarat, Curtin Tech., Queensland, New South Wales, South Australia, Wollongong.
UK (4)	Imperial College, Leeds, Nottingham, Exeter
South Africa (4)	Witwatersrand, Pretoria, Technikon Witwatersrand, Technikon S.A.
Iran (23)	Tehran, Amir kabir, Bahonar, Shahroud, Esfahan Tech., Abadan Tech., Esfahan, Tarbiat Modares, Imam Khomeini, Sahand, Yazd, Birjand, Arak, IAU (ten branches).

Table 5. Comparison of socio-economic situation and mining engineering education in selected countries [1].

	USA	Canada	Australia	UK	South Africa	Iran
Population (million)	280	31.6	19.4	59.6	43.6	66
Population below poverty line (%)	12.7	-	-	17	50	53
Literacy (%)	97	97	100	99	81.8	72
Inflation rate (%)	3.4	2.6	1.4	2.4	5.3	16
Unemployment rate (%)	4	6.8	6.4	5.5	30	14
Budget (billion US $)	1828	126	94	555	31.1	27
Export (billion US $)	776	272	69	282	30.8	25
GDP – per capita (US $)	36200	24800	23200	22800	8500	6300
Number of institutes offering mining education	16	9	6	4	4	27
Duration of B.Sc. programs	4	4-5	3-4	3-4	4-5	4
Academic members of Mining Departments	76	58	30	-	-	53*
Number of undergraduate students	417	512	-	-	200	>2800
Number of postgraduate students	130	132	44	-	-	>130
Number of annual graduates (BSc)	153	109	175	176	38	645
Number of annual graduates (MSc & PhD)	32	33	21	-	-	35

1. Data have been gathered from different national and international sources (see bibliography). To ease the comparison, the socio-economic data have been rounded to the nearest number. Some of these data are best estimates. Statistics of different countries are from years 1998, 1999 and 2000.
* Excluding the number of academic members of IAU University.
- Data are not available

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