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Multinational Programming and Operational Centre
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States

Assessment of Skill Deficiencies in the Mining Industries of Eastern and Southern Africa

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A survey to assess the skill deficiencies in the eastern and southern African subregion has been undertaken by the Lusaka-based ECA/MULPOC. The survey was conducted at the request of the member States and within the programme of work and priorities of the MULPOC. It covered eight countries, namely: Botswana, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe. The countries were chosen so as to include a broad spectrum of characteristics of the national industries of the subregion.

Role of Mining in the Subregion

The importance of mining to the subregion, particularly in Southern Africa, has been highlighted from the socio-economic perspective and relevance of the human factor. The industry accounts for 60% of foreign exchange earnings, 10% of the GDP and employs about 5% of total wage earners in the SADC region. The industry is also a significant consumer of utilities, such as electricity, and through coal fired power stations, contributes to a large amount of the electric energy generated. It further contributes the largest share to both internal and export movements of cargo on the railway system and has been responsible for infrastructural growth especially in the mining countries. The industry is a major contributor to the social sector providing hospitals, schools and community-based services.

Despite the socio-economic prominence of the industry, it operates within a number of business constraints such as the high capital intensity of the industry, its sensitivity to input costs and the intense competition it faces in the global minerals commodity markets. Thus to maintain global competitiveness, the subregional industry must have access to a sustainable supply of high quality skills and competencies. The large labour force in the industry is a cost which must be affordable and yet deliver globally acceptable operational practices with high levels of labour productivity. The high capital stock of the industry demands skills able to interface with technology over a broad range of sophistication, while the long gestation period of mining projects require management with a longer term focus. These factors emphasise the intense need for skilled manpower in the subregional mining industry.

The Context of Mining Skills

The range of skills covered by the survey relate primarily to the production environment in mining, mineral processing and extractive metallurgy. In addition to these "core" skills, the report considers support skills in mine surveying, geological, chemical and plant and equipment maintenance services. These are critical to maintaining production operations. The broad elements which define skilled manpower include technical knowledge, administrative, management and competency aspects. The elements are acquired through academic education and industry-based training. The most important aspect is the integration of the skills and competencies into a defined career path within the corporate structures of the industry.

Profile of Mining Skills in the Subregion

South Africa is the biggest repository of mining skills in the subregion, although the other mining countries, namely: Botswana, Namibia, Zambia and Zimbabwe show high levels of skills. Overall, these five countries contribute some 99% to the total number of skilled manpower in the surveyed countries. The report observes that the skill base in Malawi, Mozambique and Tanzania is small. Aggregately, the largest presence of skills is in the maintenance engineering sector, a factor which reflects the capital intensity of the industry. Mining engineers are also more abundant than mineral processing engineers and geologists in that order, while at technician level, mining technicians are the largest group followed by mineral processing technicians. Geological, mine surveying and chemical technicians are not as abundant.

Comparatively, Botswana and Namibia show the highest concentrations of skilled manpower per 1,000 industry workers, while Malawi shows low ratios with the exception of geologists for which it has the highest number per 1,000 employees in the subregion. In terms of absolute deficiencies, Botswana has deficits for mining engineers, geologists and geological technicians. There is also a high level of expatriate manpower in Botswana's mining industry. In Malawi, there is a shortage of skills at all levels due to the historical lack of a mining industry. In Mozambique, the State mining enterprises, traditionally the major employers, show diminishing levels of skills both in quantity and quality. Namibia faces severe shortages of skilled manpower at all levels in the

Government sector. In industry, there is a large presence of expatriate skills. Tanzania has an abundance of geologists and mining and geological technicians. Technical practice has been observed to be weak due to a lack of competency definition. South Africa shows deficiencies in the professional categories of mining, geology, mineral processing and extractive metallurgy but not in diploma level skills. South Africa also places emphasis on competency-based skills. Zambia shows deficits for mining engineers, geologists and geological technicians but is over employed in mining and mineral processing technicians. The country shows weaknesses in the quality of skills probably due to the lack of competency-based qualifications. The expatriate labour force is also increasing. Zimbabwe shows lower than expected numbers of skilled manpower for the size of the industry. This is probably due to the large skill-deficient small scale sector.

The major developments in the sector likely to influence the quantum of skills relate primarily to the increased levels of exploration and potential mine development led by the private sector. Although exploration has increased in all countries in the subregion, it is too soon to witness many major mine developments. More notable, however, is the fact that exploration and mine development has been increasingly undertaken by mining corporations from the subregion.

On the basis of current employment levels, exploration efforts and mine development, extrapolations of the demand for skilled manpower for the next five years are presented. The major features of the demand distribution are that South Africa accounts for about 74% of the total requirement for skilled manpower and that demand is generally concentrated in the major mining countries. With respect to specific skill categories, the demand is high for mining engineers, geologists, mineral processing engineers and extractive metallurgists in that order. However, the largest demand is for maintenance skills at both engineer and artisan levels.

The level, and availability, of specialised skills for the small scale mining sector, and in areas such as research and development, mine planning and design, geostatistics and mineral reserve estimation, mineral economics, mineral process design and project engineering are absent in the majority of the countries in the subregion. Skills for Government administrative functions, such as monitoring mine safety and the environment, implementing mineral

legislation and understanding both the technical and business side of mining operations, are also weak. Further weaknesses are visible in mining law, contract negotiating, financial analysis, and mineral tax implementation. This is more so for countries undergoing privatisation of the industry, such as Mozambique, Tanzania and Zambia, and historically non-mining countries like Malawi.

Mining Skills Development Facilities

Facilities for the development of mining skills at all levels, namely degree and diploma programmes and academic and in-company training schemes, are concentrated in three countries in the subregion. These are South Africa, Zambia and Zimbabwe. The output of the academic institutes indicates a shortfall for the degree programmes in mining engineering, geology and metallurgy and mineral processing. At technician level, output is numerically closer to demand projections. South Africa is the biggest source of both professional and technician level skills. The country possesses the largest and most comprehensive facilities, followed by Zimbabwe and Zambia.

Outside the three countries, technical training is available only in a few selected disciplines and in only a handful of countries. The most common is the geology degree programme while mining and geology diplomas are offered by one or two countries. Generally, the academic facilities are poorly funded, thus diminishing the quality of education they offer.

Industry participation in skills development takes several forms. In the major mining countries, in-company training schemes are common but not in the non-mining countries. The in-company training schemes are offered at artisan, supervisory and management levels in addition to graduate integration programmes. The lack of organised in-company training schemes, which are integrated into performance appraisal and career pathing, is largely responsible for the poor technical and management practice in the non-mining countries. Other forms of industry participation include support to academic institutes such as funding research equipment and programmes, and subsidising staff salaries. In South Africa, where industry support is strongest, academic institutes derive 60-80% of their operational budget from industry which also funds virtually all research programmes. A significant role in which industry is

involved in South Africa and Zimbabwe is the administration of competency-based training through the Chambers of Mines.

Opportunities for developing the specialised skills are limited. Geochemistry, geophysical and exploration geology courses are available at MSc. levels in Tanzania, South Africa and Zimbabwe. Mining specialisation in rock mechanics, mining geology, mineral economics, mine environment, production management and geostatistics can be undertaken in South Africa and Zambia as part of an MSc. programme or short courses building up to the Graduate Diploma in Engineering (GDE). Small scale mining oriented training is mostly absent. Token training is available in Zambia and Zimbabwe.

Agenda for a Harmonised Skills Development Strategy

The agenda proposes the following measures:-

a) addressing the numerical insufficiency by expanding intake at existing institutions and introducing a quota system to accommodate more students from the subregion. Academic education should also be up-gradable from diploma, to higher national diploma and to degree level. Arrangements to admit science graduates could also improve numbers;

b) academic institutions must be strengthened to improve the quality of graduates. Governments must improve their material support to institutes and find innovative ways of providing funding such as company rebates or using funds raised from mineral royalties;

c) industry must strengthen its role in supporting academic training such as maintaining well-structured in-company training schemes, awarding bursaries, funding research equipment and programmes and supplementing academic staff salaries;

d) skills and competencies should be unified in the subregion. This requires a SADC-wide integrative framework to identify, define and administer the competencies. A SADC Mining Industry Qualifications Board, composed of representatives of Chamber of Mines, academic institutes and SADC, is proposed. Unification of competencies makes sense due to the fact that

the major mining companies operating in the subregion are mostly from within.

e) unification of skills and competencies would lead to the free mobility of skilled manpower in the subregion. This would strengthen the case of subregional integration but would render redundant traditional notions of who is an expatriate. This may require an adjustment of attitudes.

f) Governments' mining departments must be strengthened to better cope with the private sector in their regulatory and promotional role. UN departments, including ECA, should provide technical support to build capacities in planning, management and monitoring of mining operations.

g) small scale miners must be empowered through practical non-academic courses in technical, financial and business management areas. There is also need to increase the availability of specialised training such as planning and design courses, rock mechanics and geostatistics. These courses are best offered in short modular form to enable attendance by the largest number of practising engineers.

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LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AAC	-	Anglo American Corporation
ADB	-	African Development Bank
BCL	-	Bamangwato Consolidated Limited
BHP	-	Broken Hill Proprietary Corporation
Bot.	-	Botswana
Cartog/D'men	-	Cartographers/draughtsmen
CDC	-	Commonwealth Development Corporation
CDM	-	Companhia de Desenvovimento Mineiro
Chem.	-	Chemistry, Chemical
CIDA	-	Canadian International Development Agency
CMC	-	Caledonia Mining Corporation
COMZ	-	Chamber of Mines of Zimbabwe
CSES	-	College of Science and Engineering Scheme
CSIR	-	Council for Scientific and Industrial Research
DFR	-	Diamond Field Resources
ECA/MULPOC	-	Economic Commission for Africa/Multinational Programming and Operational Centre
Eng.	-	Engineer, engineering
Exp., Expat	-	Expatriate
GDE	-	Graduate Mining Engineer
GDP	-	Gross Domestic Product
GFN	-	Gold Fields of Namibia
GFM	-	Great Fitzroy Mines
GFSA	-	Gold Fields of South Africa
GME	-	Government Mining Engineer
GPL	-	Geras Pedras Lapidadas
g/t	-	Grams per ton
HND	-	Higher National Diploma
Indust.	-	Industry, industrial
Int'l	-	International
IDC	-	Industrial development Corporation
ISCOR	-	Iron And Steel Corporation
ISTP	-	Interim Short Term Plan
JCI	-	Johannesburg Consolidated Investments
JSE	-	Johannesburg Stock Exchange
Km	-	Kilometre
Lab.	-	Laboratory
Mal.	-	Malawi
Met.	-	Metallurgy
Min. Eng.	-	Mining Engineer
Min. Proc. Eng.	-	Mineral Processing Engineer

MIQF	-	Mining Industry Qualifications Framework
MMMD	-	Ministry of Mines and Mineral Development
Moz.	-	Mozambique
MRU	-	Mineral Resources Unit
MW	-	Mega Watts
Nam.	-	Namibia
NAMCO	-	Namibian Mining Corporation
NCCM	-	Nchanga Consolidated Copper Mines
ODMC	-	Ocean Diamond Mining Corporation
PATS	-	Pre-Apprentice Training Scheme
PABS	-	Pre-Apprentice Bridging Scheme
PBS	-	Pre-University Bursary Scheme
Prodn	-	Production
RCM	-	Roan Consolidated Mines
RDP	-	Reconstruction and Development Plan
Res.	-	Resources
RTZ	-	Rio Tinto Zinc
SA, RSA	-	Republic of South Africa
SAECI	-	South African Explosives and Chemical Industries
SADC	-	Southern African Development Community
SADCC	-	Southern African Development Coordination Conference
STAMICO	-	State Mining Corporation
TAMIDA	-	Tanzania Mineral Dealers Association
Tanz.	-	Tanzania
TAZARA	-	Tanzania Zambia Railways Authority
TCL	-	Tsumeb Corporation Limited
UNDP	-	United Nations Development Programme
UNRFNRE	-	United Nations Revolving Fund for Natural Resources Exploration
UNIDO	-	United Nations Industrial Development Organisation
UNU/INRA	-	United Nations University, Institute for Natural Resources in Africa
Vac.	-	Vacancy, Vacancies
VOME	-	Village Orientation and Mineral Exploitation
Zam.	-	Zambia
ZCCM	-	Zambia Consolidated Copper Mines
Zim.	-	Zimbabwe
ZISCO	-	Zimbabwe Iron and Steel Corporation
ZMDC	-	Zimbabwe Mining Development Corporation

I. INTRODUCTION

The Eastern and Southern African subregion, particularly the southern African part, is well-endowed with minerals whose exploitation can form the basis for socio-economic advancement. The subregion possesses the world's largest resources of alumino-silicates, chromimium, gold, manganese, platinum-group metals and vanadium. In addition, the region boasts of large reserves of copper, iron ore, coal and many other minerals. In recognition of this mineral wealth, many governments in the subregion, including both the traditional and non-traditional mining countries, have placed increasing emphasis on the mineral industry to underpin the current processes of economic reconstruction and development. However, the majority of the countries in the subregion face serious shortages of skills and competencies with which to achieve this.

The current levels and quality of skills and competencies in the subregion are not fully known outside the national mining sectors. Furthermore, the distribution and adequacy of education and training facilities for mining skills have not been fully investigated. A 1986 SADC study on skilled manpower remains to-date the only significant effort undertaken to quantify the numerical levels of skilled manpower in the mineral sector. However, the relevance of the study has been superseded by:-

(a) the passage of time which has rendered a number of the projections inaccurate;

(b) the changed scenario in which the private sector, rather than State-owned companies, is the driving force in the industry;

(c) the democratization of South Africa which has provided hope of new investment in the subregional industry and added impetus to the spread of good management and technical practices.

More recent SADC efforts by the Human Resources Development Sub-Committee of the Mining Sector have identified a number of project areas to improve the stock of skills in the region's mineral sector. The major problem, however, remains the fact that recent data and trends on which a harmonised and informed plan of action for the sustainable delivery of mining skills can be based, is significantly missing.

At the request of the member States, and as part of its programme of work and priorities, the Lusaka-based ECA/MULPOC has recently conducted a survey to assess deficiencies in skills and competencies in the eastern and southern African subregion. Eight countries were included in the survey. These were Botswana, Malawi, Mozambique, Namibia, Tanzania, South Africa, Zambia and Zimbabwe. The countries were deliberately chosen taking into account a spectrum of characteristic features of the national industries. These include the resource endowment, size of the industry, its level of development and whether it is dominated by State or private enterprises. Missions were undertaken to these countries over a period of time and questionnaires distributed through the Ministries responsible for mining activities.

This report contains the findings of the survey. Among the major issues the survey has assessed are: the available quantum, type, distribution and quality of skilled manpower; the major trends in the sector and their impact on the equilibrium of skilled manpower; and the internal capacities of each country to provide skilled manpower to the mining sector. The major findings of the survey are that all countries in the subregion face numerical deficiencies in skilled manpower of varying degrees. The non-mining countries are particularly disadvantaged in redressing these deficiencies due to the uneven distribution of skilled manpower development facilities. The positive outlook, however, is that the facilities are sufficient for current subregional needs. Some of the countries have weak technical and management practices. The point has been made that the spread of uniform competencies could help arrest this. Above all, the concept of networking and establishing equitable and effective partnerships among Government departments, training institutes and private enterprise has been recommended.

Much care has been taken to ensure that information given in this report is correct. However, comments and corrections are invited. These should be submitted to the Lusaka-based ECA/MULPOC.

II ROLE OF MINING IN THE SUBREGION

The socio-economic factor

To understand the context, role and relevance of mining skills

to the subregion, it is necessary to examine the socio-economic perspective of the industry. Mining is a major economic activity in the eastern and southern African subregion. This is particularly the case for the SADC countries in which it accounts for an average of US$15 billion or 60 per cent of foreign exchange earnings, 10 per cent of GDP and employs about 5 per cent of the total wage earners in the formal sector (1,2). Table 1 shows the contribution of mining to the economies of selected countries covered in this survey. It is clear that in at least five countries of southern Africa, namely: Botswana, Namibia, South Africa, Zambia and Zimbabwe, mining is probably the most important sector in the national economies. In these countries, the industry is a dominant foreign exchange earner, a large employer, a significant contributor to the GDP and to the national tax revenue.

Table 1: Economic contribution of mining for selected countries of the subregion

COUNTRY	Estimates of Mining Output as a percentage of			Approximate Labour Force
	GDP	EXPORTS	EMPLOYMENT	
Botswana	40	90	6	13,272
Malawi	0.3	0	0.1	3,500
Mozambique	0.2	2.9	6.2	-
Namibia	28	54	5	12,300
Tanzania	1	1	1	-
South Africa	9	65	4	600,000
Zambia	13	90	15	44,200
Zimbabwe	8	32	4	50,000

Source: Country profiles in this report.

The economic significance of mining, however, extends beyond earning foreign exchange and employment creation. Mining is a major consumer of utilities and services especially in the five countries. In 1990, the mining industry purchased a third of the total electrical energy in Zimbabwe, generated 51% of the total export tonnage on the national railways and was responsible for 45% of internal traffic railway movements (3). In South Africa, the mining industry used up 23% of the total electric energy sold in 1993 (4) while in Zambia, the industry is the largest industry consumer of electric energy and coal and is responsible for 69% of export tonnages on the Tanzania-Zambia Railway Authority (TAZARA)

and 73% of the internal tonnages moved by Zambia Railways. In South Africa, mining accounted for 21% of the market capitalization of the Johannesburg Stock Exchange (JSE) in 1993 while 59.3% of the shares traded during the year were in mining (4).

Mining has been largely responsible for infrastructural development in southern Africa. Many of the major towns and developed regions, particularly in the five countries mentioned above grew out of mining activities. Specific examples include Johannesburg, the largest city in the subregion, 4 of Botswana's 7 main towns, the Copperbelt Province in Zambia, which is the most industrialised region in the country with 7 towns, and many other towns in Namibia and Zimbabwe. From an electricity generation viewpoint, the large consumption of energy by the mining industry in Zambia was the major reason for building the Kariba Hydro-electric Dam, the world's second largest man-made lake, while in South Africa, 93% of the energy generated in 1993 came from mining sources through coal fired power stations (4). Coal fired electric energy is also the major internal source of power in Botswana while similar sources contribute significantly to the energy requirements in Namibia and Zimbabwe.

Mining is also an important contributor to the social sector. Each mining employee supports, on average, between 7 and 10 dependants (4) thus extending the benefits of formal employment. In Zimbabwe, the industry in 1990 provided nine hospitals, 51 clinics, 38 doctors, housing for 330,000 people and 40,000 school places (3). The situation is similar in the other mining countries. In Zambia the industry provides a total of 11 hospitals, numerous schools and recreation facilities and owns the major part of housing stock in the seven towns on the copperbelt.

Given the socio-economic prominence of the mining industry in the subregion, it is not surprising that most countries have identified the sector as the base for their economic reconstruction and development programmes. Even in the traditionally non-mining countries, such as Malawi and Tanzania and those countries emerging from civil conflict, such as Angola and Mozambique, there has been a growing realisation that mining can play a far more significant role in accelerating the process of economic recovery and development. For this to happen, it is important to understand the major factors which drive the industry.

a) Mining is a business which operates in highly constrained circumstances and, like any business, it is expected to yield a profit on shareholder's funds.

b) Mining is a highly capital intensive industry and requires high levels of financial and technological investments. Furthermore, the business risk is much higher relative to the other economic sectors while the gestation period before profit realisation is much longer for mining projects. Capital productivity and technological innovation is a major consideration in the context of global business competitiveness.

c) Mining is a very cost-sensitive industry. This is because it is a diminishing resource-based industry in which the ore grades diminish as mining operations progress. On the other hand, the technical challenges and cost structure of the operations increase due to deeper mining levels and the winning of more complex lower grade ores at higher input costs.

d) The international mineral commodity market is highly competitive with prices determined by factors which are often unrelated to domestic operational costs. In such a market, relative cost containment is a major determinant of profitability. This is more so because the mining enterprise is locality-bound to the nature, form and location of the deposit and therefore the business cannot relocate on grounds of an unfavourable business environment.

These considerations suggest that for the subregional mining industry to deliver on its promise of socio-economic development, overcoming these impediments at the domestic level is a strategic imperative for securing international business competitiveness.

The Human Factor

The availability of skilled manpower, above all factor inputs into the mining industry, holds the key to its capacity for domestic and international competitiveness.

As demonstrated earlier, mining is a large scale employer in

the subregion. This large pool of employees is a significant working cost to the industry. In South Africa, for example, wage costs constitute 45% of industry working costs (5). In gold mining, which is relatively more labour intensive, the wage costs as a direct proportion of working costs is even higher at 54%. Under these circumstances, the quality of the human factor, supported by the highest levels of labour productivity, is fundamental to the survival of the industry. The labour must be affordable and yet still deliver globally competitive operational practice at all levels. Globally, the quest for increased labour productivity has increasingly lead to flexible work practices through multi-skilled work teams to increase the range of work processes accomplished within work place units (5).

The high capital stock and technological intensity of the industry at home, and of competitors elsewhere, demand enhanced levels of capital productivity. This cannot, however, be achieved without the availability of skills and competencies capable of interfacing with mining technologies over a wide range of sophistication. To manage the technological function in the mining industry needs intensely focused skills. In addition, however, the skilled manpower must possess flexibility and cognitive sufficiency to keep acquiring improved skills and competencies in line with technological innovation and the drive towards more efficient operational practice. This calls for a continuous evaluation of the balance between human capacities in relation to technologically-driven productivity.

The high capital stock of the industry, coupled with the high risk inherent in mining operations, and the long gestation periods to realising a return on investment, demand management skills with a long term focus. This is because the interpretation of current business threats and opportunities can only be manifested in the future by which time it may be too late to undertake any remedial action. Added to this is the fact that mining operations are intrinsically dangerous. The need to manage and control the operational environment is far more critical than in other industries. Failure to achieve this on grounds of insufficient understanding of that environment can lead to loss of life and damage to the environment. This, unfortunately does happen in the industry, particularly in the small scale sector which suffers from a dearth of skills.

The above factors constitute reasons why the mining industry must have access to a sustainable supply of high quality skills. The need for the industry to increase its stock of skills is a business strategy indispensable to both business and national economic growth. Above all, the development of skills and competencies is an empowerment process for the worker to fulfil their human potential. Both business and government have an obligatory role to ensure that human capacities are not mere business tools but a means towards the socio-economic growth at the individual, corporate and civic society levels.

III MINING SKILLS IN CONTEXT

Mining Skills Included in the Survey

An industry which impacts onto such a wide range of economic activity and participates in the delivery of an even wider range of social responsibilities requires a diversity of skills. By the nature and often remote location of mining operations, the industry is obliged to provide health and other community services as well as schools. Consequently the industry employs a number of non-industrial skills such as teachers, medical, administrative and community services personnel. Although important to the running of the industry, these skills were not covered by this survey.

The survey focused primarily on the skills covering the production environment mostly in mining, mineral processing and extractive metallurgy operations. For purposes of this report, skills in these operational areas were defined as the "core mining skills". In order to undertake mining and processing operations, a number of support technical services are required. The most critical are those of mine surveying, geological, chemical and plant and equipment maintenance services. Due to their direct importance to mining and processing operations, skilled manpower in these categories were included in the survey. However, in the latter two cases, much less effort was made to quantify the adequacy of education and training facilities in the subregion. This was because training in these areas is not specifically directed at the mining industry rather than at all economic sectors. As a result, there is a myriad of institutes in the subregion, even in the non-mining countries, which undertake training in these "mobile" skills.

Anatomy of Mining Skills

In this report, skilled manpower refers to technical personnel in the above defined areas who have been exposed to a systematic educational and training process which gives them knowledge and control over their occupational environment. Several elements may be defined as constituting this knowledge:-

Technical

This is the ability to conduct technical tasks and may be divided into basic knowledge of relevant principles and specific technical understanding of the operational procedures and environment. Basic technical knowledge is acquired academically while the latter is gained from the operational environment on in-company training schemes.

Administrative

This involves participating in procedures which allow the organisation to function smoothly, such as filling requisitions for spare parts, writing progress reports, etc. It is acquired through in-company training.

Management

Involves the assigning of work to, and supervision of, subordinates and includes performance appraisals, developing skills and monitoring progress. This is achieved through structured academic and in-company education and training programmes. An extension of management knowledge includes leadership and strategic cognizance. This involves identification of the key needs of the enterprise based on a complete understanding of the operational environment and the strengths, weaknesses, opportunities and threats which characterise it. Based on these, objectives, plans of action and strategies are formulated which are implemented under direction and result in the improved performance of the enterprise.

Experience and Competence

Experience is recognised as acquiring mastery of the work environment though systematic exposure to graduated aspects of the tasks and responsibilities over a period of time. Experience is primarily developed in the work environment and is a function of the cognitive ability and motivation of the individual and the quality of the enterprise's manpower and management practices such as well-thought out and structured induction and integration programmes. In recent times, traditional notions of skill empowerment are increasingly giving way to competence-based training schemes in which it is recognised that performance in a work situation is not only founded on skill but also in knowledge and understanding. Competence based training focuses on defining elements of the core tasks to be performed in the work environment as well as clearly identified standards or performance criteria to be met for the specified competence. Furthermore, it is rooted in the ability to perform in different contexts and the capacity to transfer skills and knowledge to new tasks and work situations. Competence reflects the ability to do something with knowledge and skills rather than mere demonstration of knowledge and skills. Skills are acquired through training while competence is the product of a close partnership between the development of cognitive skills (education) and practical learning in the work environment (training) and is outcome based.

Acquisition of Skills

It is clear therefore that the acquisition of skills and competencies comprises the attainment of relevant educational qualifications and the development of technical, administrative and managerial knowledge and skills in the work environment. The latter occurs through monitored and structured professional development expressed through a career path. Thus the development of mining skills is a function of both the academic system and industry. A good educational system provides an adequate volume of graduates to enable in-company manpower development systems provide more specific and taylor made development programmes.

The notion of a career path oriented skills and competence development programme varies between mining enterprises within the industry. Broadly, however, three functional areas of mining operations have been recognised:-

a. The **Senior Management Career Path** requiring mining degree-type of qualifications. Entry is at mining engineer level with

junior supervisory responsibilities. Through experience and specific courses in technical, financial and administrative aspects; and competency-based qualifications such as the Mine Manager's Certificate, the incumbent progresses through mine captain, underground manager, mine superintendent and general manager, provided that he has the potential for management and leadership tasks.

b. The **Senior Supervisory Career Path** assumes diploma or technician level qualifications as the entry point and through similar courses and competency qualifications the trainee can progress to mine captain and underground manager positions.

c. The **Supervisory Career Path** which allows a trainee with a basic education to undergo an accelerated practical development programme (such as staff learnership) to prepare them for shift boss, and with further study, higher positions.

The career path concept is applicable to functional areas in the industry other than mining operations such as in mineral processing and metallurgy, as well as to Government and exploration organisations, subject to the peculiar requirements of the tasks in each organisation. Tables 2, 3 and 4 show the qualifications and level of experience in the career path for selected mining industry jobs (6). The qualifications, experience and competencies required for the indicated jobs are not applied universally within the industry. Furthermore, variations occur in the basic qualifications deemed as acceptable for specific job categories. A chemical engineer may, with adequate training and experience, occupy a mineral processing engineer's job, while a competent mining technician may be assigned to a job which requires a mining engineer. An artisan level employee may, subject to the acquisition of additional training, be assigned to the job of a maintenance engineer. These considerations point to the need for career path positions which are based on uniform industry standard competencies rather than mere academic achievement and or experience.

IV PROFILE OF MINING SKILLS IN THE REGION

Distribution of Mining Skills

The subregion has a large contingent of mining skills. Table

5 shows that the total number for the skills included in the survey is more than 57,000. The table also shows that South Africa is the biggest repository of mining skills in the subregion with an estimated aggregate of about 47,500.

Table 2: Indicative qualifications for selected mining operations and technical services jobs

	BASIC QUALIFICATION	EXPERIENCE IN CAREER PATH
General Manager	Mining Degree/Equivalent	13-15 years
Mining Operations		
. Mine superintendent	Mining Degree/Equivalent	8-10 years
. Underground Manager	Mine Managers Certificate/Equivalent	8-10 years
. Sectoral Mining Engineer	Mining Degree/Equivalent	3-5 years
. Rock Mechanics Engineer	Mining (or Geology) Degree/Equivalent	2-4 years
. Mine Captain	Mine Captain Certificate/Equivalent	8-10 years
. Planning Engineer	Mining Degree or Mining Diploma	2 years 3-5 years
. Ventilation Officer	Mining/Ventilation Diploma	2-4 years
. Shift Boss	Mining Diploma or Secondary Education	2 years 4 years
Technical Services		
. Chief Geologist	Geology Degree/Equivalent	8-10 years
. Chief Surveyor	Survey Diploma	5-8 years
. Sectional surveyor	Survey Diploma/Certificate of Competence	2-4 years

Source: Reference 6

Table 3: Indicative qualifications for mineral processing/metallurgist jobs

	BASIC QUALIFICATION	EXPERIENCE IN CAREER PATH

Mineral Processing		
. Manager	Mineral Processing or Metallurgy Degree/Equivalent	10-15 years
. Technical superintendent	Mineral Processing or Metallurgy Degree/Equivalent	8-10 years
. Operations Superintendent	Mineral Processing or Metallurgy Diploma/Equivalent	10-15 years
. Plant Mineral Processing Engineer/Metallurgist	Mineral Processing or Metallurgy Degree/Equivalent	3-5 years
. Sectional Superintendent Safety and Training	Mineral Processing Diploma	10-12 years
. Sectional Superintendent	Mineral Processing Diploma	8-10 years 10-12 years
. Operations General Foreman	Mineral Processing Diploma or Secondary	8-10 years 10-12 years
. Shift General Foreman	Mineral Processing Diploma or Secondary	3-5 years 5-8 years
. Senior Assistant Metallurgist Engineer	Mineral Processing or Metallurgy Degree/Equivalent	2-4 years
. Assistant Metallurgical Engineer	Mineral Processing or Metallurgy Degree/Equivalent	Nil (new graduates)

Source: Reference 6

Table 4: Indicative qualifications for maintenance engineering jobs

	BASIC QUALIFICATION	EXPERIENCE IN CAREER PATH
Engineering/Maintenance		
. Manager	Engineering Degree/Equivalent	10-15 years
. Divisional Engineer	Engineering Degree/Equivalent	8-10 years
. Sectional Engineer	Engineering Degree/Equivalent or Technical Certificate	3-5 years 10-15 years
. Senior Assistant Engineer	Engineering Degree/Equivalent	2-4 years
. Maintenance Planning Officer	Technician Certificate or Apprentice Artisan	2-4 years 10-15 years
. Assistant engineer	Engineering Degree/Equivalent	Nil (new graduates)
. Management foreman	Technician Certificate or Apprenticed Artisan Qualification	2-4 years 8-10 years
. Assistant Foreman	Technician Certificate or Apprenticed Artisans	1-2 years 4-6 years

Source: Reference 6

Table 5: Distribution of mining skills in the surveyed countries

Skill Category	Bot	Mal	Moz	Nam	Tanz	SA	Zam	Zim	Total
Professionals									
Mining Eng.	77	4	18	99	36	2,491	224	94	3,043
Min. Proc.Eng./ Metallurgists	44	1	11	39	9	2,274	226	142	2,746
Geologists	64	27	57	47	84	1,528	104	96	2,007
Chemists	19	3	9	12	13	852	81	57	1,046
Surveyors	18	-	4	12	2	933	149	6	1,124
Other engineers/ scientists	47	-	8	98	-	4,286	553	152	5,144
Sub Total	269	35	107	307	144	12,364	1,337	547	15,110
Technicians									
Mining	42	1	11	14	108	1,654	56	216	2,102
Min.Proc.	26	-	4	33	12	963	73	59	1,170
Geological	50	4	18	16	35	439	12	9	583
Surveying	12	-	11	9	32	454	58	11	587
Chem.Lab.	15	3	15	11	14	338	20	21	437
Cartog./D'men	17	2	4	12	19	963	126	36	1,179
Sub Total	162	10	63	95	220	4,811	345	352	6,058
Artisans	461	-	46	869	-	30,323	3,968	698	36,365
TOTAL	892	45	216	1,271	364	47,498	5,650	1,597	57,533

Source: Country profiles, this survey.

This is not surprising given the considerable size of the industry in that country. The table further shows that the numerical levels of skills are also high in Botswana, Namibia, Zambia, and Zimbabwe. These, together with South Africa, are the main mining countries in the subregion and account for about 99% of the skilled manpower shown in Table 5. Although not included in the survey, Angola is a significant mining country. Further north, mining activities have been attracting increasing attention in Ethiopia, Kenya, Malawi, Mozambique, Tanzania and Uganda. However, the contribution by these countries to the quantum of skills in the subregion is insignificant. Overall, the five major mining countries contribute probably greater than 90% to the skill base of the Eastern and Southern African subregion.

Table 5 also shows the small skill base in Malawi, a traditionally non-mining country but with increasing possibilities of expanding the formal mining sector. The table further indicates the modest numbers of skilled manpower in Mozambique and Tanzania, two countries with excellent mineral potential but whose exploitation was historically restricted to state-owned mining

enterprises. The collapse of the state enterprises has resulted in low volumes of skilled manpower in the industry. In the case of Mozambique, the previous long term conflict is also a contributory factor to the low levels of skills in the country.

Numerically, the table shows that the largest concentration of skilled manpower at degree level is in the engineering and maintenance category, followed by mining engineers, mineral processing engineers and metallurgists, and geologists. At technician level, the largest population is that of mining and ventilation technicians, followed by mineral processing technicians. Geological, mine surveying and chemical laboratory technicians are not as abundant. By far the biggest population, however, is that of artisans in the maintenance category. This, together, with the observed large population of maintenance engineers, is a reflection of the capital intensity of the subregional mining industry. Engineers and artisans are engaged with the purpose of keeping production equipment running.

Table 6 shows the same information contained in Table 5 expressed as the number of skilled manpower in each category per

Table 6: Estimated number of skilled manpower per 1000 workers in the industry

Skill Category	Bot	Mal	Nam	SA	Zam	Zim	Average
Professionals							
Mining Eng.	5.8	1.1	8.0	4.2	5.1	1.9	4.35
Min.Proc.Eng./Met	3.3	0.3	3.2	3.8	5.1	2.8	3.1
Geologists	4.8	7.7	3.8	2.5	2.4	1.9	3.85
Chemists	1.4	0.9	1.0	1.4	1.8	1.1	1.3
Surveyors	1.4	-	1.0	1.5	3.4	0.1	1.5
Other Eng./ Scientists	3.5	-	8.0	7.1	12.5	3.0	6.8
Technicians							
Mining	3.1	0.3	1.1	2.8	1.3	4.3	2.2
Min. Proc.	2.0	-	2.7	1.6	1.6	1.1	1.8
Geological	3.8	1.1	1.3	0.7	0.3	0.2	1.2
Surveying	0.9	-	0.7	0.8	1.3	0.2	0.8
Chem. Lab.	1.1	0.9	0.9	0.6	0.4	0.4	0.7
Cartog./D'men	1.3	0.6	1.0	1.6	2.8	0.7	1.3
Artisans	34.7	-	70.6	50.5	89.8	14.0	51.9
Total Labour Force	13,272	3,500	12,300	600,000	44,200	50,000	723,272

Source: Recaculated from Table 5

1,000 workers in the mining industry of each country. The ratio is essentially a measure of comparative availability of skilled manpower among the surveyed countries. Mozambique and Tanzania were not included in the table due to uncertainties in the total number of employees in their mining sectors.

The table indicates that Botswana probably has the best comparative distribution of skilled manpower in the subregion; the only exception being the number of maintenance engineers and other scientists which is below the average level. The low skilled manpower position of Malawi is clear from the table, although it must come as a surprise that the country has the highest number of geologists per 1,000 industry employees. Namibia shows the highest relative concentration of mining engineers and mineral processing technicians but has deficiencies in the categories of mining technicians. South Africa shows about average concentrations of skilled manpower, while Zambia has a relative surplus of mining engineers and mineral processing engineers with deficiencies in geological skills both at the degree and diploma levels. Zambia also has the highest relative concentration of engineers and artisans. Zimbabwe has surprising relative deficiencies in all the indicated skill categories with the exception of mining technicians in which it possesses the highest concentration of manpower among the included countries. Given the considerable size of the sector in Zimbabwe, the apparent relative deficits in skilled manpower probably reflects the labour intensity of particularly the large small scale gold sector.

The data shown in Table 6 is of a comparative nature only and is itself deficient. Whereas it proposes the relative abundance and deficiencies with respect to the other countries, it does not yield information on the absolute deficiencies existing within each country's mineral sector. Furthermore, it neither gives information on the distribution of skilled manpower in each country's mineral sector nor the quality of available skills.

Although **Botswana** has a high concentration of skilled manpower relative to the other countries, information given in the country profile indicates that the country has slight deficits in virtually all the skill categories shown in Table 6. Numerically, the deficits are noteworthy for mining engineers in industry, and for

geologists and geological technicians, in Government service. Furthermore, Botswana has a high concentration of expatriate skilled manpower. On average, 9% of all industry employees are expatriates and in some cases, this figure is as high as 30%. Previous studies (6) have shown that the expatriate labour force is predominant in managerial and technical jobs, and that at general management levels, all jobs were held by expatriates. Thus the expatriate manpower occupy mostly jobs requiring man-management and strategic leadership skills. Career profiles given earlier in Tables 2, 3 and 4 indicate that it takes long periods to develop skills and attain high levels of competency in these jobs. The expatriate factor is exacerbated by the lack of qualified manpower on the local market, especially at degree level.

In **Malawi**, industry employment is dominated by the small scale unskilled lime burners. The skill deficiencies are acute and exist at all levels. The returning semi-skilled and unskilled workers, who have previously worked in South African mines and elsewhere in the subregion, provide a core pool of "experienced" miners. Mining engineers, mineral processing engineers and geologists are all in short supply, as are their technician equivalents. Due to the infancy of the industry, Government is the major employer but faces a serious shortage of skilled manpower. Although Table 6 suggests that Malawi has the highest number of geologists per 1,000 industry employees, there is a deficit of about 50% for geologists in Government service. In addition, Government lacks skilled manpower to administer the Mining Act and provide a regulatory framework for the emerging industry.

In **Mozambique**, Government has continued to be the major employer through the shrinking state-owned sector. Due to the fact that at the height of the industry, most skills came from eastern Europe, the country exhibits a narrow skilled manpower base. Probably due to the insecurity situation, technical practice in the state sector grew weak due to lack of operational mines or field work. As a direct result, the emergent new private owners of mines prefer to use expatriates, which are increasing in number with each new mine development. Geologists, with little hands-on experience, are reasonably available but not sufficient. Mineral processing engineers and mining engineers are in short supply as well as virtually all technician level staff with the possible exception of geological and chemical laboratory technicians.

In **Namibia**, the profile of mining skills is much like that in Botswana. The Government departments face deficits at all levels the major ones being for mining engineers and geologists. In industry, the deficits are small and insignificant on account of the good wages paid by the private sector owners. Although Table 6 indicates a comparatively above average skilled manpower availability, the industry is dominated by expatriate manpower with recruitment from local sources virtually impossible. About 35% of the total skilled manpower positions are occupied by expatriates. As in Botswana the biggest fraction of expatriates are in strategic jobs of management and professionals. However, even for technicians, artisans and supervisors, the proportion of expatriates is high at 25%. The large expatriate labour force has contributed to excellent technical practice and high levels of competencies, particularly since fresh local graduates are not only few but hardly stay due to high expectations.

In **Tanzania**, the declining state enterprises are still the major employers. Geologists are abundant and the population of mining engineers reasonable while mineral processing engineers are in short supply. At technician levels, there is a profusion of mining and geological technicians but not mineral processing technicians. A major problem in Tanzania is the weak technical practice and management structures, aggravated by the lack of competence definition. Thus, although technicians are available, their qualifications, skill capacities and competence are not fully known. This applies to degree level technical staff to a lesser extent. The numerical levels of skilled manpower is also probably insufficient bearing in mind the large small scale sector which has little or no skills.

In **South Africa**, there are apparent deficits for mining engineers, mineral processing engineers and metallurgists, and especially geologists. The deficits for mining engineers and geologists are more significant in the Government sector. This sector has a numerically large pool of skilled manpower due to the broad range of monitoring services it undertakes including mine safety, health, land rehabilitation and provision of economic information. For mineral processing and metallurgy, the deficiencies are probably exacerbated by the country's increased diversification into value-added mineral products which has created a demand for metallurgical engineers. At technician and artisan levels, there does not appear to be any significant deficiencies. South Africa has a large labour intensive gold sector in which

about 80% of workers possess few or no skills at all. The challenge is to improve labour and capital productivity by broadening the skill base of the large previously disadvantaged work force. A significant point in South Africa is that industry places much emphasis on measurable competency as a basis for progressing along career paths. This has resulted in a pool of skilled manpower with good operational practice and affords an opportunity to a wider number of people to use their full potential to acquire skills and competencies.

Zambia has a large concentration of skilled manpower in industry in line with its large size. However, there are deficits for geologists and mining engineers. The largest deficits are for artisan level skills although Table 6 indicates that the country probably has the largest relative concentration of artisans per 1,000 workers. There are also deficits for mining engineers and geologists in the Government sector as a result of the decentralisation of services to the mining districts. At technician level, there is over-employment especially for mining and metallurgical technicians although there are deficiencies in the number of geological technicians. The over-employment appears superfluous and is related to the overlap of skill requirements with in-house trained staff learners who have the same career path as technicians. Available evidence shows that there are deficiencies for jobs located along this career path. The view of the minority share holders are that skills at management levels and technical competencies have declined in the industry. The latter may be related to the fact that competency-based qualifications, such as mine manager's certificate and others, are absent in the industry. The former may stem from the excessive government-based decision-making which may not have been in the best corporate interest of the company. Evidence of the declining standards lie in the increasing number of expatriates in jobs at management and senior technical levels in order to arrest the seriously declining mine production. The level of expatriates had previously declined to about 0.4% of the labour force. The increasing levels of expatriates supports the view that maintaining internationally competitive competencies is key to the industry's improved performance.

In **Zimbabwe**, the level of skills is surprisingly lower than expected for such a large industry. This is probably due to the skill-deficient large labour intensive small scale gold sector. The

deficiencies in industry appear acute for mining engineers and geologists and for maintenance engineers. At technician and artisan levels, the deficits are more visible for geological technicians and artisans. There is a small surplus of mining technicians. At major mines, technical practice is good due to emphasis on competence-based qualifications, such as mine manager's and mine surveyor's certificates. In the small scale sector, however, there is a proliferation of skill types leading to weak technical practice. The Government sector is large due to the large number of services offered to industry in the areas of safety, health, plant hire and loan schemes, surveying and geological services. This has resulted in deficiencies in Government for particularly mining engineers and geologists. Given the large small scale sector in Zimbabwe, it is probable that the skill deficiencies are much larger than indicated in this report.

Table 7 summarises the above country-specific deficiencies in pictorial form. It is quite clear that at the country level, all countries covered by the survey face skilled manpower deficiencies of various intensities. The table provides an intuitive picture of

Table 7: Indicative skilled manpower deficiencies in the surveyed countries

Skill Category	Bot	Mal	Moz	Nam	Tanz	SA	Zam	Zim
Professionals								
Min. Eng.	X	XXX	XXX	X	X	X	X	XX
Min. Proc.	X	XX	XXX		XX	X		X
Eng./met.	X	XXX	X	XX		XX	XX	XX
Geologists	X							
Chemists		XX	XX		XXX	X	X	X
Surveyors	X	XX	XX	X			X	XX
Other Eng/ Scientists								
Technicians								
Mining		XX	X	X			++	+
Min.Proc./Met.		XX	XXX	X	XX		++	
Geological	XX	XX	X	X			XX	XX
Surveying		XX	XX					X
Chem. Lab.	X						X	X
Cartog/D'men	X		XX	X			+	X
Artisans		XX	XX	XX			XXX	XX

Source: Survey data and country profiles; this report.

Key: X - Slight deficiency
XX - Reasonable deficiency
+ - Slight surplus
++ - Reasonable surplus

XXX - Acute deficiency +++ - Major surplus
Blank - Probably sufficient

the challenges which the member States of the subregion individually and collectively face with respect to the availability of skilled manpower for the mining industry.

Major Sector Developments and Demand for Mining Skills

A number of changes, which directly affect the mining industry, have taken place in the subregion in recent years. Politically, the major developments have been the holding of democratic elections in several countries including Malawi, Mozambique, South Africa, Tanzania and Zambia. The elections have resulted in Governments which are much more receptive to the needs of the private sector than their predecessors. From a mining viewpoint, these political changes have resulted in the following:-

a. most countries have reformed their mineral legislation to make it competitive for private sector investment. The revisions in the mining acts have centred on attractive fiscal incentives, guarantees against nationalisation, right to market own mineral products and increased security of tenure for mining rights.

b. the previous monopoly of state-owned mining enterprises has been eroded. Historically, mine output from such enterprises has been declining due to lack of re-investment and business-oriented corporate philosophies. As a result, the industry is being privatised in countries such as Mozambique, Tanzania and Zambia where the State was the major investor in mining activities. As elsewhere in the subregion, notably in Botswana, Namibia, and South Africa, Governments now perceive their role as that of facilitator rather than investor.

The increased emphasis on attracting private sector investment into the industry has directly led to increased exploration expenditure by international mining houses in the subregional industry. Thus virtually in all countries of the subregion, including in the traditionally non-mining countries, exploration activities, financed by the private sector, have been intensified. Attention has been largely focused on the high unit value minerals,

especially diamonds, gold, base metals and platinum. However, industrial minerals have been receiving some attention, as in the case of South Africa, where they are expected to play a more significant role in the light of the Reconstruction and Development Programme. Exploration has also been intensified around existing mining areas particularly in the mining countries of Botswana, Namibia, South Africa, Zambia, and Zimbabwe.

Probably the most notable development in the subregional industry is that the active international mining houses have increasingly come from within the subregion following the democratisation of South Africa. South Africa's mining companies are globally some of the major investors in the mining industry. Their positive integration into the subregional mining industry should therefore prove to be the major inflection point for the growth of the industry, the spread of expertise and technology and the impetus to sharing good practices in human resources development.

In terms of actual mine development, it is rather early to expect significant major mines from the current exploration initiatives, particularly in the non-mining countries. However, there have been several new mines which have recently opened notably in Mozambique, Tanzania, South Africa and Zimbabwe. At the same time, there has been a number of mine closures, particularly in countries where private mining is entrenched, such as in South Africa, Namibia and Zimbabwe.

Considered aggregately, the increased exploration efforts and the resultant potential mine development point to a higher demand for skilled manpower in the subregional mining sector. Table 8 shows the estimated demand for skilled manpower in the surveyed countries for the period 1996 - 2001. The major point to note in the table is that the estimated numerical demand of some 22,600 for the indicated categories of mining skills is quite large. The estimates indicate that South Africa alone accounts for about 74% of the requirement for skilled manpower. This is a further reflection of the large mining sector in that country. Generally, the table shows that the demand for skilled manpower is strongest in the mining countries of Botswana, Namibia, Zambia and Zimbabwe and is small and at best modest in the non-mining countries of Malawi, Mozambique and Tanzania.

In terms of specific skill categories, the largest need for

the core mining skills is for mining engineers, followed by mineral processing engineers and metallurgists and geologists. The corresponding annual requirements for these skills are estimated at 242, 206 and 171, respectively. For technician level skills, by far

Table 8: Estimated demand for skilled manpower in the surveyed countries for the period 1996-2001

Skill Category	Bot	Mal	Moz	Nam	Tanz	SA	Zam	Zim	Total	Annual Demand
Professional										
Mining Eng.	38	29	33	95	11	872	90	41	1209	242
Min.Proc.Eng./	22	13	29	34	3	796	78	56	1031	206
Metallurgists	34	48	37	66	23	535	75	37	855	171
Geologists										
Chemists	14	2	12	10	5	298	27	23	391	78
Surveyors	11	5	11	8	1	327	67	2	432	86
Other Eng./	24	n.a.	49	93	n.a.	1500	186	72	1924	385
Scientists										
Sub Total	143	97	171	306	43	4328	523	231	5842	1168
Technicians										
Mining	34	25	22	15	28	579	-17	81	767	153
Min.Proc./	22	12	11	24	4	338	-6	25	430	86
Metallurgy	37	23	11	15	9	154	25	2	276	55
Geological										
Surveying	10	n.a.	9	15	9	159	18	3	223	45
Chem.Lab	13	3	9	13	4	118	12	9	181	36
Cartog./D'men	14	2	11	11	5	337	33	14	427	86
Sub Total	130	65	73	93	59	1685	65	134	2304	461
Artisans	198	n.a.	344	575	n.a.	10613	2350	380	14460	2892
TOTAL	471	162	588	974	102	16626	2938	745	22606	4521

Source: Country profile; this report.

the biggest need is that for mining technicians with an annual demand of 153. Generally, the demand figures for technician level staff are less than those of professional skills. However, the largest demand for skilled manpower is in the maintenance service functions of artisans and engineers. The data suggests that the annual demand for these skills are some 2,900 artisans and 385 engineers and scientists. This factor, as earlier suggested, is

testimony to the technological intensity of mining operations in the subregion.

The basis for the extrapolations given in Table 8 are explained in Annex II. The main element in the extrapolations has been replacement of current manpower through natural attrition. Where figures have been available, expatriate replacement and current deficiencies have also been taken into account. Furthermore, where current plans for mine development are firm, the potential employment creation for skilled manpower has been included. Despite these efforts, the indicated data can only be treated as a base line case. It is not possible to include all potential mine development or the demand for skills in the small scale sector, which is quite large in some countries. Thus the potential demand for skilled manpower in the subregion is most likely much higher. However, the usefulness of the data lies not so much in its numerical accuracy rather than the orders of magnitude on whose basis a reasonable opinion of the demand distribution can be made.

There are several features of the demand distribution shown in Table 8 which are not explicit. In South Africa, for example, the thrust towards capital-intensive, greater manufacturing value added for mineral products has increased and diversified the demand for skilled manpower in metallurgical engineering, while the increasing cost structure and the difficulties of mining relatively poorer grades at great depths has resulted in the demand for a more skill focused labourforce to boost both capital and labour productivity. In Mozambique, the demand for skilled manpower is likely to double on account of major projects in coal and beach sand minerals. The required skilled manpower can only come from expatriate sources. In Zambia, the demand for skilled manpower is likely to be influenced by the pattern and pace of privatising the large copper sector, while in Tanzania, swift privatisation of the State Mining Cooperation and SARUJI Corporation may lead to the restarting of operations at a number of closed mines and increase the demand for skilled manpower. In Zimbabwe, the mining boom currently taking place, as evidenced in the development of the Hartley Platinum project, is likely to result in a sustained demand for skills. Most of these country-specific features are described in greater detail in the country profiles at the end of the report.

Availability of Specialised Skills

Small Scale Mining Skills

The small scale mining sector is a significant factor in many countries in the subregion, particularly in gemstones, gold and diamond mining. Small scale mining also extends to other minerals such as chrome, tin and tantalite ores and industrial minerals. A recent study (7) in small scale mining contends that numerically, as many as 90% of mines in the SADC region are probably of a small scale nature and produce as much as 25-30% of the total value of mineral products.

A study by the ECA/MULPOC in Lusaka (8) recently revealed that in the gemstone sector, for example, mining operations are often conducted by local inhabitants or small entrepreneurs who have no knowledge of the technical requirements of mining as a discipline. The mines are often disorganised trenches, shallow pits or holes in the ground from which openings follow the profile of the narrow veins of ore. Relevant aspects of rock mechanics, mine planning, ventilation and environmental management are ill-understood resulting in unnecessary dangers to both humans and the environment. The study recommended that artisanal or micro scale miners could greatly benefit from practical non-academic oriented training in mining techniques, equipment maintenance and elementary business and financial skills.

There are similar accounts of the debilitating effect of lack of skills in the small scale gold sector in Zimbabwe where estimates indicate that about 4,600 kilometres of riverbeds are worked by some 200,000 gold panners resulting in increased siltation of rivers and dangers of mercury poisoning to both humans and the environment. Apparently, the menfolk believe that the drinking of small quantities of mercury restores their vitality!

R & D, Planning, Design and Consultancy Skills

In the course of the survey, it became clear that a range of skills in the areas of research and development, mine planning and design, geostatistics and mineral reserve estimation, mineral economics, mineral process design and flowsheet development, project engineering and plant construction are absent in the majority of the countries in the subregion. These skills are well developed in South Africa, and to a much less extent, in Zambia and Zimbabwe. In the emerging mining industries in Malawi, Mozambique

and Tanzania, these skills are totally absent while in the established mining economies in Botswana and Namibia, limited operational skills such as mine planning are available at mine sites. The balance of the skills are procured through parent mining companies mostly located in South Africa.

The above skills are necessary to develop a new target into a producing mine. Given the current high profile of exploration activities and potential mine development, it can be assumed that these skills are going to be in demand in the subregion in the short term future.

Government Administrative Skills

During the survey, it also became clear that Governments' capacity to play a regulatory and promotional role in the industry was weak. In many countries in the subregion the lack of administrative skills was in a number of areas including monitoring mine safety and the environment, implementing mineral legislation and understanding both the technical and business side of mining operations, particularly in relation to the global exigencies of the industry. Further weaknesses in Government administrative mechanisms manifest themselves in the inability to provide technical support services to industry and economic information necessary to stimulate private sector investment into the sector. The range of services that Governments could provide includes geological and technical extension services, especially to the small scale sector.

The weaknesses in Government administrative structures unwittingly make many Government representatives difficult working partners for private sector investors who perceive the weaknesses as unnecessary bureaucracy which costs them money. On the other hand, Government officials are wary of the high-pressure salesmanship of the business world and fear the possibility of signing contracts which hardly extract the maximum benefit in economic rent. Government administrative skills are particularly weak in Malawi where there is no previous history of mining. In Mozambique, Tanzania and Zambia, where the industry is privatising, difficulties have been experienced in fielding mining lawyers, contract negotiators, financial analysts, and mineral tax specialists resulting in a dependency on external sources. In Botswana and Namibia, Government administrators are simply in short supply.

V MINING SKILLS DEVELOPMENT FACILITIES

Academic Facilities

Distribution of Facilities

Table 9 gives the estimated annual output of the core mining skills in the surveyed countries compared against the projected annual demand. The table is based on the current output, and not the potential capacities of the academic training institutes. The table does not include non-mining specific academic institutes for the service functions such as chemists, engineers, draughtsmen and chemical technicians. As stated earlier, most countries in he subregion have educational facilities in these areas. These offer training for other economic sectors, rather than the mining industry alone.

Table 9: Estimated current output of mining skills academic institutes in the surveyed countries

Skill Category	Bot	Mal	Moz	Tanz	SA	Zam	Zim	Total	Annual Demand
Professional									
Mining Eng.					69	11	15	95	242
Min.Proc.Eng./Met									
Geologists					125	11	15	151	206
	9	5	5	20	70	5	10	124	171
Sub-Total	9	5	5	20	264	27	40	370	619
Technicians									
Mining	10		?		120	28	15	173	153
Min.Proc./Met					67	23	15	105	86
Geological			?		22	?	?	22	55
Mine Surveying					24	9	8	41	45
Sub-Total	10				233	60	38	341	339
TOTAL	19	5	5	20	497	87	78	711	958

Source: Country Profiles; this report.

Aggregately, Table 9 suggests that the subregion is under-training in all the three degree programmes of mining engineering, metallurgy and mineral processing and geology. The most acute shortfall in output is that for mining engineers. The major source of degree level training is South Africa which accounts for some 264 graduates out of 370, a proportion of 71%. At technician level, there appears to be a slight surplus of diploma graduates over the projected annual demand in the fields of mining and mineral processing and metallurgy, while there are small deficits in geological training and mine surveying. Not much can be read in this surplus, however, due to the fact that the demand figures are probably understated for reasons earlier advanced. The bulk of technicians are supplied by South Africa which accounts for 233 or 68% of the total output of 341. The figure for metallurgy and mineral processing technicians includes only the extractive metallurgy category, and not engineering metallurgy. A point to be noted is that the numerical output for the technician level staff is closer to the estimated demand for the skills indicating some general sufficiency.

Table 9 gives the quick impression that dedicated academic facilities for the development of skilled manpower in the subregional mining industry are few and far in between. It is clear that at both degree and diploma levels, full academic facilities are only available in three major mining economies of the subregion, namely, South Africa, Zambia and Zimbabwe.

South Africa has many mineral related institutes. At degree level, 2 universities offer training in mining engineering; 6 in metallurgy and mineral processing and 7 in geology. However, only two universities, namely the Universities of Pretoria and Witwatersrand offer all three programmes. Admission of diploma holders to degree programmes is possible in some cases and conversion courses for science graduates to metallurgical programmes are available. The universities of Pretoria and Witwatersrand also offer bridging schemes for disadvantaged students which spreads the study programmes over a longer period. These arrangements ensure that degree level technical education is available to a wider number of people. At diploma level, technical training is available in mining engineering, extractive metallurgy, engineering metallurgy, economic geology and mine surveying. These courses are available at the Technikon Witwatersrand and Technikon

SA on a correspondence basis. The Technikons Pretoria and Vaal Triangle offer engineering metallurgy courses. The national diploma courses can be upgraded into higher national diploma and masters diploma. Plans are underway to extend some of the options into a Bachelor of Technology Degree programme. Overall, the output from the institutes appear insufficient in the degree programmes, while at diploma level, the number of graduates is adequate.

In **Zambia**, degree training in mining engineering, metallurgy and mineral processing and geology is available at the School of Mines of the University of Zambia. At diploma level, courses are available in mining, ventilation, mineral processing and mine surveying at the School of Technology of the Copperbelt University. A diploma level a geology programme has been commenced at the School of Mines but details are unavailable at present. There are plans to admit diploma holders to the mining and metallurgy programmes. Output at degree level is adequate for national needs. At technician level, there is over-training in mining and mineral processing disciplines. The coincidence of career paths with in-house staff learnership schemes is probably responsible for the low absorption rates of these skills, and is made worse by the absence of competency-based certificates which would widen the upward mobility of diploma holders. Their integration into degree programmes should therefore be welcome.

In **Zimbabwe**, degree qualifications in mining engineering, metallurgy and mineral processing and geology are offered by the University of Zimbabwe. At diploma level, the Zimbabwe School of Mines offers intermediate and full national diplomas in mining, mineral processing and extractive metallurgy, and mine surveying. A course in mining geology commenced in 1995. Internal training capacities appear adequate relative to national demand although diploma graduates are numerically low.

Outside the above three major mining economies, technical training is available only in a few selected disciplines in only several countries. Geological training at degree level is the most common and is available at the Universities of Botswana, Dar-es-salaam, Maputo and Chancellor College in Malawi. The Geology training in Malawi is part of a BSc. general course, is non-mining specific and has no field component. Namibia has no training

facilities of its own both at degree and diploma levels. For mining engineers and mineral processors, Botswana and Namibia have traditionally used the facilities in South Africa and elsewhere. Tanzania has traditionally used the facilities in Zambia for training mining engineers and mineral processors.

At diploma level, academic training facilities in the subregion are even more sparse. A mining diploma is available at the University of Botswana where another in mineral processing is planned. Information suggests that diploma education in mining and geology may be also available in Mozambique. The information was, however, incomplete. At certificate level, Tanzania offers courses in mineral exploration, mining technology and mineral processing while Botswana has been contemplating starting programmes in mineral processing and mine surveying. However, certificate level skills have not been fully considered in this survey. Generally, the survey revealed that the countries without academic facilities were keen to use the existing ones in the subregion but sponsorship was a major handicap, especially for non-mining countries like Malawi.

Weaknesses in Academic Facilities

Although the academic facilities for skills development are few, they are grossly underfunded with the exception of those in South Africa and to lesser extent Botswana. The funding constraints have resulted in inadequacies in physical infrastructure such as buildings and laboratory equipment; and shortages of teaching materials including books and journals. The funding constraints have also limited field visits and in several cases, particularly in Zambia, led to an exodus of teaching staff due to uncompetitive remuneration.

Industry Participation in Skills Development

In-company Training Schemes and Bursaries

As a general observation, the participation of mining companies in skills development is weakest in countries where the mining industry is least developed, such as in Malawi, Mozambique and Tanzania. In these countries, there are virtually no in-company training schemes or regular functioning links with the academic facilities. Furthermore, the criteria for skill assessment and performance measurement in the State-owned mining companies of

Mozambique and Tanzania are mostly absent. The lack of methodical job evaluation schemes, which are integrated with job descriptions and a firm career path, is probably responsible for the weak skill and competence base in these countries. In Malawi, the problem is simply that the industry is nascent and there are yet no big mining companies in the industry.

In contrast, in the major mining countries, the mining corporations are integrated into skills development to various extents. This is probably due to the fact that the mining companies in these countries are large and are major consumers of mining skills. They therefore have a business interest to ensure that skills and competencies are available in the right quantities and quality and at the right time. The most common forms of company involvement in skills development are in-company training schemes and the award of bursaries for college studies. In-company training schemes are offered at several levels including artisan, supervisory and management training in addition to graduate integration programmes into the work environment. In all the main mining countries the schemes are well articulated with job evaluation procedures and performance appraisals, and related to career path progression. However, the performance criteria is not necessarily the same in the countries. Details of available in-company training schemes are given in the country profiles in the appendices.

In all the five mining countries, in-company artisan and supervisory training facilities are liberally available locally. Management training is in some cases available locally but external training is common as is the case with Botswana and Namibia where such training is undertaken in South Africa either at Colleges or parent company facilities. Bursaries for study at local colleges and universities are common although overseas sponsorship is also practised like in Zambia. Local sponsorship habits also vary. The best practices are those in which the student works in industry for a period, usually one year, to orient his career bearing prior to college or university entry. This, for example is the case in South Africa, Namibia and Zimbabwe and allows the practical aspects of training to take root before academic education. In all cases, additional practical training is undertaken during vacations in industry further reinforcing the experience component of learning. As a general rule, the majority of the students in the mining and related programmes in the subregion's institutes are fully

sponsored by industry. However, in Botswana and Namibia the shortage of matric level students with technical and science subjects is a major problem. A major recent feature of in-company training are the multi-skilling programmes which have increasingly become common in the main mining countries especially at artisan level.

Institutional Support and Chambers of Mines

A different form of support by industry to skills development is institutional support to academic institutes. In the mining countries, companies commonly sit on Training and Advisory Committees of the institutes. Further support from mining companies is in the form of funding research programmes. Most of the research programmes in South Africa, such as the two centres of expertise in welding engineering and corrosion engineering at the University of Pretoria, and that in rock mechanics at the University of Witwatersrand, are funded by private mining companies. Likewise, the reputation of the Mining Department at the University of Zimbabwe in the development of open pit mining software is largely due to industry support. Unfortunately this type of support is not common and is restricted to South Africa and, to a much less extent, Zimbabwe. In addition to material support from individual mining companies, such support is mostly channelled through Chambers of Mines, which have proved to be effective forums for the collective advancement of the interests of the private sector companies and the mining industry as a whole.

In South Africa, the Chamber of Mines assists in providing research equipment to colleges and universities and funds a number of teaching posts in mining disciplines. In 1995, their level of support for such activities amounted to about US$ 5.0 million. As a matter of fact, the major teaching departments in mining disciplines are able to cover some 60-80% of their operational budgets through material support from industry. In addition, the Chamber of Mines of South Africa provides training for engine winding drivers, in radiation control and in environmental aspects of mining. It also runs a colliery institute for training artisans. Similarly in Zimbabwe, the Chamber of Mines has 50% representation on the Board of the School of Mines in Bulawayo.

A significant initiative in which the Chamber of Mines in South Africa is participating is the current education and training

reform. The aim is to marry industry-oriented qualifications with those from academic institutes to create unified and nationally recognised competencies which meet industry standards. As a result, mining training is being reviewed into suitable competency-based formats to define the minimum levels of competency required to perform specific tasks, and grouping the tasks in the form of cumulative learning modules. The competency-based certificates are also in the process of being transferred from the Government Mining Engineer's office to industry. In Zimbabwe, the School of Mines, on which the Chamber is represented, is also responsible for training candidates in competency-based certificates. These efforts guarantee industry a major hand in determining the quality of skills which they require to remain competitive. Regrettably, they are not common in the subregion.

Facilities for Developing the Specialised Skills

Opportunities for specialising into narrower skill categories in the subregion are limited. Most of the available opportunities are in the form of short specialty courses at academic institutes or postgraduate programmes in specific areas of interest.

In geology, MSc. programmes in geochemistry and geophysics are offered at universities in Tanzania and South Africa. Another MSc. programme in mineral exploration commenced in 1995 in Zimbabwe and is targeted at the SADC region. In the area of mining, specialisations in fields such as rock mechanics, mining geology, mineral economics, mine environment, production management and geostatistics are possible only in South Africa and Zambia. In Zambia, these areas are part of the MSc. programme while in South Africa, they may also be taken in short modular form as part of the Graduate Diploma in Engineering (GDE). The GDE programme generally provides opportunity for practising engineers to undertake short courses, spread over a period, to expand their horizons and effectiveness in specific areas in the world of work. They are also available in mineral processing like the one in coal processing offered at the University of Witwatersrand. Design related programmes, such as mineral process and flow sheet design, appear to be absent in the subregion. Specialty courses covering the broad areas of industrial minerals, and their beneficiation and utilisation, are also absent.

With respect to the development of research skills, functioning research institutes are few. The Institute of Mining Research in Zimbabwe is notable. However most research is undertaken in South Africa, either in Universities as part of MSc and Ph.D studies or at specialised institutes such as MINTEK, the Council for geoscience, the Atomic Energy Corporation and Council for Scientific and Industrial Research. Some of these institutes, such as MINTEK, are contemplating introducing distance-based training scheme for the SADC region in which the theoretical aspects are undertaken through a local college while the practical part is undertaken at MINTEK's laboratories. A useful extension to such a scheme would be the provision of opportunities for plant personnel in the subregion to periodically review the relevance of operational practice using the strong process design research orientedness of the institute.

An area in which training facilities are ill-developed in the subregion is the small scale mining sector. The Department of Mining at the University of Zambia offers a training programme for small scale miners known as Village Orientation and Mineral Exploitation programme (VOME) in collaboration with the Geology Department at the same University and the Ministry of Mines and Mineral Development. In Zimbabwe, where services to the small scale sector are well developed, the School of Mines provides a course in gold extraction for small scale miners although participation is disappointing due to an inability to pay fees.

VI AGENDA FOR A HARMONISED SKILLS DEVELOPMENT STRATEGY

The mining industry is of fundamental importance to the survival and growth of a number of economies in the southern African region. Its emerging importance in the traditionally non-mining countries adds to the key role that the industry is destined to play in the region as a whole. However, mining is an externally-driven and internationally competitive industry. To be assertive as an industry, its stewardship must reflect competitiveness of skills and competencies at the enterprise level. This report has highlighted a number of issues and constraints related to the availability and development of mining skills in the subregion. For the survival and growth of the industry in the subregion, it is imperative that these obstacles are addressed.

The **numerical insufficiency** of skilled manpower is present in all countries in the subregion to varying degrees. At the same time, facilities for the developing of skills and competencies are very limited and mostly concentrated in only three of the subregional countries. Although there is a shortfall in output from present facilities in certain skill categories, the magnitude of deficiencies points to the view that the available facilities are sufficient to meet the skilled manpower requirements of the subregion. For most countries, it would not be cost-efficient to establish parallel facilities due to the various constraints they individually face such as the small demand for the various categories of mining skills, lack of financial and institutional capacity, insufficiency of matric-level candidates, etc. The numerical levels of skills in the subregion can be improved by undertaking the following measures, among others:-

a) expansion of volumes at the present institutions which are operating at below their capacities;

b) extending the present cross-country training arrangements to accommodate more students from other countries. This could benefit from institutional arrangements to provide for a quota system for students from SADC countries. It would also require structures for sponsorship given the perennial funding constraints characteristic of the subregion. SADC's efforts to explore the establishment of a scholarship fund for financially distressed students is therefore a step in the right direction.

c) a continuum of opportunity to upgrade skills training, such as from diploma to higher national diploma, to degree level and other specialised skills, should be promoted. Bridging schemes to accommodate science graduates also help increase the numbers enroling in the mining disciplines at degree level. Similar schemes, to compensate for academic entry deficiencies, at lower levels should be encouraged to improve the skills and competencies of the large semi-skilled work force. Some of these practices are already being implemented on a limited scale or being contemplated, particularly in South Africa.

The **academic institutions must be strengthened** in order to operate at higher capacities as well as improve the quality of

graduates. The delivery of educational and training is a dedicated partnership between Government-funded institutes and industry. Government cannot abrogate its obligation to provide buildings, laboratory infrastructure, books and journals, and pay decent salaries to retain teaching staff. If the member States want the mining sector to anchor their national economic growth, then the interminable budget difficulties for infrastructural development should be overcome. Innovative arrangements for raising supplementary funds to Government's own contribution to education and training, should be explored. This could include: a revolving fund to which contribution qualifies a company for rebates; establishing a training support fund from royalties and other forms of economic rent charged to mining companies; and lobbying for direct support from industry. Inter-institute links could also contribute to strengthening academic training. Such links include external examinerships, sabbaticals, electronic links into data bases and library holdings, and attendance of seminars and professional lectures on specific topics.

Industry's role in education training must be strengthened especially in the non-mining countries. As the major consumer, industry is obliged to play its part in developing skills to suit its requirements. However, education and training is a business cost which industry would naturally like to minimise. Graduates from under-funded state educational systems possessing insufficient practical orientation but an abundance of expectations are of little use to industry and add to re-training costs. Practice in mature mining economies, including South Africa where industry funds the major part of academic institutes' operational budgets, reveals a number of areas in which industry's role makes the difference in the delivery of mining skills and competencies. These include:-

a) maintaining well-structured and career oriented in-company training schemes which strengthen the practical component of learning.

b) award of scholarships and providing facilities for the practical component during vacations. The practice in South Africa and Zimbabwe of spending a year in industry prior to or during academic study is beneficial and strengthens the understanding of the work environment.

c) representation on training and advisory units of academic

institutes to ensure curricula are of relevance to industry.

d) providing material support to research programmes, equipment and journals to make academic teaching more stimulating and directed at the solution of technical problems in the industrial operational environment.

e) funding some teaching posts to ensure that good and experienced lecturers do not leave academic institutes;

f) participating in the definition of industry-wide competencies in collaboration with academic institutes.

Chambers of Mines, which are neutral bodies for collective industry action must play a prominent role in discharging these tasks. The burden for the provision of the above material support should also be lessened by the fact that mining-related academic institutes in the subregion are few.

There is a strong case to be made for the **unification of skills and competencies** in the subregion. Lack of competency-based certificates have diluted management and technical operational practice especially in countries with previous State controlled mining operations. Harmonisation of competencies, however, requires a SADC-wide integrative framework for the definition and identification of standards on which the competencies are based. This would provide legitimacy and portability of such competencies from one company to the next, as well as among the countries of the subregion. Furthermore, the competencies should provide for similar credit and benefit across the participating countries. As a practical step towards this, a SADC Mining Industry Qualifications Board could be instituted composed of representatives from the Chambers of Mines or mining corporations, where not possible, SADC and academic institutes. A national initiative in this direction is well advanced in South Africa. This could be used as a basis for designing the SADC competencies. The argument for the unification of skills and competencies is strengthened by the fact that the major mining companies in all the countries are the same and mostly from within the subregion.

The notion of a SADC-wide competency-based qualifications framework favours the **free mobility of skilled manpower** within the

subregion. This may run contrary to national aspirations and the traditional view of replacing expatriate labour force. This is especially so in countries whose industry is under privatisation like Mozambique, Tanzania and Zambia, where the levels of expatriate manpower are increasing, as well as in Botswana and Namibia where expatriate levels have traditionally been high. Governments always have an acknowledged responsibility to provide for human resources development of nationals and have a vision for fully autonomous local management structures even within private mining companies. At the same time, the concept of subregional integration favours the liberal migration of skills, particularly in a subregion where the stock of mining companies are the same. Governments' role should be to ensure that education and training opportunities are available to nationals and that they get the same job opportunities as any similarly qualified SADC national. Mining corporations should undertake, on the other hand, that career path ladders in their corporate structures discriminate only on basis of performance and not nationality. This proposal may well require re-adjustments in attitudes both by Governments and mining corporations but should create a healthy spirit of competition within the corporate career ladders.

For most countries in the subregion, there is need to **strengthen Government mining departments** to better interface with the private sector in their regulatory, promotional and monitoring functions. The departments are in many cases staffed by inexperienced officers and the numerical numbers are often insufficient. Major areas of weakness include environmental, health and safety aspects of mining which have either been traditionally ignored or weakly enforced. Additional areas of difficulties have been in interpreting mining laws, contract negotiations, financial analysis and issues of mineral tax. UN institutions such as ECA, the Department for Development Support and Management Services, and the World Bank, as well as bilateral and Multilateral donor agencies should provide technical support to build capacities in planning, management and monitoring of mining operations at all levels including small scale mining. With respect to environmental control, international mining companies should be partners in this as they can help to bring to the region the best practices in environmental abatement characteristic of their home countries.

Small scale miners must be empowered with basic knowledge to make their mining operations safe to humans and the environment. Firstly, there is need to increase the number of dedicated short

courses of a practical non-academic nature in fields such as exploration and mining techniques, rock mechanics and ground support, environmental management, equipment maintenance and elementary business and financial skills. Secondly, there is need to explore ways in which their participation in such programmes could be enhanced in the light of the present fees constraints they face. Capacity building for small scale mining is also an area in which Government mining departments, academic and other training institutes could lobby the UN system for material and technical support.

Specialised training must be encouraged in a number of areas including MSc. programmes in geochemistry and geophysics. Other fields include rock mechanics, mining geology, mineral economics, mine environment, production management, geostatistics, mineral process and flow sheet design. These courses should be designed in short modular form, such as the Graduate Diploma in Engineering (GDE) in South Africa, to afford the opportunity for practising engineers to undertake them without long periods of absence from their work places.

The above agenda for creating a sustainable pool of quality skills and competencies in the subregion reflects the integrative thinking required of all the major actors. Clearly, networking, promoting the spread of best practices and creating effective partnerships are concepts which must take root among education and training institutes and Government departments, on the one hand, and mining corporations on the other. These concepts can only add to the overall aim of creating a competitive subregional mineral industry.

ANNEX I - COUNTRY PROFILES

Annex 1.1 - BOTSWANA

Overview of the Mining Sector

Botswana represents a rare paradigm in Africa where mining has decisively reversed the national economy from one of the world's poorest to one of the most thriving in Africa. The country's economic growth rate has averaged some 10% over the last two decades and is largely attributable to the mining sector (9). Significantly, mining contributes close to 90% to foreign exchange earnings, 40% to the GDP and about 6% to the country's formal sector employment. In terms of the multiplier effect, mining has been estimated to create 10 non-mining related jobs for every single mining job. Indeed, the majority of principal towns in Botswana have evolved through mining activities (9).

All this has happened in the post 1970 period! Prior to that, Botswana had a long nondescript mining history which was centred around small gold and base metal operations. Currently the country produces a variety of mineral products which include diamonds, copper, nickel, soda ash, coal, gold, manganese, clays and aggregate. By far the most significant of these are diamonds for which Botswana is the world's third largest producer by output after Australia and Russia (9). Production of diamonds is undertaken by Debswana Diamond Company in which the Government of Botswana and De Beers Centenary AG own equal shares. The company operates three mines; namely Orapa which hosts the world's second largest known kimberlite pipe, Letlhakane and Jwaneng which ranks among the world's richest mines. At current production levels, diamond reserves are reported to be sufficient to last beyond the next fifty years.

Copper and nickel are mined by Bamangwato Consolidated Limited (BCL) at Selebi-Phikwe. The product is a high grade copper-nickel matte containing small amounts of cobalt. Reserves are estimated at about 95 million tons (11). BCL's share holding is distributed equally between Government and Anglo American of South Africa. BCL also operates Selkirk mine, a smaller copper-nickel deposit on behalf of Tati Nickel Mining Company in which Anglo American and De Beers have a 43% shareholding (13).

Botswana has extensive coal reserves exceeding 17 billion tons of mostly bituminous grade. Morupule Colliery is the country's sole mine and is owned and operated by Anglo American Corporation. It produces about 900,000 tons of coal per annum most of which is consumed by a coal fired power station, BCL and Botswana Ash (Pty) Ltd. The latter company produces soda ash and salt at Sua Pan and is the only such mine in Southern Africa. It was originally owned by a private consortium of companies led by the South african Explosives and Chemical Industries (SAECI) Limited of South Africa and Government. It has, however, been recently restructured after provisional liquidation (10).

Other than these operations, Botswana has several small scale gold mines concentrated around Francistown. The more successful of these is the Monarch mine run by Mining and Development Ltd. There are also several small semi-precious minerals processing units, crushed stone quarries and a small manganese mine (9).

Notably, the Botswana mining industry is private sector-driven. Although Government is a share holder in the major mining companies, management is totally in the hands of the private sector partners. It is probably due to Government's responsiveness to private investors interests that mining has been so successful in Botswana.

Administratively, the mining sector is regulated by the Ministry of Mineral Resources and Water Affairs whose major development policy is to provide an enabling business and mining environment for continued private sector growth. The major arms of the Ministry are the Department of Mines, whose key functions are the evaluation of mining leases and monitoring of mining operations, and the Geological Survey Department, whose tasks include the compilation of the national geoscience inventory, undertaking fundamental research and controlling private sector mineral exploration.

Profile of Mining Skills

As earlier stated, the mining industry is a significant employer of labour in Botswana. The sector accounted for 13,272 of the 221,890 formal sector jobs in 1994. Table 1 shows a distribution of the skilled manpower in the industry at the end of 1995.

Table 1: Estimated distribution of skilled manpower in the mineral sector of Botswana

Skill Category	Government		Industry		Total	
	Filled	Vacant	Filled	Vacant	Filled	Vacant
Professionals						
Mining Engs	13	2	64	11	77	13
Min Proc.Eng/ Metallurgists	3	1	41	6	44	7
Geologists	32	13	32	2	64	15
Chemists	8	2	11	6	19	8
Surveyors	1	1	17	3	18	4
Other Eng.	9	1	38	8	47	9
Sub-Total	66	20	203	36	269	56
Technicians						
Mining	5	0	37	4	42	4
Min.Proc.	2	0	24	3	26	3
Geological	30	12	20	2	50	14
Survey	3	1	9	1	12	2
Chem.Lab	9	6	6	1	15	7
Cartographer/D'men	10	4	7	0	17	4
Sub-Total	59	23	103	11	162	34
Artisans	-	-	461	37	461	37
TOTAL	125	43	767	84	892	127

Source: Ministry of Mineral Resources and Water Affairs, 1996.

The Government data includes the skilled manpower employed by the Headquarters of the Ministry of Mineral Resources and Water, and the Departments of Mines and the Geological Survey of the same Ministry. It also includes staff in the Department of Geology of the University of Botswana. The industry data includes the major mining houses which are Debswana and BCL, which had a labourforce of some 5,259 and 4,845 at the end of 1993, respectively. The industry data also includes Morupule Colliery, Botswana Ash and Monarch Gold Mine. These companies constitute the main employers of mining skills in Botswana. The data does not include the small quarries and gold re-processing operations which do not utilise mining skills in any significant proportion.

The significant point of Table 1 is that, unlike in some of the countries of the subregion, industry rather than Government is the major employer of mining skills in Botswana. This ofcourse merely reflects the size and strength of the industry. The sector shows a good distribution of mining skills with all the key quota of particularly mining and, to a lesser extent, metallurgical engineering, and geology being well represented. Although not shown in Table 1, the distribution of professional skills in the sector is largely accounted for by Debswana and BCL who between them employ 57 of the 77 mining engineers (74%) and 39 of the 44 metallurgists (88%). Debswana, alone employs 51% of the complement of mining engineers and 77% of metallurgists. The proportions for BCL are much less being 23% and 11% for the two categories, respectively. Notwithstanding this, the sector shows a vacancy of some 56 out of the 325 total professional posts. The bigger contributors to this are the areas of mining and geological skills although mineral processing engineers and chemists also show small deficits.

Table 1 also shows that the number of technicians is generally less than that of professionals, indicating that more effort is probably justified in training more technical support staff. The table shows 34 vacant posts out of an approximate establishment of 196. In the case of technicians the deficit is largest in the geological category.

A conspicuous aspect of the Botswana mining industry is the levels of expatriate manpower. Table 2 gives an indicative distribution of mining labour and the proportions of expatriate manpower in the industry in 1992. On average, the industry employed 8.7% of expatriate labour relative to the total labourforce during the year. Expatriate employment was above average at Debswana and Botswana Ash, a factor which may be related to the skill intensity of the operations. The expatriate factor is least observable at the colliery, the small scale manganese and gold mines and BCL. With the possible exception of BCL, this may be related to the labour intensity of these operations.

Table 2: Indicative distribution of mining labour in 1992

Company/Operation	Local	Expatriate	Total	%Expatriate
Debswana	4842	534	5376	9.9
BCL	4927	287	5214	5.5
MORUPULE COLLIERY	347	12	359	3.3
BOTSWANA ASH	464	196	660	29.7
JACOMAR MANGANESE	57	2	59	3.4
GOLD MINES	268	16	284	5.6
QUARRYING	533	44	577	7.6
TOTAL	11438	1091	12529	8.7

Source: Reference 4

One factor which is not explicit from Table 2 is the distribution of the expatriate labourforce in the mining industry. The data is insufficient to indicate this. Other studies (6) have indicated that the expatriate labourforce predominates in the job categories involving leadership and strategic skills. In 1986 for example, a survey found that all jobs in general management in the industry in Botswana were occupied by expatriates. In jobs at middle management level (such as mine and plant managers and superintendent), the fraction of expatriate labourforce declined to an average of 87%, while that for engineers, professionals and senior supervisors averaged 67%. These figures would not be expected to have significantly declined over the intervening period primarily due to a lack of skills on the local market.

The dominance by expatriate manpower in key decision-making jobs may always provoke sentimental and national spirits of patrimony. If the success of the Botswana economy is testimony to the benefit of international exploration and mine development capital, there would be a clear and inescapable case for recognising the exigencies of such capital which explicitly argues for the employment of universally competitive skills to remain assertive on world mineral and metal markets.

Major Developments and Demand for Mining Skills

Like mining, exploration activities in Botswana are dominated by the private sector, with De Beers being the leading company for the diamond sub-sector. Although healthy exploration efforts are

expended in Botswana, and private sector programmes have actually increased (10), there has been no significant major mine development in recent years. Most of current exploration, like that at BCL is aimed at extending reserves for existing operations, while major investments at both BCL and Debswana have been directed at improving productivity rather than creating new mine development.

It is reported (13) that Tati Nickel Mining is planning to open a nickel mine near Francistown with a planned production of 1.2 million tons per annum. No further information is available. There are also other small copper nickel deposits such as Phoenix and Thakadu/Makala which could be developed dependent on metal prices. On the balance of these considerations, there are no signs of significant employment creation in the immediate future arising from new mine development.

On the basis of present employment levels, estimates of the distribution of skills for the short term future have been compiled. The estimates are indicated in Table 3. The major feature of the table is that due to the present size and buoyancy of the industry, mining skills will continue to be in reasonable demand. For example, projections indicate a requirement of some 8 mining engineers, 4 metallurgists and 7 geologists per year. This demand is echoed for technicians.

The demand projections indicated in Table 3 are a baseline case which do not include small scale operators and skilled manpower in the many small quarries. As earlier stated, the quantum of skills in these areas is insignificant. The more significant bearing on the projected skill requirements is the expatriate factor. An express and deliberate strategy of indigenisation of the industry at the professional and managerial echelons would certainly inflate the projections significantly. Assuming the percentages of expatriate skills earlier given, the numerical demand for professional skills would more than double. However, this is somewhat hypothetical given the lack of sufficient skills locally.

At the Ministry level, little expansion in skilled manpower can be expected primarily due to budgetary constraints. The services provided by both the Departments of Mines and Geological Survey could certainly be improved by filling in the vacant positions. The Department of Mines plans to initiate metallurgical testwork services while the Geological Survey encourages professional staff to study for post graduate qualifications in

specialist geological fields. These efforts are not expected, however, to add significantly to the demand for skilled manpower in the short term.

Table 3: Estimated demand for mining skills during the period 1996 to 2001

Skill Category	Government	Industry	Total
Professionals			
Mining Engs.	5	33	38
Min. Proc. Engs/ Metallurgists	2	20	22
Geologists	21	13	34
Chemists	4	10	14
Surveyors	2	9	11
Other Eng.	3	21	24
Sub-Total	37	106	143
Technicians			
Mining	2	32	34
Min. Proc.	1	21	22
Geological	20	17	37
Survey	2	8	10
Chem.Lab.	8	5	13
Cartographer/D'men	7	7	14
Sub-Total	40	90	130
Artisans	n.a.	198	198
TOTAL	77	394	471

Source: Re-calculated from Table 1.

Mining Skills Development Facilities

Academic Facilities

Due to the short history of large scale mining in Botswana, the country's skilled manpower development facilities are limited and still developing. The only available degree level training in mining sciences is the 4 year general geology programme offered by the University of Botswana. Table 4 shows that the programme graduates an average of 9 geologists per year, equivalent to 36

over the next five years. Compared to the demand for geologists outlined in Table 3, and the expansion in private sector exploration activities, the internal capacity to supply geologist skills is about sufficient. Currently, no specialist postgraduate programmes in geology exist although there are plans to introduce an MSc. course in hydrogeology. The undergraduate programme in geology is also being revised to include more field classes, an area perceived (10) to be weak at present.

Table 4: Academic mining training programmes available in Botswana

Level	Course	No. of Graduates					Total
		1996	1997	1998	1999	2000	
Degree	Geology	9	9	9	9	9	36
Diploma	Mining	10	10	10	10	10	50
	Min.Proc.*						
Certificate	Mine Surveying*						
	Min.Proc.*						

Source: Ministry of Mineral Resources and Water Affairs, 1996
* Planned programmes.

With respect to the other mining skills, Botswana has no academic training facilities to degree level. Mining, mineral processing and metallurgical engineers have always been trained overseas, particularly in South Africa, Zimbabwe, Canada and the United Kingdom. Estimates contained in Table 3 indicate that Botswana needs to train about 8 mining engineers and 4 metallurgical/mineral processing engineers per year to fill up present vacancies and maintain current levels of mine production. Allowing for a modest expansion in mine output and expatriate replacement, the demand for these skills is likely to be much higher. Clearly, there is a daunting task for the country to keep abreast with the demand for mining and processing engineers.

At the technician level, the Botswana Polytechnic, renamed the Faculty of Engineering of the University of Botswana, offers a 3 year diploma in mining engineering. This is the only diploma level

course offered in the country. With an estimated output of 10 graduates per year, the faculty is clearly able to cope with the current projected demand of some 7 mining technicians per year. The diploma has a sandwich structure with a mandatory 6 month pre-entry industrial experience period, followed by alternate years in college and industry. This system results in well-grounded diplomates.

Comparison of Tables 3 and 4 indicates that the greatest shortfalls at technician level are for mineral processing and geological technicians. These have sometimes been trained at the Bulawayo School of Mines in Zimbabwe. The faculty of engineering is planning to establish certificate courses in mining, mine surveying and mineral processing, and a diploma course in the latter. These courses may go a long way in alleviating the demand for these skills.

The academic facilities in Botswana are good and are well funded. Contacts with industry are also good and strengthened with the existence of the Mining Industrial Advisory Committee which meets every 2 months to review progress and course content of the Faculty of Engineering. A major problem for Botswana is, however, the sheer lack of numbers imposed by the county's small population which makes the availability of a pool of qualified people limited. As a result, Botswana does not currently produce large numbers of matric level students suitable for graduate and post diploma programmes. This factor also mitigates against the establishment of large training institutions, a consideration totally at variance with the country's vibrant mining industry and the strong demand for mining skills.

In-Company Training Schemes

Botswana's main mining companies, namely Debswana, BCL, Morupule Colliery and Botswana Ash, are all part of large international mining houses. As would be expected, they are well organised and have well established manpower development programmes at various levels. The bigger companies like Debswana have a fully fledged Manpower Development Unit, while for smaller companies like the Colliery, the manpower development function is overseen by personnel officers. Also the two big companies BCL and Debswana have more comprehensive training schemes ranging from graduate integration, to supervisory and management training, and technician/artisan training schemes. Smaller companies like the

Colliery have no local graduate development programmes and rely on sister companies for artisan training. More or less all the companies use the Patterson Job Grading Scheme, supplemented by internal performance criteria, to assess the suitability of candidates for specific job categories and gauge training requirements. For most of the companies, this is done at yearly intervals. Most companies also agree that the curricula, particularly at technician and lower levels, should be re-designed to multi-skill the mining labourforce.

Most of the companies are unanimous that fresh graduates suffer from lack of experience and exposure, too high expectations and therefore show a high turnover rate. All companies complain about non-availability of suitable graduates from the open job market including, at times, fresh geology graduates. This appears to be one of the main reasons there is a high expatriate labourforce in Botswana. In relation to specialised skills like process and flowsheet design, project engineering, ore reserve estimation, mine planning and development, these are done mostly by expatriates either at mine site or through parent companies in South Africa. For example, BCL has the potential to employ 5 metallurgists and 5 engineers to flowsheet development and project engineering functions but cannot obtain CAD literate candidates from the open market. Graduate geologists and mining engineers are available and are being locally developed in ore reserve estimation and mine planning although sufficiency of numbers a problem.

With respect to specific in-company training facilities, the most notable is the dedicated state of the art Debswana Management and Training Centre located at Jwaneng Mine. The centre offers a wide variety of courses from secretarial to management skills development programmes. A summary of the courses offered at the Debswana Management Training Centre is shown in Table 5. Similar training programmes are conducted by BCL to suit their requirements. In addition, Debswana runs an artisan training centre at Orapa Mine which is also used by other companies including the Colliery. Various trades including boilermaking, electrician, fitters, machinist, rigging, fabrication welding, etc are taught over a four year period. As a reflection of their strong commitment to training, Debswana had at the end of 1993 a total of 155 sponsored students engaged in studies in various disciplines at universities or specialised institutions at home and abroad.

Table 5: Course programmes offered by the Debswana Management training Centre at Jwaneng.

COURSES

1. **Management/Supervisory Development Programmes**

   Supervisory:
   Shopfloor Supervisory Development Programme (SSDP)

   Junior Management:
   Supervisory Development Programme (SDP)

   Middle Management:
   Leadership Programme for Middle Managers (LPMM)

2. **Performance Management Skill**

   Supervisory & Junior Management:
   Day-to-Day Performance Management Skills
   Performance Management Skills

   Middle & Senior Management
   Management Support Programme
   Maximising Performance

3. **Shopfloor Relations Workshops**
   Junior & Middle Management:
   Conflict and Grievance Handling
   Creating Positive Employee Relations
   Handling Disciplinary Enquiries
   Performance Counselling

4. **Financial Skills**

   Budget Holders:
   Budgeting and Cost Management

5. **Team Problem Solving & Improvement Skills (TPSI)**

   Supervisory & Junior Management:
   Analytical Trouble Shooting (ATS)
   Participate & Contribute to Solutions (PACTS)

   Middle Management:
   Rational Management Skills

6. **Lifeskills Workshops**

   Supervisory & Junior Management:
   Assertive Communication Skills
   Career Exploration and Planning
   Self Development Workshop
   Shopfloor Customer Service
   study and Examination Techniques
   Time Management

   Junior & Middle Management:
   Building Productive Teams
   Coaching and Counselling
   Conflict Resolution in Personal and Professional Relationships
   Creative Problem Solving
   Selection Interviewing Skills
   Stress Management

   Middle & Senior Management:
   Customer Service
   Making Meetings Work
   Mentorship Workshop
   Motivating Employees
   Project Management

7. **Secretarial Skills**

   Secretaries:
   Secretarial Development Programme

   Managers:
   Effective Use of a Secretary

8. **Computer Programmes**

   Computer Users:
   Introduction to Personal Computers
   Coreldraw Basics
   DBase IV
   DBase IV Workshops
   Quattro Pro 5 for Dos
   Quatro Pro Workshops
   WordPerfect 5.1 - Advanced Windows
   WordPerfect 5.2 for Windows

9. **AIDS - Information Education & Communication Skills**

   Counselling Skills for AIDS
   Creating AIDS-Supportive Environment in the Workplace
   Home-based Care
   Peer Education for AIDS

Source: Reference 10

In summary, Botswana has a strong and continuing demand for mining skills due to the large breadth of its mining industry. This demand is strengthened by current deficits and a significant presence of expatriate labour in the sector. The gap between demand and supply for mining skills is in all areas excluding geologists and mining technicians for which training facilities exist. To close the gap, the country is certainly going to rely on cooperative arrangements with external institutions for the supply of its requirements for mining skills.

Annex 1.2 - MALAWI

Overview of the Mining Sector

Although Malawi has always been considered as an agricultural country, it does not entirely lack mineral resources. Major reported minerals include gemstones, vermiculite, phosphates, bauxite, heavy mineral sands, clays and glass sands, kyanite and graphite. Most of these deposits are, however, small with the exception of bauxite and heavy mineral sands. At 28 million tons of reserves, the Mulanje bauxite deposit constitutes the largest known deposit in the eastern and southern African subregion, while large at 70 million tons, the heavy minerals sand deposits are perhaps small even by regional standards.

In line with the small known mineral portfolio, mining in the country has never been of major economic significance. Mining operations have always been dominated by small scale lime burning activities, quarrying for aggregate and cement production, small scale gemstone and coal mining operations. The total contribution of these activities to GDP is reported (14) to be less than 1%.

Profile of Mining Skills

Due to the limited capacity of the mining industry, it has never been a major employer of mining skills. Table 1 shows employment levels for the industry in 1991. The total employment figure of around 3,500 includes the main reported mining operations comprising coal, aggregate for road construction and limestone for

Table 1: Mining Industry Employment Figures for 1991

Mineral	Employment
Coal	560
Aggregate	828
Dolomite	191
Limestone for Cement	730
Limestone for Lime	1,153
Gemstones	N/A
Total	3,462

Source: Reference (15)

N/A: Figures not available

cement production. It also includes the small scale lime burners dotted around the country but excludes gemstone miners a number of whom operate illegally. The figures show that the small scale lime burners constitute by far the biggest group of miners although they do not possess any formal skills. In terms of employment creation, they are nevertheless a significant factor, particularly in terms of economic empowerment of rural communities.

The major mines in Malawi are the labour-intensive coal mine at Mchenga which in 1995 employed 519 people and the Portland Cement Company quarry at Changalume with a labour force of 149 for the same year. Some indication in the skill deficiencies in the industry may be given by the numbers of mining engineers employed by the two companies in 1995. Despite the relatively large employment levels, the coal mining company had two mining engineers during the year, while the cement quarry had one engineer with only diploma level qualifications.

That the industry lacks skills may further be shown by examining the distribution of skills in the aggregate industry. A survey of six quarries, through records held at the Department of Mines, employing some 227 people, revealed that none had personnel with formal mining qualifications at any level. Most employees had been trained on site while some of the experienced ones had been migrant workers in South Africa, Zambia or Zimbabwe. For example, in 1987 there were 3,220 Malawian citizens working on the gold mines in South Africa but this had dwindled to zero by 1991 (16). By and large, mining operations in Malawi, particularly for gemstones, appear to be dominated by this group of semi-skilled workers.

The principal employer of mining skills in Malawi are the Government Departments of Mines, the Geological Survey and, to a lesser extent, the Department of Water Affairs, who employ a number of hydrogeologists. Table 2 shows the distribution of skilled manpower in the three Departments. For the Department of Water, only geologists have been included in the data but not support skills because the Department cannot be regarded as a mainstream mining institution.

The commanding feature of Table 2 is the conspicuous shortage of mining skills at all levels. At the Department of Mines all sections are understaffed. Particularly severe is the lack of mining engineers of whom there are only two on hand for all the departmental sections against a requirement of 16. The mineral

processing laboratory is currently manned by a laboratory assistant who is unqualified even at diploma level. The only mineral processing engineer available in the Department is the Acting Chief Mining Engineer. The inspectorate section of the Department also needs gemologists to monitor the gemstone operations; none are available in the country.

Table 2: Distribution of skilled manpower in the Departments of Geological Survey, Mines and Water

Skill Category	Establishment	Filled	Vacant
Professional			
Mining Engs.	16	4	12
Min. Proc. Engs.	3	1	2
Geologists	48	27	21
Gemologists	2	0	2
Chemists	4	3	1
Computer Analyst	1	0	1
Sub-Total	74	35	39
Technicians/Artisans			
Mining	5	1	4
Min. Proc.	2	1	2
Geology	5	4	1
Chem. Lab.	5	3	2
Cartographers	3	2	1
Engineering (Drillers)	3	2	1
Sub-Total	23	12	11
Total Skilled	97	47	50
Administration	44	37	7
Unskilled	41	23	18
Total Labourforce	182	107	75

Source: Departments of Geological Survey, Mines and Water, 1995.

At the Geological Survey, the circumstances are similar. The Survey faces constraints in its activities due to a number of posts which cannot be filled. Although partly due to financial constraints, the major reason for this is the unavailability of qualified manpower which limits recruitment levels. Continuing financial limitations have further resulted in an inability to retain qualified manpower. Between the Survey and the Department of water, only about 50% of established posts were filled.

The situation for middle level skills is not much different. Major deficiencies occur in the mining and mineral processing technicians categories. The problems of the Departments enumerated above do not restrict themselves to the shortages of skills and funds. The available trained staff, though motivated, are largely inexperienced and have had very little hands-on experience.

Major Developments in the Sector

The mining industry in Malawi may be embryonic. However, there is a definite air of optimism in the present Government that the minerals industry can play a more significant role as a foreign exchange earner and in the creation of employment. Evidence for this may be found in the relocation of the mining portfolio from the Ministry of Natural Resources to that of Energy and Mining, and also in the number of current mineral projects. Some of the projects are at advanced stages of feasibility studies.

Table 3 summarises the main planned projects. Major plans include the expansion of coal production from 50,000 to 120,000 tons per year, possibly rising to 300,000 tons per year. Most of this would be consumed by a proposed 400 MW thermal power station. Companies involved in coal projects include MDM of South Africa, Russell Engineering of Australia and Inde Fund, a local company.

Table 3: Planned mineral development projects and their status during 1995

Mineral/Location	Company	Status
Coal/Mchenga	MDM, S.A. Inde Fund, Malawi	Development
Gold, Platinum, Nickel and Chromium; Lilongwe	Sub-Saharan Min. Res. Co., Canada	Exploration
Limestone (Cement Prod) Kasungu	Shayona Cement Corp.	Development
Graphite, Katengeza	Malawi, Dev. Corp. and Ind Fund	Development
Black Granite	Chen Ta Chuan, S. Korea	Market Analysis
Ruby, Sapphire	Minex, S.A., Central Emerald, SA, Willard Int'l (UK) and Mal. Indust. Corp.	Initial Prodn. stage
Bauxite, Mulanje	Government	Feasibility

Source: Department of Mines, 1995

Two other projects which have progressed past the feasibility stage are the Shayona Cement and the Mulanje Bauxite projects. Estimates by the Department indicate that the former will create 221 jobs while the latter will have a total labour force of 469 employees. Assuming that a number of the projects are developed, there can be little doubt that the demand for mining skills in Malawi would experience growth.

Unfortunately there are not many signs yet that the projects at the development stage will be implemented in the near future. The Shayona Cement Corporation, Katengeza Graphite and Mulanje bauxite projects have all been on the drawing board for several years. The bauxite project, which is really the first major mineral development project in Malawi, has the blessings of SADC. Its full development is, however, likely to be influenced by the market dynamics for bauxite and aluminium products in southern Africa, particularly in South Africa which is by far the major consumer in the subregion. This is more because Gencor, the major South African investor in aluminium products has much bigger operations located in Australia, Brazil, Guinea, Ireland and Suriname which are the major sources of South African bauxite and alumina. The company may therefore well not feel beguiled by the small nature of the bauxite project in Malawi.

Notwithstanding this, attempts to project the required skills complement in the mining industry in the next 5 years were made with the help of the Department of Mines. The resultant data is indicated in Table 4. It is apparent that to sustain the present level of mineral development plans and provide a base on which a viable mining industry can flourish, Malawi is going to require a wide range of mining skills in numbers which are presently unavailable. Major deficiencies occur at all levels including particularly mining and mineral processing engineers, and geologists. In addition mining, processing and geological technicians are required to support the activities of professional manpower.

An added problem in Malawi is the lack of skills for the administration of the Mining Act and provision of basic services to industry by Government Departments. For example, the Department of Mines offers technical extension services to small scale miners in environmental control, mining safety and efficient methods of lime burning. It also offers services in mineral processing bench scale

Table 4: Estimated skill requirements for the mineral sector during the period 1996 to 2001

Skill Category	Industry	Government Departments	Total
Professionals			
Mining Engs.	16	13	29
Min. Proc. Engs.	10	3	13
Geologists	20	28	48
Gemologists	4	2	6
Chemists	n.a	2	2
Surveyors	5	n.a	5
Sub-Total	55	48	103
Technicians			
Mining	20	5	25
Min. Proc.	10	2	12
Geological	20	3	23
Chem Lab	n.a	3	3
Cartographers	n.a	2	2
Drillers	n.a	2	2
Sub-Total	50	17	67
TOTAL	105	65	170

Source: Industry data was estimated by the Department of Mines. Government data has been recalculated from Table 2.

tests and conducts seminars in mine planning and the use of explosives. It plans to develop a capability to conduct full feasibility studies for potential mine developers. The Geological Survey, on the other hand, offers services in geochemical analyses, drilling and quarry siting and are planning to establish a full division to cater for mining, environmental and engineering geology. The ability to offer these services is limited far more by unavailability of appropriate skills than funds.

The above weaknesses suggest that to develop the industry in Malawi, the Government Departments will initially need strengthening so that they can provide policy direction to, and management of, the emerging mining industry. In this connection, Table 5 shows the current 5 year training programme for the Department of Mines. Given the severe skill shortages outlined in Table 2, it is clear that the Directorate does not only lack

numbers but also a range of specialised skills required to preside over the industry. These skills are needed at several levels

Table 5: Projected training requirements for the Department of Mines (1995-2000)

Level	**Programme**	**No. of Candidates**	**Objective Function of Training**
MSc	Mineral Economics Mineral Processing Mineral Law and Environment Mineral Techniques and Design Mine Production Management	1 2 1 1 1	Management and Policy
BSc	Mining Engineering Minerals Engineering Quarry & Explosives	2 2 1	Professional Implementation of Activities
Diploma	Mineral Processing Gemology Mine Surveying Quarry & Blasting	2 3 2 2	Technical/ Practical Implementation of Activities
Certificate	Occupation Health and Safety Mining & the Environment	1 2	
TOTAL		23	

Source: Department of Mines, Lilongwe.

including decision-making, professional competence in programme implementation, augmented by practical skills at diploma and certificate levels. To reinforce practical skills, academic qualifications will need to be supplemented by regular and systematic attachment to mining houses, government departments and other institutes in the neighbouring countries where a mining culture is entrenched. These thoughts are indeed a daunting task for a country like Malawi seeking to create a sustainable base for the development of its mining industry.

Mining Skills Development Facilities

In line with its history as a non-mining country, mining skills development facilities in Malawi are more or less non-existent. There are no training facilities devoted to mining

disciplines at any level. The closest earth science training programme is that for a geology major offered as part of a general four-year BSc. programme in the Department of Geography and Earth Sciences, at Chancellor College in Blantyre. There is no stand-alone full time geology programme, as is common practice. The programme comprises a curious spectrum of courses of geology, mathematics, chemistry, physics, biology and geography. There are no geological field programmes to anchor graduates in the geology major. Furthermore, the teaching of the geology component is constrained by a serious lack of lecturers; there being only two full time and one part-time lecturers. Professional opinion (14) indicate that the programme lacks depth and covers about 30% of a "normal" geology programme.

The above difficulties result in geology graduates of little use to the mining sector. Even then, the numbers of graduates are totally insufficient. Table 6 shows that on average, 5 students per year graduate with a geology major. Of this two would join the Geological Survey while the other three join the Department of Water Affairs. At this rate of output and nature of graduates, it is clear from Table 4 that the mining sector's requirements cannot be met, at least in the immediate future.

Table 6: Graduating students with a Geology Major from the Department of Geography and Earth Sciences, Chancellor College.

Year	1991	1992	1993	1994	1995	Average
Graduating Students	8	2	3	4	6	5

Source: Department of Geography and Earth Sciences, Chancellor College.

To partly remedy this, the College is planning to create an independent Geology Department. The course structure has been revised to increase the depth and variety of geology subjects. However, funding to implement the changes has not been secured. In addition to increasing the number of teaching staff, the existing laboratory facilities are for physical geography. New geological laboratories would be required. Although these plans were to be implemented by 1996, it is now accepted (1) that this will take another few years.

It is clear that the development of mining skills in Malawi poses a dilemma of sorts. Due to the small mining base, the absorption rate of trained manpower would not make training institutions sustainable in the long term, with the possible exception of that for geologists. This has been recognised by the Ministry of Energy and Mining whose policy is to encourage the use of training facilities in South Africa, Zambia and Zimbabwe. However, sponsorship has been a problem. To circumvent this, the Ministry has tried to establish formal training links through joint-commissions, like the one between Malawi and Zambia, to take advantage of student exchange programmes. Little progress has, however, been achieved in this direction. Perhaps the political discourse of such commissions overwhelms the rather expedient needs of training for an industry desperately needing to be jump-started.

Annex 1.3 - MOZAMBIQUE

Overview of the Mining Sector

Mozambique has a large and diverse mineral potential which includes coal, rare earth and beach sand minerals, gold, gemstones and a variety of industrial minerals including graphite, phosphate and dimension stone. The reserve base of some of these minerals is quite large. This is particularly so for coal with reserves of 9.75 billion tons, phosphates at 274 million tons, titanium sands at 438 million tons and graphite with reserves of 40 million tons (17). Despite the considerable mineral wealth, commercial mining has played a relatively insignificant role in the national economy of Mozambique.

Traditionally, mining activities in Mozambique were restricted to State-owned companies. In recent years, however, private companies have been allowed into the industry, although State-owned companies are still present. Current mining activities are limited to gold, gemstones, bentonite, graphite, coal, bauxite and quarrying for dimensional stone, aggregate and cement production. More or less all the operations are, however, small by industry standards.

In gold, the two major mines are Monarch Mine and Alluvioes de Manica, both located in Manica Province. The former is operated by Mincor Mozambique Lda, and is linked (19) to the Johannesburg Consolidated Investment (JCI) of South Africa. The latter is a joint venture between Lonrho and the State but the mine is operated by Benicon, a South African Company, under a lease arrangement (19). Pirate gold mining is a major problem, particularly in Niassa Province near the border with Tanzania where it is reported that in 1993, some 2,500 people were engaged in illegal mining and smuggling activities in the area. Official mine production of gold is reported (20) to be about 1 ton/year. If illicit sources are included, production is estimated to be between 3 and 4 tons/year.

Like gold, gemstone mining is dominated by illegal and small artisanal operations. Prescribed mining activities are undertaken by Geras Pedras Lapidadas (GPL), a State-owned company, which operates in partnership with Hagura of Israel. Operations have involved garnet mining at Cuamba, Niassa Province and emerald mining at Gile in Zambezia Province. The bentonite mining activities are undertaken by the State company, Companhia de Desenvovimento Mineiro (CDM). Operations are on an ad hoc basis due

to financial, technical and marketing problems. As a result, the company has been set aside for privatisation. CDM also operated the Marmonte Marble Mining and Cutting Company at Montepuez but this too has been privatised.

Graphite mining is represented by the joint venture company Graphites de Ancuabe, owned by Kenmere Resources of Ireland, Government and the Commonwealth Development Corporation (CDC). The company commenced operations at Ancuabe, in Cabo Delgado Province, in 1994. Bauxite mining is undertaken on a small scale at Mina Alumina, at Serra de Moriangane in Manica Province. The mine is owned by Meikles and Co. of Zimbabwe to which country the bauxite is sent for the manufacture of aluminium sulphate. Other mining activities include quarrying for aggregate and cement production. Originally under the Ministry of Construction, the country's three cement plants located at Matola in Maputo, Dondo near Beira and at the port of Nacala, have recently been privatised.

The insignificant contribution of mining to the national economy, is ironical because Mozambique has a previous history of mining. In Manica Province, there are more than 40 abandoned gold mines (1). Also in Manica Province, a copper mine with an installed capacity of 200,000 tons per month was closed down in 1990. At the time, the mine was producing about 40,000 tons/month. Other mines which closed down include a tantalite mine at Morrua and other several small mines. Perhaps a more significant example of the decline in mine output is the Moatize Colliery, operated by the State-owned coal mining company, CARBOMOC. The mine, after a previous peak production rate of 600,000 - 800,000 t/a, produced only 693 t/a of coal in 1993, by which time mining operations had come to a virtual standstill (18).

There are many reasons cited for the decline in mine output. The more obvious and overriding one is the country's insecurity situation which persisted until the UN supervised elections in 1994 and which made both exploration and mining activities unsafe. More technically inclined reasons, however, include, the incomplete geological data, a previously underdeveloped and politically inclined legal and business environment, the lack of financial resources for exploration and mine development and probably most importantly, the lack of skilled human resources following the exodus of expatriate manpower after independence in 1975.

Administratively, the industry is regulated by the Ministry of Mineral Resources and Energy which operates through a central Management Department, 10 Provincial Directorates, and the National Directorates of Geology, Mines, Coal and Hydrocarbons and the

Office for the Coal Programme. The Ministry is also responsible for the State mining companies, the main ones being the coal mining company, CARBOMOC, CDM and GPL which were earlier mentioned.

Profile of Mining Skills

Like in the other economic sectors in Mozambique, employment patterns in the mining sector has historically been influenced largely by the political atmosphere in the country. Following independence and nationalisation of the industry, the State through the Ministry of Mineral Resources and Energy became the major employer of mining skills both in its own right and through a number of companies directly under its control.

Table 1 gives the present numbers and distribution of skills in the mining sector of Mozambique. The data includes employment statistics in the major Government Departments concerned with mining activities, the State enterprises and the private sector. It does not include employment in the informal mining sector, mainly comprising gemstone and gold mining, for which statistics were impossible to obtain. It does not also include the private sector-based exploration companies.

The Government data was primarily based on the skilled manpower employed by the Departments of the Ministry of Mineral Resources and Energy outlined earlier. Other minor Government employers of mining skills, such as the Institute of Housing Research, and the University of Maputo were also included. The main State enterprises included were the National Oil and Gas Company, CARBOMOC, CDM, and GPL. The private sector companies included Monarch and the Alluvioes de Manica gold mines, Mina Alumina Lda, Graphites de Ancuabe and Marmonte Marble de Montepuez. The two gold mines are the largest employers in Mozambique with a combined workforce of about 500.

In terms of numbers, Table 1 suggests that the mining sector in Mozambique is small employing a complement of some 217 people in skilled manpower positions. It is also observable that Government, together with the State-owned enterprises, has continued to be the major employer of mining skills in Mozambique. Of the estimated 217 skilled jobs, 131 or 60% were in State employment. In the professional (Licenciados/Bachareis) category, the fraction of skills directly employed by the State increase to about 65% or 70 out of the total of 108 personnel.

Table 1: Distribution of mining skills in the formal mining sector of Mozambique

Skill category	Government Departments	Industry parastatal	Industry private	Total
Licenciados/Bachareis				
Mining Engineers	6	3	9	18
Mining Proc. Eng.	2	2	7	11
Geologists	39	6	12	57
Chemist	3	2	4	9
Surveyors	0	2	2	4
Gemologists	0	1	0	1
Other Engineers	3	1	4	8
Sub Total	53	17	38	108
Technicas Medios				
Mining	0	5	6	11
Processing/metallurgy	0	0	4	4
Geology	6	6	6	18
Survey Technician	5	2	4	11
Chemical lab tech	9	0	6	15
Cartographer/D'men	1	1	2	4
Sub Total	21	14	28	63
Artisans	5	21	20	46
Total	79	52	86	217

Sources: Ministry of Mineral Resources and Energy, personal interviews and reference (18).

Of greater interest, however, is the distribution of mining skills. Table 1 indicates that there is a predominance of geologists, particularly in Government Departments, but also in the State-owned enterprises and the private sector. 75% of all professionals employed by Government Departments are geologists while if the State-owned enterprises and the private sector are included, this figure drops to about 53%. Notably, there are far less mining engineers and even lesser mineral processing engineers in the mineral sector of Mozambique. The estimated combined total for this group of skills is only 29 out of 108 people. This is only 27% of the total number of people with professional skills. The

table also shows that other professional skills, such as mine surveyors and gemologists, are in short supply.

In the case of technician and artisan level skills, (with Technicos Medios qualifications), similar trends are observable. The complement of geological and chemical technicians is predominant, particularly over mining and mineral processing technicians. Noticeable also is the small numbers of cartographers in the sector.

Part of the reason the numerical strength and skill base of the mining sector is small is that there has been a sustained decline in mining operations due to the insecurity situation as explained earlier. Naturally, the decline occurred far more in industry due to the location of mines while employment levels in administrative Government Departments increased substantially. An understanding of the decline in employment levels may be gleaned from the number of jobs lost through the closure of the copper and tantalite mines in Manica and Zambezia provinces, respectively, and the reduced level of activities at Moatize Colliery. For the three operations, the total number of jobs lost was estimated at 1,450 (20). This is about double the current labourforce in the new private sector mines.

Unfortunately, the fraction of skilled manpower jobs lost is not known. An indirect indication of this may be shown by considering the present skill base of the two main surviving State enterprises CDM and GPL. CDM previously operated a number of the closed mines and was the major employer of mining skills in the country. When visited during the survey, the company's sole surviving mine was the bentonite operation at Boane which employed a total of 15 people with a professional staff of 1 geologist, 1 mineral processing engineer and a chemist. At GPL, who were also visited during the survey, the total skilled manpower staff comprised 1 mining engineer, 1 geologist, 1 gemologist, 1 mining technician, 1 geological technician and 2 laboratory technicians. Furthermore, the private sector partner provided virtually all the professional staff under a management agreement. GPL was obliged to provide senior staff at deputy director level but suitable candidates were not available. Also local mining engineers and experienced geologists were not available. Ironically, reports (20) indicate that there were more than 200 geologists in Mozambique prior to the war compared to the present estimate of 57.

A feature of the private mining operations not shown in Table

1 are the levels of expatriate staff. For Monarch and Benicon gold mines, which are the two major employers in the private sector, their complement of professional staff for the categories indicated in Table 1 was 21 out of which 17 were expatriate staff. Thus more or less all professional staff at the two mines were expatriate. Generally, foreign-based private mining companies have argued that qualified local people are not present in sufficient numbers and that the few that are available lack hands-on experience. This is related to the fact that at the height of the industry, the skilled manpower came mostly from the then Eastern Europe (20). With the cessation of exploration and mining activities in most parts of the country there were few opportunities for gaining experience.

Major Developments in the Sector and Demand for Mining Skills

Since the implementation of the new mining act in 1986, the signing of the peace accord in 1992 and the installation of a democratically elected Government in 1994, there has been an unprecedented surge of interest in the mineral industry of Mozambique. This has been provoked by a conducive atmosphere in which the private sector is the inflection point of growth in the industry. There is recognition by Government that mining can provide the ingredients required for economic recovery and growth through increased foreign exchange earnings, rapid provision of employment and the development of infrastructure. In the new policy, participation by Government in mining ventures has been reduced to joint ventures, which are not mandatory and in which the private sector partner provides organisational and management direction.

As a direct result of the improved business ambience, investment in Mozambique's mineral industry by international and regional exploration and mining companies has increased in the last few years. Table 2 provides a listing of current major mining projects in Mozambique and their development status. Although it is not possible to predict whether all the projects will result in actual mine development, it is likely that overall employment levels and the demand for skilled manpower in the mining industry of Mozambique will both experience an increase in the next few years. The major projects close to development stage are the beach sand minerals at Angoche and coal at Moatize. Estimates of the number of jobs the two projects will create are about 500 and 6,000 jobs, respectively (6,20). The Angoche project, although entirely feasible under present parameters, is undergoing additional drilling to expand the reserve base. In the case of the coal project at Moatize, the large production rate at 10 million tons/year on reserves of 9.75 billion tons in the Moatize coal

basin, are incentives for the development of the mine.

Table 2: Major Projects at Exploration, Feasibility and Development Stages

Mineral Deposit/Province	Company	Status
Heavy mineral sands, Angoche/Quinga, Nampula	Kanmere Res, (Ireland) BHP (USA)	Feasibility/ Development
Heavy mineral sands, Moebase, Zambesia	Gencor (SA) Edlow Res, (USA)	Exploration
Heavy mineral sands, Xai Xai, Gaza	Aquater Spa (Italy)	Exploration
Rare earths, Morrua, Zambesia	Grupo Madal S.A.R.L.	Proposed Development
Rare earths and Kaolin, Muiane, Zambesia	African Mining Trust (RSA)	Proposed Development
Black Granite, Gondola, Sofala	Benicon mining (RSA)	Proposed Development
Goal, Moatize, Tete	Companhia do vale do Rio Doce (Brazil) and Government of Mozambique	Feasibility/ Development

Source: Reference 17.

Projections of the distribution of skilled manpower in the industry, assuming that the two projects proceed, were made. The resulting demand for skilled manpower opportunities up to the year 2001 is shown in Table 3. The main message is that the requirements for skilled manpower in the sector is likely to more than double from 217 to 590 if the two projects are implemented in the next five years. Furthermore, this increase in demand will occur for virtually all skill categories required by industry. In terms of specific disciplines, Mozambique will need to provide some 7 mining engineers, 6 mineral processors cum extractive metallurgists and 7 geologists per year. The sector will also require a good supply of engineers and artisans. These demand projections do not take into account expatriate replacement and any current deficits in skilled

manpower in the sector. This information was not available in quantitative form. The projections can therefore only be a baseline case. The demand for mining skills is most likely higher than indicated.

Table 3: Projected Skills Requirements for the Mining Sector to the year 2001

Skill Category	Current Levels	projected Levels	Annual Demand
Professional Skills			
Mining Engineers	18	33	7
Mining Proc. Engineers	11	29	6
Geologists	57	37	7
Chemists	9	12	2
Surveyors	4	11	2
Gemologists	1	2	1
Other Engineers	8	49	10
Sub Total Professionals	108	173	35
Technicians/Artisans			
Mining	11	22	5
Min.Processing	4	11	2
Geology	18	11	2
Survey Techs.	11	9	2
Chem Lab Techs.	15	9	2
Cartographer/D'men	4	11	2
Sub Total	63	73	15
Artisans	46	344	69
Total	217	590	118

Source: Recalculated from Table 1 assuming industry employment creation of 6,500 jobs.

In the light of the country's weak skilled manpower base, it is likely that the majority of skilled manpower positions in the industry will be occupied by expatriates, particularly for professional and management positions. Some notion of this may be adduced from Table 4 which shows the distribution of skilled jobs for the proposed beach sand project. The table indicates that all professional staff and about 54% of technicians and artisans would have to be expatriate. This factor reflects the major gaps in the availability of skilled manpower in the mining industry of Mozambique and the legacy of structural discontinuities in its operations which persisted over many years.

Table 4: Distribution of Skilled Manpower for a Proposed Beach Sands Mining Project in Mozambique

Skill Category	Number of Posts	Expatriate staff
Professional		
Mining Eng.	3	3
Metallurgist/ Min. proc. eng.	2	2
Geologists	0	0
Chemists	1	1
Surveyors	1	1
Other engineers/ Scientists	2	2
Sub-Total	9	9
Technicians/Artisans		
Mining Techs	6	6
Processing/Met.Techs.	8	6
Geological techs	0	0
Survey techs	0	0
Chem lab techs	5	1
Cartographer/D'men	0	0
Maintenance Eng.	20	8
Sub-Total	39	21
Total	48	30
Administration/Security Officers	19	
Non-Skilled Manpower	363	
Total Labourforce	430	41

Source: Recalculated from data supplied by the Directorate of Mines.

Mining Skills Development Facilities

The lack of education and training facilities in the mineral sector of Mozambique has contributed to the desperate shortage of mining skills in the country.

The University of Maputo, through the Department of Geology, offers a five-year degree programme in geology. Students graduate with a licence (Licenciados) with entry at "O" levels. Previously, a bachareis was awarded after 3 years of university study. This would appear to be the equivalent of a higher national diploma or technologist in the other educational systems in the subregion. Table 5 shows the number of graduating students for the period 1990-95. The department was only reopened in 1985. The figures indicate that the number of graduate geologists averages between 4 and 5 per year. This level of output is insufficient given the current and potential demand for geologists in the country. Comparison to the projected requirements for geologists in Table 3 shows that only 25 geologists would be made available by the department over the next five years leaving a shortfall of some 12 geologists. It must be remembered too that the demand for geologists shown in Table 3 is a baseline case and that the actual demand is probably much higher.

Table 5: Numbers of graduating Geology students from the Department of Geology, University of Maputo

1990	1991	1992	1993	1994	1995	Average
7	3	7	6	4	2	5

Source: Geology Department, University of Maputo.

Ironically, the current absorption levels for geologists in the country is low. The major employer, the National Directorate of Geology is severely underfunded and is unable to employ all geology graduates. This is despite the fact that the department is reported (20) to be understaffed by 20 to 30%. Due to the severe financial difficulties, the department also has had to curtail its field programmes, reducing the practical utility of its employees. On the other hand, private sector companies prefer to employ experienced geologists. This further reduces the absorption levels.

Table 3 indicates that Mozambique would need a minimum of 7 mining engineers and 6 mineral processing engineers per year. Training in these skill categories is not available in the country although that for chemists and the engineering category is. Mining and mineral processing engineers, as well as mine surveyors, gemologists all have to be trained outside the country. There have been plans to establish a Department of Mining at the University in Maputo by 1996. Little progress has been achieved due to a lack of financial resources. Ministry sources (20) indicate that the

department is unlikely to be established in the next five years. Thus Mozambique will have to continue to look externally for training opportunities in these skill categories.

With respect to middle level training, the Instituto Medio de Geologia e Minas runs a four year geological technicians programme. In 1995, they are reported to have started a four year mining technicians programme. It also appears that a general non-mining specific surveyor's course is available in Maputo. Details of these programmes were not available. It would appear from this that the major gap in the development of technician level skills is in mineral processing technicians, cartographers and the specialised areas such as ventilation and mine surveyors. It is reported (20) that technicians for heavy engineering work are also in short supply.

The major conclusion to be drawn from the data presented is that the requirements for mining skills in Mozambique cannot be met from internal sources at present or in the near future. A well focused longer term strategy for human resources development for the sector, in which advantage is taken of subregional training institutes, is imperative.

Annex 1.4 - NAMIBIA

Overview of the Mining Sector

Mining is the most important sector of the Namibian economy being the largest source of corporate tax revenue and the biggest private-sector employer (21). It contributes 28% to the GDP and remains the major source of foreign exchange although its share of total exports has declined from 74% in 1989 to 54% in 1993 (21,22,23). There are over 40 operating mines and quarries producing as many different types of mineral products. Diamonds, which account for 64% of the total value of mine production, constitute the most important mineral product. Other significant mineral products are uranium, copper, gold, lead, zinc and silver. Industrial minerals and gemstones are also produced in small quantities. In terms of the value of mineral output, Namibia's mining sector is the fifth largest in Africa after South Africa, Zaire and Botswana and Zimbabwe (25,29).

Namibia possesses world-class marine and onshore alluvial diamond resources in the Oranjemund - Elizabeth Bay coastal area and inland along the Orange river. Although the country is a relatively medium scale world producer, it has the highest carat value per output in the world (21). Until recently, all of Namibia's diamonds were recovered from onshore alluvial terrace deposits north of Oranjemund. However, production from off-shore sources has steadily expanded, accounting for 31% of the total output in 1994, and may possibly surpass the declining onshore sources by 1997 (21). Virtually all diamond production has traditionally been undertaken by subsidiary companies of the De Beers group through Consolidated Diamond Mines (CDM) and De Beers Marine, the latter being responsible for offshore operations. In 1994, the onshore operations by CDM were taken over by Namdeb Diamond Development Corporation, an equal equity joint-venture company between De Beers Centenary and the Namibian Government. De Beers Marine was retained by the parent company and has been contracted by Nandeb for the offshore operations. Other offshore mining operations are undertaken by the South African-based Ocean Diamond Mining Corporation (ODMC) around the Penguin Islands, and the Namibian Minerals Corporation (Namco), a British-based company operating off Luderitz and Hottentots Bay (21,23,24).

Uranium is produced soley by the Rossing Uranium Mine, near Swakopmund, which hosts one of the largest low-grade deposits in the world. The major shareholder in the mine is Rio Tinto Zinc (RTZ) of the UK with a 68.3% equity interest while minority shares are distributed between South Africa's Industrial Development

Corporation (IDC), Iran and the Namibian Government (21,22,25). Copper lead and zinc are produced principally by the Tsumeb Corporation Limited (TCL) who own several mines at Kombat, Otjihase and Tsumeb, and Namibia's only smelter at Tsumeb. The Corporation is a subsidiary of Gold Fields Namibia (GFN), in which Gold Fields of South Africa (GFSA) owns a 69% equity interest. Lead, zinc and silver are also mined at the Rosh Pinah Mine, which until liquidation in 1993, was operated by IMCOR Zinc, a subsidiary of the South African Iron and Steel Corporation (ISCOR). In 1995, the mine was taken over by IMCOR Tin, also a subsidiary of ISCOR (21).

The Navachab Gold Mine, located 10 km west of Karibib, is the only gold producer in Namibia. It is operated by the Erongo Mining and Exploration Company in which Anglo American Corporation and De Beers Centenary own two thirds and one third of equity, respectively (18,21). The dore bullion product is sent to Switzerland for refining. Manganese is mined at Otjosondu, North East of Windhoek by Purity Manganese of South Africa who in 1994 took over operations from the Johannesburg Consolidated Investments (JCI), also of South Africa.

There are also several dimensional stone quarries in Namibia with the principal products being granite, marble and sodalite. Industrial minerals such as fluorspar, lithium minerals and wollastonite are mined on a small scale, as are a range of gemstones including, aquamarine, heliodor, tourmaline, rose quartz, amethyst, chalcedony and beryl. A number of these small mines are concentrated around the Karibib, Usakos and Spitzkoppe areas, and are operated by local interests or joint ventures, the latter mainly with South African companies.

A characteristic feature of the mining industry in Namibia is that it is fundamentally owned by the private sector through a number of international mining companies. These account for 95% of the value of mine production and a similar proportion of the total mine investment (21,23). Notably, the mineral output is nearly all exported in raw or semi processed form. Inter-sectoral linkages with the rest of the economy and domestic transformation for local use are minimal. These factors are traceable to the origins of the industry which was developed largely as an extension of the South African mining industry during the period of occupation. However, it is noteworthy that, as a matter of policy, Government is very supportive to the private sector, a factor responsible for its high profile.

Administratively, the mining industry is regulated by the

Ministry of Mines and Energy (MME) through the Geological Survey Directorate and the Mining Directorate. The Survey's chief function is the preparation, publication, and distribution of geological reports, maps and databases on Namibia's geology and mineral potential. The role of the Mining Directorate, on the other hand, is to administer the Mining Act and ensure that mining is undertaken in a manner which is equitable and safe both to the environment and humans. There is also a Chamber of Mines, a private sector-driven interest group, whose membership includes all the major mining companies.

Profile of Mining Skills

The mining industry remains the major private sector employer, despite the decline in employment numbers from a peak of 21,200 in 1977 to 12,300 in 1993. This represented about 5% of total wage earners in the country and 15% of total formal sector wages (29). Available information (18,22,24) indicates that Namdeb is the largest industry employer with a labourforce of some 3,250 while the Tsumeb Corporation and Rossing are estimated to have 3,090 and 1,224 employees, respectively. IMCOR Tin has a labour force of approximately 425; Navachab Gold Mine 300 and the Ocean Diamond Mining Southern Africa Limited 88.

With respect to skilled manpower, employment data is given in Table 1. The table was constructed from information supplied by the Ministry of Mines and Energy. The data relating to Government employment mainly reflects the skilled manpower employed by the Geological Survey and the Mining Directorates of the MME. It excludes employment figures for private sector exploration companies whose population and employment base are small. The industry statistics have been based on employment by the major mining companies operating in Namibia, namely: Namdeb, Tsumeb Corporation, Rossing Mine, IMCOR Tin and Navachab Gold Mine. The Ocean Diamond Mining Southern Africa Limited has also been included in the manpower statistics.

The companies included in the survey, together with the Government Departments of the Geological Survey and Mining Directorates, are responsible for more than 95% of the total labourforce in the mineral sector of Namibia, and as earlier reported, a similar proportion of mine by output value. The small scale labour-intensive mines have not been included in the survey. This group of mines is represented mainly by the aggregate industry (for cement and road construction), and the small scale mines for gemstones and industrial minerals. The group does not generally

utilise mining skills.

Table 1 shows the expected dominance of industry over Government as the major employer of mining skills, in contrast to some countries in the subregion. This is the case for all the indicated skill categories included in the table. In terms of specific skill categories, industry employs nearly five times as many mining engineers as Government and all of the mineral processing/metallurgical engineers. Although not indicated in the table, most of the mining skills are concentrated at Namdeb and Rossing Mine, and to a lesser extent at Tsumeb and IMCOR Tin. For example, some 58% of all mining engineers and 72% of mineral processing engineers are employed by Namdeb and Rossing Mines while about 50% of all technicians and artisans are employed by Namdeb alone. This reflects the size and dominance of the diamond and uranium mining operations.

Table 1: Estimated distribution of skilled manpower in the mineral sector of Namibia

Skill category	Government			Industry			Total		
	Filled	Vac.	Exp.	Filled	Vac.	Exp.	Filled	Vac.	Exp.
Professionals									
Mining	18	10	0	81	0	52	99	10	52
Min. Proc./ Met.	0	0	0	39	2	16	39	2	16
Geologists	17	29	4	30	0	18	47	29	22
Chemists	0	0	0	12	0	2	12	0	2
Surveyors	2	0	0	10	2	1	12	2	1
Other Eng./ Scientists	5	3	0	93	3	53	98	6	53
Sub-Total	42	42	4	265	7	142	307	49	146
Technicians									
Mining	0	0	0	14	5	3	14	5	3
Min. Proc./Met	0	0	0	33	5	6	33	5	6
Geology	2	8	0	14	1	0	16	9	0
Survey	0	0	0	9	0	6	9	0	6
Chem Lab.	0	0	0	11	0	5	11	0	5
Cartog./D'men	6	5	0	6	1	1	12	6	1
Sub-Total	8	13	0	87	12	21	95	25	21
Artisans	0	0	0	869	0	271	869	0	271
TOTAL	50	55	4	1,221	19	434	1271	74	438

Source: Calculated from data supplied by the Ministry of Mines and Energy.

Table 1 also shows major skilled manpower deficiencies in the

Government sector for both the professional and technical levels. For example, only 17 geologist posts out of a requirement of about 46 are occupied representing a major deficit of 63%. The void in geologists is mostly at the Geological Survey Directorate where there are currently only 14 geologists out of an estimated total complement of 38. The equivalent figures for mining engineers are 18 out a complement of 28, a deficit of 36%. Information available (24) indicates that there are no chemists or mineral processing/metallurgical engineers in Government service. Ordinarily, Chemists are required to provide support analytical services, particularly at the Geological Survey while mineral processing engineers are responsible for laboratory beneficiation programmes and ensuring compliance to efficient and safe metallurgical practice at operating mines. Technicians are also required to provide technical support to professional personnel.

The universal point to be noted is that Government is critically understaffed in all skill categories, a point which must raise questions related to its capacity to provide adequate services to, and the efficacy of its monitoring role of, industry. Table 1 shows that relatively, skilled manpower deficiencies in industry are much smaller. This imbalance is expected because of the relatively more competitive wages offered by the private sector mining companies, particularly for skilled and semi-skilled workers. Both categories of skills are in critical short supply in Namibia as a whole (21,23,24). As a matter of fact, wage costs in Namibia are much higher than in most neighbouring countries.

It is also evident from Table 1 that the Namibian mineral sector continues to retain high levels of skilled expatriate manpower. For reasons already adduced, the levels are higher in industry compared to those in Government. For the professional categories indicated in the table, there are only four expatriates out of 42 (9%) filled positions in Government employment compared to an average of 142 of 265 (54%) professional manpower in industry. Other than the competitive wage factor, the concentration of expatriates skills in industry is largely historical and is common to all technical operations in Namibia. The pre-independence apartheid system excluded most of the population from the benefits of education and training. This has created a disadvantaged indigenous group which is mostly under-qualified and relatively inexperienced (23). Although the new Labour Act of 1992 swept away racially discriminatory procedures embodied in previous laws, the acute shortage of skills, coupled with the continuing linkages with South African mining companies, has left Namibia with few options other than to look to that country for most of its skilled manpower needs.

It would be interesting to examine the distribution of the expatriate skills in industry. This has been done in Table 2 where the proportions of expatriates have been estimated for several job levels at general and middle management; engineers, scientists and senior supervisors; and technicians, artisans and supervisors. The table shows that expatriate staff are present at all levels, including the junior categories of technicians, artisans and supervisors. However, the concentration is clearly greater at higher levels, particularly in middle management and general management positions. These are key decision-making jobs which require technical qualifications, long experience, leadership skills and vision to maintain business and operational competitiveness and make a profit for the shareholders.

Table 2: Distribution of expatriate manpower for different job levels in the mining industry of Namibia

Job Level	Namibians	Expatriate	Total	% Expat.
GM	5	18	23	78
MM	26	55	81	68
ESSS	174	192	366	52
TAS	747	247	994	25
Total/ Average	952	512	1464	35

Source: Calculated from data supplid by the Ministry of Mines and Energy

Key: GM: General Management
MM: Middle Management
ESSS: Engineers, Scientists and Senior supervisors
TAS: Technicians, artisans and supervisors

The concentration of expatriates in the mineral industry of Namibia, like in the case of Botswana, is likely to be contentious with respect to the participation of Namibians in what is a key industry to the national economy, especially given the unfair historical distribution of learning and employment opportunities. These sentiments are not helped by the observation that the only multinational mining enterprise with Namibians in general management is Rossing Mines, a non-South African enterprise. Clearly, although the industry is critical to the national economy and its continued success in the international minerals market must be guaranteed, its fundamental role must be supported by a longer

term equitable employment policy which seeks to maximise the development and utilisation of Namibia's major resource; its human potential.

Major Developments and Demand for Mining Skills

Namibia is one of the few countries in the subregion where exploration expenditure, particularly the component financed by private capital, has been maintained and even increased in recent years. Much of the exploration effort has been for base metals in the Kunene, western Omusati and other regions (22). Companies prospecting for base metals have included Caledonia Mining Corporation (CMC) of Canada and the Metal Mining Agency (MMA) of Japan. GFN are also evaluating a large copper deposit at Tschudi while prospecting for precious metals has also been modest in the vicinity of Karibib and Usakos. Offshore diamond prospecting has maintained a brisk momentum, partly induced by diminishing onshore reserves. Although De Beers Marine remain active, a large part of marine exploration has increasingly been undertaken by new entrants including Namco and Diamond Field Resources (DFR) of Canada, operating in the offshore areas of Hottentots Bay and Luderitz. The Canadian company has formed a joint venture company with Australia's Broken Hill Proprietary (BHP). Ocean Diamond Mining has also teamed up with BHP to explore the deeper-water extensions of their current areas.

Despite this exploration effort, there has been no major mine development in Namibia in the last few years. A deterioration in world markets for graphite in 1993 prevented the development of a graphite mine at Okanjande despite the large size and good quality of the deposit (22,26). Purity Manganese of South Africa have plans to extend current mining to underground operations. GFN is developing a new 25,000 ton/year lead smelter, a tailings reclamation facility and a short term copper/lead mine at Khusib due to come on-stream in 1996. The GFN developments are intended to bridge the effects of the looming closure in 1996 of their Tsumeb mine which has reached the end of its useful life (2). A major mining operation could come on-stream by the end of the decade, depending on the result of the feasibility study currently being undertaken on a large copper deposit at Haib. A joint-venture company between Great Fitzroy Mines (GFM) of Australia and South Africa's Rand Merchant Bank is responsible for the feasibility work expected to be complete in 1997. The production rate is anticipated to be 60,000-85,000 tons/year of cathode copper per year (28,29).

The lack of major mine development from current and recent

exploration efforts, coupled with the market-oriented nature of mining in Namibia, makes it difficult to predict any significant growth in the demand for mining skills. The pressing need to sustain economically viable mining operations has in a number of cases resulted in a suspension, and at times closure, of mining operations, with inevitable losses in employment. This offsets any gains which may be made in the creation of employment opportunities by new mine development. As a matter of fact, about 10, though mostly small scale, mines have closed during the period 1980 to 1993 (22). It is also significant that the major mining companies do not envisage expansion in skilled manpower employment levels (24). Several of them, including Namdeb actually foresee a progressive contraction in both skilled and general manpower categories by the year 2000, principally determined by the drive towards cost competitiveness in the light of diminishing reserves and grades of ore.

These considerations suggest that opportunities for skilled manpower in Namibia are unlikely to increase significantly in the near future. Based on current employment levels in the sector, an attempt to project the demand for mining skills in Namibia for the next five years has been made. The results are indicated in Table 3. The projection takes into account the existing deficiencies in the sector. It is further assumed that, as a matter of policy, Government would wish to replace expatriates with equivalently qualified Namibians.

Table 3 shows that Namibia requires some 306 professionals, 93 technicians and 575 artisans for the next five years to maintain current mine production. In terms of specific skill categories, the country needs of the order of 19 mining engineers, 13 geologists, and 7 mineral processing engineers per year. Clearly the greatest areas of need are for mining engineers, geologists, engineers and artisans although the other skill categories will also need to be addressed. This is a daunting task for a country with major deficits in practically all technical operations of the economy.

Mining Skills Development Facilities

Academic Facilities

Namibia has no skilled manpower training facilities in mining disciplines despite the presence of the Namibian Institute of Mining and Technology in the country. The institute runs apprenticeship and skills upgrading programmes in welding/boiler making, mechanics, fitting and turning, electrical and

instrumentation. The apprenticeship runs on alternate programmes of 6 months in industry and at the institute. The skills upgrading programmes are short term courses for periods of between 4 and 6 weeks in the same course areas. All trainees must be employed to facilitate their industrial attachments. Through industry

Table 3: Projected demand for mining skills for the period 1996-2001 in the mineral sector of Namibia

Skill Category	Government	Industry	Total	Annual Demand
Professionals				
Mining Eng.	15	80	95	19
Min. Proc./Met	2	32	34	7
Geologists	37	29	66	13
Chemists	4	6	10	2
Surveyors	1	7	8	2
Other Engs./ Scientists	4	89	93	19
Sub-Total	63	243	306	62
Technicians				
Mining	2	13	15	3
Min. Proc/Met	2	22	24	5
Geological	9	6	15	3
Surveying	6	9	15	3
Chem.Lab	4	9	13	3
Cartographer/ D'men	7	4	11	2
Sub-Total	30	63	93	19
Artisans	0	575	575	115
TOTAL	93	881	974	196

Source: Recalculated from Table 1.

sponsorship, good contacts are maintained with industry and also through the National Vocational Training Board. Plans are being considered to introduce mining programmes, particularly if students from other SADC countries can participate. This would avoid duplication and diseconomies of scale due to limited Namibian interest and numbers. Like Botswana, Namibia does not produce many matric level students so that candidates for training at diploma and higher levels are scarce. This presents a dilemma of sorts and thwarts the dedicated Government efforts which devote considerable resources to formal training, especially in technical fields. In 1993, the budgetary allocation for education and training was nearly 25% of total budget (23). It will, however, be some time before this effort is reflected in actual increased numbers of

skills and, much longer for, technical competencies.

In-Company Training Schemes

Due to the fact that the Namibian mineral industry is dominated by major international mining houses, in-company training schemes tend to be organised and well-structured. The training schemes, which are offered at several levels, are well articulated with established job evaluation and grading procedures, with most companies using the Patterson Job Grading scheme. The scheme is in many cases integrated with an in-house appraisal system, based on defined job description, and in which experience, qualifications experience and performance form the key appraisal elements. Most of the companies use qualified job analysts who, based on psychometric tests and individual weaknesses, identify areas in which training intervention is necessary. All the major mining companies consider training to be integral to an employee's career path along which he is allowed to advance to the maximum of his ability.

Table 4 below gives a generalised view of the in-company training schemes offered by the main mining corporations in Namibia. The schemes are mainly at the managerial, supervisory and technician/artisan level skills. Due to a lack of tertiary institutions, management development schemes are mostly undertaken at external institutions, mostly in South Africa. This includes bursaries to Universities, such as the Stellenbosch Business School in the case of Namdeb, or at more extensive training facilities owned by parent companies in South Africa, as is the case for IMCOR Tin and Tsumeb Corporation who use the ISCOR and Gold Fields facilities in South Africa.

Table 4: Availability of in-company training schemes at major mining companies

Training Scheme	Namdeb	IMCOR	Rossing	Tsumeb
Management	External	External	Local	External
Supervisory	Local	External	Local	Local
Technicians/ Artisans	Local	Local	local	Local

Other	Local Certificate in Open Cast Mining; also vocational training	-	-	External Learner Official

Source: Compiled from information supplied by the Ministry of Mines and Energy

Supervisory and technician/artisan level training tends to be more localised with the latter often delegated to the Namibian Institute of Mining and Technology. However, some companies, such as IMCOR Tin train their own artisans at the OBIB Centre. Namdeb also offers mining certificates for opencast mines and vocational programmes to prepare candidates for apprenticeship. Tsumeb, on the other hand, has introduced a learner official scheme, through Gold fields of South Africa, on which employees with potential are encouraged to obtain certificates of competency as a prelude to appointing them to engineering posts.

In terms of specific courses, Rossing Mine offers more than 20 courses for employee development at the management and supervisory levels in areas such as: Leadership Skills; Performance Management; Supervisory Skills; Industrial Relations; Communication Skills and Business Concepts and Skills. Namdeb supervisory courses include: the SuperVision programme, focusing in areas of quality, cost, safety and production; industrial Relations, Analytical Troubleshooting and Effective Internal Relationships.

The main difficulties encountered by the mining companies in accessing skills were enumerated as:

* Low recruitment levels, particularly for but not limited to professional skills, due to their virtual non-availability on the local market. This makes external recruitment imperative.

* the total lack of local training facilities in the mining sector coupled with the very small pool of school leaving citizens who have the required subjects to pursue careers in mining and metallurgy.

* young graduates have high expectations but very little hands-on experience.

With respect, to specialised skills such as mine planning and development, mine and process design, engineering and consultancy,

these are largely unavailable locally. The major mining houses, particularly for isolated operations like Rossing, aim to retain those which meet the regular operational requirements, such as mine planning. Ordinarily, this group of skills are procured invariably from parent companies located in South Africa or elsewhere.

On paper, virtually all of the major mining companies are mindful of, and sympathetic to, recruiting and training Namibian citizens and progressing over time to "fully autonomous local management structures". Given the problems outlined, this is unlikely to happen over the mine life of most current operations.

Annex 1.5 - TANZANIA

Overview of the Mining Sector

Tanzania has an excellent mineral resource potential although most deposits are under-explored. Notable among the country's mineral stock are gold deposits occurring in several greenstone belts, diamonds with over 300 known Kimberlite occurrences, and a large variety of gemstones (30). Tanzania also has significant reserves of iron ore, nickel and titanium minerals. At Linganga, iron ore reserves are estimated at 45 million tons, whereas at Kabanga and Msimbati nickel and titanium resources have been assessed at 40 million and 33.5 million tons, respectively (31). Coal occurs in large quantities in the Ruhuhu and Songwe-Kiwira basins where reserves are estimated at some 300 million tons (31). Tanzania also boasts of a large variety of non-metallic minerals including high purity limestone in Morogoro, phosphate at Minjingu and Mbeya, and graphite resources in the Usagaran and Ubendian gneisses like those at Merelani in Arusha. Despite this significant potential, minerals have yet to play a major role in Tanzania's economy with the possible exception of diamonds, and to a much lesser extent gold, gemstones, coal and phosphate. Mining contributes about 1.2% to GDP and employs about 1% of total wage earners (30).

Diamonds have been commercially mined at Mwadui since 1941. In the 1970s, Tanzania was a major world producer with a world share of about 1% in the 1970's (30). With the rich ore nearly exhausted, production has more than halved and has increasingly become sub-economic. Gold mining has an equally long history in Tanzania dating back to 1895 during the German occupation (30). Total gold production this century has been estimated at 80 tons with 90% of it coming from numerous mines located in the greenstone belts south of Lake Victoria. However, by the late 1970s most of the gold mines had closed down. The last major mine, Buckreef which belonged to the State Mining Corporation (STAMICO), closed down in the 1980's. Current gold mining activities are dominated by artisanal operations and a few organised small surface mines belonging to TANCAN Gold, Mans Mining and DEMCO Limited (30).

Like gold, gemstone mining is overshadowed by numerous artisanal miners most of who operate disorganised unsafe mines due to a serious lack of technical skills and capital. The range of gemstones produced is large and include tanzanite, ruby, rhodolite, sapphire, emerald, chrysoprase, peridot and tourmaline. A few of the mines are organised, these include the new GRAFTAN tanzanite/graphite mine in Merelani, which is a joint venture

between SAMAX (UK), African Gems Ltd (UK) and the Tanzania Gemstone Industries; TOFCO, another joint venture between STAMICO and a Swiss company, and Afro-Asian Minerals.

Other minerals mined on a commercial basis in Tanzania include coal and bentonite with operations at Kiwira and Pugu, respectively. Production at the coal and kaolin mines, which are owned by STAMICO, has drastically declined in recent years. STAMICO also operated the Minjingu phosphate mine near Arusha, which closed down in 1990 due to a lack of market following the closure of the only fertiliser company at Tanga. Graphite mining operations were commenced by GRAFTAN Limited at Merelani during 1995.

Industrial minerals have been mined by SARUJI for cement, ceramic and glass production. Unfortunately, the ceramic factory also closed down in 1990 while the sheet glass factory was never brought on-stream. The cement factories at Dar-es-salaam, Mbeya and Tanga continue with poorly operations. The Dar-es-salaam factory operates under a joint venture with a Swedish company while the other two are the subject of similar negotiations.

Clearly, mining in Tanzania has declined despite the country's commanding potential in mineral resources. A cauldron of factors have connived to precipitate the decline. The visible factors include technical, financial and economic inadequacies; coupled with a political structure which previously sought to restrict participation in major mining activities to State-owned enterprises and nationals. Both the enterprises and nationals had neither the skills and expertise nor the capital and technical capacity for both exploration and mine development.

Government regulates the industry through the Ministry of Water, Energy and Mineral Resources. The Mineral Resources Department of the Ministry is divided into the Mines Division with mines registry and inspectorate functions; the Geology Division responsible for mapping and ore deposit investigations; the Research and Laboratory Division operating the mineralogy, chemical and mineral processing laboratories; and the Mineral Trade Division for promoting trade in Tanzania's mineral resources. A Chamber of Mines has recently been formed although it is not yet fully operational. There is also the Tanzania Mineral Dealers Association (TAMIDA), a predominantly private sector lobby group for promoting the marketing of mineral.

Profile of Mining Skills

Excluding artisanal and small scale miners, the Ministry of Water, Energy and Minerals, together with STAMICO and SARUJI, the state-owned enterprises, have traditionally been the major employers of mining skills in Tanzania because, as earlier outlined, private mining enterprises were previously not encouraged.

Table 1 gives an indication of the distribution of mining skills in Tanzania. The Government data was based on skilled manpower employed by the above divisions of the Mineral Resources Department in the Ministry of Water, Energy and Minerals. The industry data was supplied by the current main mining companies namely, STAMICO and SARUJI, and the new private mine GRAFTAN Ltd. It does not include the numerous small scale and artisanal gold and gemstone mines most of which do not utilise mining skills. It does not also include exploration companies and quarries for aggregate, although those for cement production are included under SARUJI, the holding company. Due to this, the data presented in Table 1 may numerically understate the levels of skills employed by industry.

Table 1 shows that Government has continued to be the main employer of mining skills in Tanzania relative to industry. The table further shows that there is an abundance of geologists relative to mining engineers and, more so, mineral processing engineers. There appears to be a relatively large contingent of technician level personnel in Government service. This is particularly the case for mining and geological technicians, but mineral processing technicians appear to be in short supply. The large number of mining technicians is explained by the inclusion of technical level personnel employed at the mining inspectorate zones offices which fall under the Mining Division. It is not known whether the large number of technicians have full diploma level qualifications or their equivalent. It appears that most of them have acquired their experience on the job.

Tanzania does not have many formal mines at present. It is therefore tempting to conclude that the present stock of skills is adequate. However, this should be weighed against the fact that Tanzania has a large artisanal and small scale mining sector particularly in diamonds, gold and gemstones. In the Merelani area alone, for example, there are reported (32) to be over a hundred small tanzanite mines. Elsewhere, there are small scale tin mining operations. These small mines need to be brought into the main stream of mining activities by promoting their use of skilled manpower to improve their operations.

Table 1: Indicative distribution of skills in the mining sector of Tanzania, in 1995

Skill Category	Industry	Government	Total
Professional			
Mining Engs	16	20	36
Min. Proc. Engs.	6	3	9
Geologists	17	67	84
Gemologists	2	4	6
Chemists	10	3	13
Surveyors	2	-	2
Sub Total	53	97	150
Technicians			
Mining	15	93	108
Min. Proc.	2	10	12
Geological	3	32	35
Surveying	12	20	32
Cartographers/D'men	4	15	19
Chem. Lab.	2	12	14
Sub Total	38	182	220
TOTAL	91	279	370

Source: Government data was supplied by the Ministry of Water, Energy and Minerals. Industry data was supplied by STAMICO, SARUJI and GRAFTAN Mines.

Technical practice, especially for operational personnel appears weak in the mineral sector of Tanzania (32). For geologists this is related to a lack of operational funds to undertake field practice. For mining engineers and mineral processors, the lack of adequate hands-on experience prior to taking over responsibilities, coupled with inadequate funds for manpower training appear to have been a problem. This is exacerbated by the general lack of in-company training schemes and career path oriented manpower development in the mineral industry of Tanzania. It would therefore appear that, exposure to good operational practices elsewhere would be useful in further developing the available skilled manpower.

Major Developments in the Sector and Demand for Mining Skills

As earlier outlined, exploration and mining output declined particularly during the 1960s to 1970's period. Since about 1980, the sector has undergone major changes initiated by an improved

mining act in 1979, the introduction of trade liberalisation in 1985 and the passing of the National Investment Promotion and Protection Act in 1990. From a mining perspective, the fundamental change in government policy has been to leave mining operations in the hands of the private sector. Government now sees its major role as supervising and regulating the sector so that it can fulfil its potential as a foreign exchange earner, provide jobs and generally underpin the process of national economic and social advancement. As part of the changes, the restriction of mining operations to the State Mining Corporation (STAMICO) has been discontinued and the company restructured to operate more autonomously. Under the new changes, STAMICO, like SARUJI, have been scouting for external joint-venture partners who would not only provide the much need capital to rehabilitate mining operations but also management expertise.

As a direct result of the improvement in the economic atmosphere, a number of overseas exploration companies and bilateral agencies have been active in the country in the last few years. Table 2 shows some of the projects currently being undertaken. Probably the most significant of the projects in terms of employment potential is the Kabanga nickel project being undertaken by BHP, Sutton Resources and Romanex International. However, the projects are all at exploration stage and their impact in creating additional skilled manpower opportunities can only be assessed in the longer term. It is notable too that most of the exploration interest is in gold and diamonds where no large mines can be expected on the basis of known current resource potential, and job creation is therefore limited. Unfortunately, the Linganga iron and steel project, which would have been a significant employer of mining skills, has been seriously obstructed by the very high developmental costs. This is because of the remoteness of the deposit, thus requiring heavy investment in infrastructure. The project has been promoted for some ten years without much success.

These considerations make it difficult to predict any major expansion in the demand for skilled manpower in Tanzania in the next few years. For the mining operations making a transition from public to international private mining houses, the main visible changes can be expected to be a reduction in the total labourforce and an increase in the complement of expatriate manpower at management levels. This has, for example, happened at the Williamson diamond mine where De Beers has extended its share holding from 50 to 75%, retrenched 500 workers and is planning major reductions in expenditure on social infrastructure (31).

Table 2: Planned mineral development projects and their status in 1995.

Mineral/Location	Company	Status
Nickel, Cobalt, Zinc, Lead and Platinum; Kabanga	BHP (USA), Sutton Res. (Canada) and Romanex int'l (Canada)	Exploration
Gold, Forest Reef Mine, Ikungu Peninsula	JCI (SA) and Patrician Gold Mines (Canada)	Exploration
Diamonds, Mwadui	Anglo American Coop. (S.A.) and De Beers (SA)	Exploration
Gold, Geita and Nzega	UNRFNRE	Exploration
Gold, Ingengi, Mhunze and Iborogero	Metal Mining agency of Japan	Exploration

Sources: References 13 and 31.

Based on current employment levels, attempts were made to estimate requirements of skilled manpower for the mining sector in the medium term. Indicative new opportunities likely to arise in the next five years are shown in Table 3. In the projections no new major mines have been included as there are no indications of these developing within this time frame. Furthermore, the projections do not include vacancies in the present staffing levels as these were not known.

Table 3 shows a somewhat small increase in the demand for skilled manpower. In terms of specific skills, the table shows that Tanzania will require an annual complement of about 2 mining engineers, 1 mineral processing engineer and 5 geologists. At the technician level, the annual demand is estimated at some 6 mining technicians, 1 mineral processing, 2 mine surveying and 2 geological technicians. It must be remembered, however, that these projections assume no major mine development and do not include requirements for skills in the artisanal and small scale mining

Table 3: Projections of mining sector skill requirements to the year 2001

Skill Category	Industry	Government	Total
Professional			
Mining Engs.	6	5	11
Min. Proc. Engs.	2	1	3
Geologists	6	17	23
Gemologists	1	1	2
Chemists	4	1	5
Surveyors	1	-	1
Sub Total	20	25	45
Technicians			
Mining	5	23	28
Min. Proc.	1	3	4
Geological	1	8	9
Survey	4	5	9
Cartographers/ D'men	1	4	5
Chem. Lab	1	3	4
Sub Total	13	46	59
TOTAL SKILLED MANPOWER	33	71	104

Source: Recomputed from Table 1

sectors. Due to these considerations and based on the current level of exploration activities, it is likely that the demand for mining skills is much higher. The demand should also be improved by the restarting of operations at the closed mines, such as Buckreef and Minjingu, rehabilitating the operations at the kaolin and coal mines and the development of a number of new small gold and diamond mines. The latter is possible given Tanzania's resource potential in these minerals for which large scale mining is probably not viable. The figures indicated in Table 3 can therefore be considered to be minimum estimates.

Mining Skills Development Facilities

Part of the reason Tanzania has large numbers of geological skills is that there is a long standing and well established Department of Geology at the University of Dar-es-salaam. The Department offers geological training at BSc., MSc. and Ph.D levels

with the BSc. programme lasting 3 years with "A" level entry. On average, 15 to 20 students graduate at BSc. level, with 2-3 at MSc. level and 1 PhD at three year intervals. With the current demand for geologists shown by Table 3, and the existing population of geologists in the country (Table 1), the possibility exists that there may be over-training of geologists if not at present then in the near future. This is more so if the volume of exploration activity does not increase substantially beyond current levels. The MSc. and PhD programmes give scope for specialisation into areas like structural geology, geochemistry, geophysics and mineral deposits exploration. In addition, the Department plans to embark on a new course in Environmental Geology. These sub-specialisations may diversify the geology graduate into other useful areas but would not subtract from the point that the geology discipline may be over-subscribed.

With the exception of geological training, Tanzania does not possess professional training facilities in the other mining disciplines. Mining and mineral processing engineers have always been trained outside the country. Notably, the University of Dar-es-salaam have had a student exchange programme with the University of Zambia for the last ten years or so where mining and mineral processing engineers have been trained at the School of Mines in Zambia. Current numbers average about 4 mining and 2 mineral processing engineers per year. Based on present demand projections for these skills this arrangement, coupled with other external training schemes, appear adequate to address the envisaged increase for these skills in the near future.

Under the Human Resources Development Sub-committee of the SADC Mining Sector, Tanzania has been given the responsibility to establish a Gemological Institute. To this end, a feasibility study has been initiated with the assistance of the French Government to establish the institutional framework of the institute. The institute should fulfil the demand for gemological skills not only in Tanzania but for other countries in the subregion.

Technician training facilities are not available in Tanzania. The requirement for mining, mineral processing, geological and mine surveying technicians will have to be met using external sources. The MADINI Training Institute in Dodoma offers a one year certificate course in mineral exploration, mining technology and mineral processing. The institute has the capacity to enrol 40 students per year but due to recurrent budget constraints, enrolment has been reduced to 20-25 students per year. The institute has been housed in temporary premises for a number of

years. Construction of the new premises has been severely handicapped by lack of funds from Government, the sponsors of the project. The institute lacks qualified lecturers in mineral processing and mining technology, as well as teaching materials. It needs support to develop a curriculum which will meet the needs of industry for technical manpower (32). In the light of the lack of facilities for technician training, an option may be to upgrade the institute to technician level training. Whether the institute is maintained in its present form or upgraded, funding constraints would have to be addressed.

In summary, the demand for mining skills in Tanzania will be determined by its large small scale sector, the current exploration efforts and the rehabilitation of present mines. Currently, there appears to be an overcapacity in geological training while there are potential shortfalls for mineral processing and mining engineers. The greatest need, however, is at technician level training. The certificate level training facilities need to be improved to produce an industry-oriented graduate. There is also need to improve the available stock of skills in technical and managerial practices. Both STAMICO and SARUJI, the two major employers of mining skills have weak in-company human resources development programmes. Identification schemes for job grading and performance standards for use in determining competencies required for specific jobs are more or less absent. This makes it difficult to determine training requirements for the various levels of skills demanded by their operations. These problems can be ameliorated with improved contacts with industry and institutes in the other countries of the subregion.

Annex 1.6 - SOUTH AFRICA

Overview of the Mining Sector

South Africa is truly well-endowed with mineral resources. It possesses the world's biggest deposits of alumino-silicates, chromium, gold, manganese, platinum group metals and vanadium as well as world class reserves of other minerals (34). This immense mineral potential has enabled the country establish one of the world's largest and most diversified mining industries which has been the pillar of the country's economy for more than 100 years. In 1994, mining contributed some 9% to the GDP while exports of mining and mineral-related products, which grossed US $12 billion, accounted for 65% of total foreign exchange earnings. During the same year, more than 60 different minerals were produced from approximately 870 mines and quarries and exported to some 90 countries around the globe. By far the major mineral export was gold, which accounted for 58% of export revenue, precious minerals at 21% and coal at 12%. Domestic mineral sales, which accounted for 20% of total mine output by value, were dominated by coal at 52%, followed by metallic minerals at 20%, non-metallic minerals at 16% and precious metals at 12% (33).

Although South Africa has a large mineral industry, mining output is dominated by only five major mining groups, each administering a number of autonomous mining, financial and associated companies. The five groups are Anglo American Corporation (AAC), Anglovaal, Gencor, Goldfields of South Africa and Johannesburg Consolidated Investments (JCI). There are, nevertheless, several smaller groups and companies exploiting modest deposits which are considered economically unattractive by the bigger groups.

The mining companies interact through the Chamber of Mines of South Africa, a private coordinating organisation whose primary objective is to protect and promote the interests of its members. In addition, a number of organisations protect and serve the specific interests of smaller mining companies and independent operators. These include among others: the Aggregate and Sand Producers Association; the Ferro Alloy Producers' Association, the South African Copper Development Association; and the Aluminium Federation of South Africa. There are also professional associations which include the South African Institute of Mining and Metallurgy and the Geological Society of South Africa.

The South African Government's policy is not to participate in

the exploitation of minerals and views its fundamental role as to provide a legal and fiscal environment, as well as an efficient infrastructure, which allow unimpeded exploitation of the minerals by the private sector. It regulates the industry through several branches of the Department of Mineral and Energy Affairs. The Mineral and Energy Management Branch administers the mining act and related legislation, and is the registry for mining titles. The Mining Branch's primary functions are the supervision and control of the safety, health and environmental aspects of mining operations. The Council for Geoscience, previously the Geological Survey, undertakes geological mapping and other studies relevant to mineral deposits. There are nine Regional Directorates which regulate and promote safe and optimal mining operations within the region and coordinate prospecting and rehabilitation activities.

South Africa possesses several autonomous world class Government-funded mineral research organisations. These include the Council for Geoscience, referred to above, Mintek, the Atomic Energy Corporation, and the Division of Mining Technology of the Council for Scientific and Industrial Research (CSIR). Mintek's chief function is to promote process design and technology development in the minerals field. The Atomic Energy Corporation investigates the use of radioactive minerals, such as uranium, for nuclear fuel and other applications. The CSIR undertakes a wide range of investigations including exploration, mining and mineral processing, and water pollution and purification.

The above research institutes, in addition to research conducted in the universities and technikons, have ensured that the South African mineral industry is underpinned by a high degree of domestic scientific and technical expertise. Particularly significant is South Africa's expertise in the mining and processing of low grade ores and mining at depth.

Profile of Mining Skills

The South African mineral industry is a major employer with a total labour force of about 600,000 workers in 1995, representing about 4% of the economically active population of the country. Of these 64% were employed in gold mining, 15% in platinum mining, 12% in coal mining and 3% in diamond mining (33). The labour force has, however, been declining due to a number of mines approaching their life cycle coupled with the need to maintain and improve labour productivity. The number of recorded mines and quarries declined from 896 in 1993 to 870 in 1994 while the total number of workers on Chamber of Mines gold mines has over the last 10 years declined from a peak of 534,255 in 1986 to 391,288 in 1994 (33,34,35).

South Africa also has a large migratory labour force of unskilled and semi-skilled workers which still remains substantial despite the declining numbers in recent years. Table 1 shows that the number of migratory employees on Chamber of Mines member mines fell from a total of 534,083 in 1984 to 368,004 in 1994. The majority of the migrant workers are from within South Africa, particularly from what used to be the self-governing territories. Botswana, Lesotho, Mozambique and Swaziland also contribute significantly to the migrant labour force but the numbers from Malawi and Zimbabwe have drastically decreased.

Table 1: Levels of migratory employees for Chamber member mines over the period 1984 to 1994.

Country of origin	1984	1994
South Africa	330,251	202,653
Lesotho	108,312	87,421
Botswana	18,742	11,963
Swaziland	11,673	15,347
Mozambique	47,764	50,619
Malawi	17,332	0
Zimbabwe	9	1
	534,083	368,004

Source: Chamber of Mines, 1994.

Table 2 shows estimates of skilled manpower in the mineral sector of South Africa. The Government data was obtained from the Department of Mineral and Energy Affairs (36) and includes skilled manpower employed by the Directorates under its control, namely Mineral Rights and Management Services, the Minerals Bureau, the Council for Geoscience, the Mining Branch and the 9 Regional Directorates. The Government statistics do not include skilled manpower employed by the research organisations mentioned earlier and the academic institutes.

The industry data was based on the submission by the Chamber of Mines of South Africa for the gold and coal mines which belong to their members. Because not all mines in South Africa belong to the Chamber, the data was extrapolated to the national level on the basis that the Chamber's mines employ about 67% of the total workforce in the mining industry (35). In the table, a number of skill categories have not been included because of the incomplete information provided by the Chamber. It was understood that this was partly due to the nature in which they compiled the

information. Attempts were made to obtain more complete data from all the main mining corporations and research institutes. However, the response was poor.

Table 2: Estimates of skilled manpower in the mineral sector of South Africa

Skill Category	Government		Industry	Total		Estimated Levels of Skills
	Filled	Vacant		Filled	Vacant	
Professional						
Mining Eng.	142[a]	18	-	142	18	2,491
Min. Proc./Met.	-	-	2,324	2,324	-	2,274
Geologists	115	31	173	288	31	1,528
Chemists	-	-	55	55	-	852
Surveyors	1	0	-	1	-	933
Mineral Econ.	15	6	-	15	6	-
Gemologists	-	-	-	-	-	25
Other Eng.	-	-	266	266	-	4,286
Sub-Total	273	52	2,818	3,091	52	12,389
Technicians						
Mining	12	0	-	-	-	1,654
Min. Proc./Met.	-	-	-	-	-	963
Geological	18	6	-	-	-	439
Surveying	-	-	-	-	-	454
Chem.lab.	21	0	-	-	-	338
Cartog/D'men.	1	0	-	-	-	963
Sub Total	52	6	-	52	6	4,811
Artisans	-	-	12,973	12,973	-	30,323
Total	325	58	15,791	16,116	58	47,523

a: This may include some mine surveyors employed by the mining branch.

Source: Chamber of Mines of South Africa and estimates from survey

Although the information in Table 2 is incomplete, the observation can be made that the number of professional skilled manpower employed in the Government administrative structure is relatively large compared to the other mining countries in the region. This reflects the diversified level of support Government provides to an industry which is quite large. For example, the large number of mining engineers is explained by the nine regional directorates and the Mining Branch. The latter provides multiple services in mine safety and health, mine equipment, land rehabilitation, mine surveying, and environmental control. Most of the geologists are employed by the Council for Geoscience while there is a good number of mineral economists employed by the Minerals Bureau, unlike in the other countries in the subregion.

Despite the large numbers of mining engineers and geologists in Government service, Table 2 shows that there are deficits in these skill categories.

In view of the limited data available to the survey, estimates of the expected levels of skilled manpower were made using information compiled for Botswana, Namibia, Zambia and Zimbabwe; the major mining industries in the subregion. The projections were based on the direct ratio of the total labour force in the industry in the four countries to that in South Africa.

The results of the extrapolation, are showed in Table 2. The key feature of the industry estimates is that for all skill categories, the extrapolated levels of skilled manpower are much higher than those indicated by the Chamber of Mines figures with the exception of mineral processing and metallurgical engineers for which the Chamber's figure is of the same magnitude. The extrapolations indicate that given the size of the industry in South Africa, the current numbers of various skilled manpower categories are probably as large as 2,500 mining engineers, 1,528 geologists, 4,286 other engineers, 1,654 mining technicians and as many as 30,323 artisans.

These estimates are only indicative. Nevertheless, the large discrepancy between the Chamber of Mines statistics and the estimates point to the fact that the mining industry in South Africa is probably numerically skill-deficient with a high ratio of non-skilled to skilled workers. This view is supported by reports that many of the small mines and quarries in South Africa are operated by persons who have little or no mining experience and that the industry in general is labour intensive with a high level of illiteracy estimated to be as high as 60% (35,36). The high level of illiteracy is historical due to the inferior and lack of educational opportunities which created a large workforce with a low skill base (38). This particularly applies to gold mining where out of a total labour force of 391,288 in 1994, nearly 80% were unskilled migratory labour. For these reasons, wage costs at gold mines are reportedly higher at about 54% of operational costs compared to an industry average of 45%.

Major Developments in the Sector and Demand for Mining Skills

South Africa is one of the few counties, along with Australia and Canada, which has over the years managed to attract a high level of private exploration expenditure. In recent years, there has been an upsurge of interest in marine diamond resources off the

west coast in addition to kimberlite prospecting in the Northern Transvaal area. Gold prospecting has also continued mainly in the areas of existing mines while the metropolitan areas have witnessed an increase in the exploration and exploitation of industrial minerals in readiness for the anticipated increase in construction activities during the Reconstruction and Development Programme (RDP). Prospecting for coal has also continued mainly in the Eastern Transvaal while the search for base metals has included iron and manganese in the Northern Cape and nickel-copper-cobalt-platinum group metals in the Eastern Transvaal. Despite these exploration efforts, mine development and mining activities in general have largely been determined by economic factors due to the private nature of the industry and its integration into the international mineral commodity markets.

In the gold industry, the major contributor to mine output by value, the major trend has been towards contraction of mine output. During the period 1975 to 1994, gold production fell from 713 to 585 tons. Over the same period, some 16 gold mining projects were initiated, and currently, there are several major gold development projects, such as the Moab, South Deep and Target projects. However, due to a number of mine closures, the gold development projects have essentially just replenished diminishing gold output (37). A further important trend in the gold industry has been the escalating costs arising from mining lower grades at deeper levels. The stoping (rock-breaking) level has increased from an average of about 1,600m in the 1980s to more than 2,000m in many cases while the average grade has fallen from 9.4g/t in 1975 to 5.4 g/t in 1994 (37,16). This has led to increased capital intensity arising from deeper openings and increased technical problems such as those associated with increased heat and rock pressures. Available estimates show that the 1995 capital stock of the gold sector was 2.6 times higher than 1975 values despite a decrease in capital productivity over the same period (37).

The increased cost structure has been the major driving force for the declining labour force and re-organisation in work practices to improve labour productivity. It is, however, recognised that real improvements in labour productivity can only be secured from a more skill-focused labour force. This is particularly more important because of the unique nature of gold mining operations, such as narrow reefs, which frustrate the introduction of capital intensive technologies.

In the non-gold mining sector, the major developments have been towards more capital-intensive mining projects to expand production volumes and the increased beneficiation to add value to

mineral products. The major developments have included (33,37):-

a. expansion in coal output from 69 million tons in 1975 to 185 million tons in 1994 which has elevated coal to second position in terms of mine output by value;

b. six platinum ventures which came into production during the 1975-1994 period and the expansion of locally processed platinum into auto-catalysts from 2.1 million to 3.1 million units in 1994;

c. expansion in the production of stainless steel by over 400% in 1995, notably through the Columbus Stainless joint-venture;

d. the proposed Alusaf aluminium smelter at Hillside and the expansion of the Bayside smelter, which is expected to increase domestic aluminium production from 170,000 t/y to 676,000, making Alusaf the fifth largest aluminium producer in the world.

e. the new Namakwa Sands heavy minerals mine near Vredendal on the west coast with a capacity to produce 195,000 t of titanium slag, 120,000 t of pig iron, 123,000 t of zirconium and 36,000 t of rutile concentrate yearly;

Unlike in the gold mining sector, these projects have been able to achieve significantly higher capital to labour ratios due to their large throughput and technological intensity.

The above considerations point to both a higher demand for, and diversified, skills. For example, the increased mining depths in the gold sector and the resultant technical difficulties suggests increased intensity in skills supported by adequate research to ensure safe and efficient operations. The increased processing and fabrication suggests larger numbers of metallurgical engineers in addition to extractive metallurgists while the increased gearing in the capital to labour ratio requires flexible competencies at all levels to interface with new technologies. These thoughts suggest that the demand and types of skilled manpower in South Africa is probably undergoing rapid expansion and diversification and will continue to do so in the short term.

Numerical data to demonstrate this expansion is not available and would require a major survey beyond the scope of this one. Based on Table 2, the demand for basic mining skills has been estimated in Table 3 for the five year period 1996-2001. The

information in Table 3 does not take into account any new mines due to unavailability of data. The situation depicted by Table 3 is also similar to some equilibrium where the number of new mine developments equal the mine closures.

Table 3 shows that under these circumstances, the mining industry would require of the order of 174 mining engineers, 159 mineral processors and metallurgists, and some 107 geologists per year to maintain current mine output. Larger numbers are indicated for "other" engineers and artisans for which projected demand is 300 and 2,123 per year, respectively. These figures are only estimates and not accommodate the rapid developments, particularly in the non-gold sector. Their usefulness, however, lies not so much in their accuracy rather the orders of magnitude which point to the large numbers of skilled manpower which must be available to industry every year. The fact that a number of non-corporate mines operate without skills, and the developments in the non-gold sector earlier outlined, may well act to inflate the figures given.

Table 3: Projected demand for selected skilled manpower in the mineral sector of South Africa to the year 2001

Skill Category	Current Estimate	Projected Demand	Annual Demand
Professional			
Mining Eng.	2,491	872	174
Min. Proc./Met.	2,274	796	159
Geologists	1,528	535	107
Chemists	852	298	60
Surveyors	933	327	65
Gemologists	25	9	2
Other Eng.	4,286	1,500	300
Sub-Total	12,389	4,336	867
Technicians			
Mining	1,654	579	116
Min. Proc./Met.	963	338	68
Geological	439	154	31
Surveying	454	159	32
Chem. lab.	338	118	24
Cartog./D'men.	963	337	67
Sub Total	4,811	1,684	337
Artisans	30,323	10,613	2,123
TOTAL	47,523	16,633	3,327

Source: Recalculated from Table 2.

Mining Skills Development Facilities

Academic and Research Facilities

South Africa has a number of mineral-related academic and research institutions. At degree level, for example, training is available in geology at Rhodes University and the Universities of Pretoria and Witwatersrand in addition to four other universities; in mining engineering, at the Universities of Witwatersrand and Pretoria; in metallurgy and mineral processing, at the Universities of Potchestroon, Pretoria, and Witwatersrand; while mineral processing options are available at the Universities of Cape Town, Natal and Stelenbosch. Due to the multiplicity of institutions, it was not possible for the survey to cover all of them. However, only the Universities of Pretoria and Witwatersrand offer all three undergraduate programmes in geology, metallurgy and mineral processing, and mining engineering. Both the two universities were covered by the survey.

The **University of Pretoria** has offered geology degrees since 1908, and metallurgical and mining engineering degrees since 1958. The programmes are offered by the School of Mining and Mineral Sciences. The undergraduate programmes are of four year duration after matriculation and include an honours option. The programmes are run on a semester basis with 10 weeks of field work and industrial training for geology and mining and metallurgical engineering students, respectively. The geology curriculum has recently been re-structured to include modules in exploration geology, applied mineralogy, African geology and environmental management and entrepreneurship. Changes in the metallurgical engineering have focused on engineering skills development while in mining engineering, the modules in shaft building, surveying, and supply of utilities to mine openings have been recently restructured. Almost all undergraduate students are on industry scholarships.

All three Departments offer masters and Ph.D programmes and have a strong research tradition. Two national metallurgical centres of expertise are run by the School. The Centre for Corrosion Engineering undertakes research in the field of metal corrosion. The Centre for welding Engineering undertakes research in the weldability of metals. Both the centres are fully supported by industry, as most other research programmes in the school.

Progress has also been made towards the establishment of a third Centre in hydro-metallurgy. The industry-orientedness of the school is one of its key strengths.

In terms of cooperation, the school has contacts with the metallurgy departments at the Universities of Zambia and Zimbabwe and see seminars, sabbaticals and external examinerships as the best way of maintaining contacts.

As mentioned earlier, the **University of Witwatersrand** offers undergraduate programmes in geology, metallurgy and mining engineering, and a further course in mineral resource management. The programmes are of similar duration to those at Pretoria University. The courses, which are part of the Department of Metallurgical and Materials Engineering, have in recent years shifted towards more materials engineering in response to the changes in industry. The department also offers a conversion course for science graduates who wish to pursue metallurgical engineering studies. Furthermore, diploma holders from technikons may be admitted to the department at third year level.

Postgraduate studies are available at both MSc. and Ph.D levels and had a total enrolment of 48 students in 1995, an indication of the research capacity of the Department. The MSc. programme includes courses in welding engineering and extraction metallurgy. A Graduate Diploma in Engineering (GDE) course in coal processing is also available. It is essentially a series of modular short courses over a two-year period and is more suited to practising engineers. The Department has excellent support from industry from which 80% of its operational budget is derived. Three teaching posts are funded by industry while the Chamber of Mines also supplements the relatively low salaries of academic staff. Laboratory facilities are adequate and are augmented by those at Mintek and CSIR.

The Department of Mining Engineering offers both undergraduate and postgraduate programmes. Historically, Wits University has provided about 60% of mining graduates in South Africa with Pretoria University providing the remaining 40%. The MSc. courses offer a diversity of options including mining geology, mineral economics, geostatistics and rock mechanics. In 1995, the total number of graduate students undertaking GDE, MSc. and Ph.D programmes was 135, reflecting the large research capability. The department also offers non-formal qualifications short courses to upgrade employees from industry as part of the Continuing Engineering Education programme. Contacts with industry are excellent with all undergraduate students fully sponsored during

1995. There is a state of the art industry-supported Research Centre for Rock Engineering, which particularly is useful for the study of rock behaviour in-situ.

Both the Universities of Witwatersrand and Pretoria participate in two bridging schemes to assist disadvantaged students; the Pre-University Bursary Scheme (PBS) which is funded by Anglo American Corporation and the College of Science and Engineering Scheme (CSES) which spreads the duration of the first year to two years for students with a weaker academic background.

The Faculty of Mining and Metallurgy of the **Technikon Witwatersrand** is the only college in South Africa which offers full-time national diploma courses in metalliferous mining, coal mining, extractive metallurgy, economic geology and mine surveying. In addition, there is a programme in engineering metallurgy. The courses are of three years duration with alternate six-month periods of practical training in industry and academic study at the technikon, respectively. The courses can be extended to Higher National Diploma level with a further year of study, similarly divided into a practical and an academic component. The HND can further be extended to a Masters Diploma in Technology in Minerals Engineering by completion of an applied research project. The masters diploma allows for registration as an engineer. Current plans are examining the possibility of replacing the masters diploma with a Bachelor of Technology degree programme for the geology, and mine engineering and surveying options.

The college has an excellent relationship with industry with most of the students sponsored by industry. At second year level sponsorship was as high as 90% in 1995. Short courses are available to prepare candidates for relevant competencies such as the Government Certificate for Mine Managers. A course for trainee Inspectors of Mines is currently planned for January, 1997. Staff salaries for non-seconded staff are subsidised by the Chamber of Mines. 60% of the budget of the faculty is met from industry sources. Each programme in the faculty has a liaison committee which meets with training managers from industry on a quarterly basis. Upgrading from artisan to technician programmes is, however, difficult at present due to students having to meet different minimum entry requirements. This appears likely given the future approach to education in South Africa currently being discussed.

Other than the Technikon Witwatersrand, the **Technikon SA** offers similar mining programmes on a correspondence basis aimed at students seeking to (re)enter the Technikon Witwatersrand for full-

time studies. The **Technikons of Pretoria and the Vaal Triangle** offer engineering metallurgy courses which are mainly directed at the iron and steel industry.

Table 4 shows the output of skilled manpower from the Universities of Pretoria and Witwatersrand, and the Technikons Witwatersrand, Pretoria, South Africa and the Vaal Triangle. The table indicates a combined national output of 44 and 69 mining engineers between the two universities for the years 1993 and 1994,

Table 4: Indicative output of skilled manpower from the Universities of Witwatersrand and Pretoria, Technikon Witwatersrand and artisan sources

Graduates	Wits. Univ.		Pretoria Univ.		Total	
	1993	1994	1993	1994	1993	1994
Degree						
Mining Eng.	24	37	20	32	44	69
Met./Min.Proc.	25	25	45	41	70	66
Geology	20	11	11	6	31	17
Sub-Total	69	73	76	79	145	152
	Technikon Witwatersrand (others)					
Diploma	National Dip.		Higher Nat. Dip.		TOTAL	
Mining	1993	1994	1993	1994	1993	1994
Metallurgy	58(2)	52(2)	56	67	116	121
Geology	60(602	47(48)	43(42)	43(46)	205	184
Mine Survey	3	6	6	16	29	22
	26(1)	2(2)	22	20	49	24
Sub-Total	230	159	169	192	399	351
Artisans	MEIETB		MIETTB		TOTAL	
	1993	1994	1993	1994	1993	1994
	2,695	1,092	1,249	299	3,944	1,391
TOTAL	2,695	1,092	1,249	299	3,944	1,391

n/a: Figures not available.

Sources: Universities of Pretoria and Witwatersrand; Witwatersrand Technikon and Department of Labour. Figures in brackets indicate outputs from

Technikons Pretoria, South Africa and Vaal Triangle.

MIETTB: Mining Industry Engineering Trades Training Board.
MEIETB: Metal and Engineering Industries Education and Training Board.

respectively. Measured against the projected national demand of 174 mining engineers in Table 3, it appears that South Africa faces a shortfall of mining engineers in the short term. Mining engineering programmes are only available at the two universities. Similar conclusions may be made for geologists for whom the number of graduates is indicated by Table 4 as 31 and 17 for 1993 and 1994, respectively. The national output for geologists for 1993 and 1994 was 60 and 69, respectively while the estimated annual demand shown in Table 3 is 107 geologists. In the case of metallurgical and mineral processing engineers, the number of graduates from the two Universities was 70 and 66 for 1993 and 1994, respectively. National output for this group of skills is estimated at about 125 graduates per year. Compared to the estimated demand of 159, there is clearly a shortfall in metallurgists and mineral processing engineers. Given the rapid diversification into metallurgical manufacturing value-added mentioned earlier, it is highly likely that the deficiency for this skill group in South Africa is more acute than the figures suggest.

With respect to technicians and technologists, Table 4 indicates that the 1994 total output of mining, metallurgy, geology and mine surveying diploma graduates is about the same as the predicted demand shown in Table 3. For metallurgical technicians, there appears to be an excess of diploma graduates. However, the majority of graduates in this category are in engineering metallurgy for the processing industries. Of the total number of 184 metallurgical technicians, only 67 are in extractive metallurgy, a figure which is about the same as the projected demand for mineral processing and metallurgy technicians. The main conclusion to be made is that South Africa is well able to meet the demand for technicians and technologists in mining, metallurgy, geology and mine surveying.

In-Company and Other Training Schemes

As earlier indicated, mining in South Africa is dominated by several major corporations. Each of the corporations runs its own training facilities. The Group Education and Training Centre at James Park in Randfontein belonging to the Johannesburg Consolidated Investment Limited (JCI) is typical of the in-company

training facilities run by the corporations.

The **JCI Group Education and Training Centre**, located at Randfontein offers a variety of training programmes ranging from engineering disciplines to mining and metallurgy, and in finance and administration. Table 5 shows the number of disciplines on offer and the training routes for achieving the qualifications. The training programmes are offered on a cooperative basis comprising of academic learning in educational institutions interspaced with practical training at group companies.

Depending on an individual's ability and interest, the choice of learning follows any one of three routes between university and technikon studies or an entirely practical programme augmented by structured in-house courses. The exit points for the three routes are degree, higher national diploma and artisan level qualifications, respectively. For the university and technikon routes, the trainee works for the company for an initial period of one year to explore and confirm his career orientation after which he is offered a scholarship. During vacations, the students return to the group companies for industrial training.

Table 5: Available disciplines and training routes on the JCI cooperative training schemes

Courses	University Route	Technikon	Practical Route
Engineering			
Mining	+	+	+
Metallurgical	+	+	-
Chemical	+	+	-
Instrumentation	-	+	-
Mechanical	+	+	-
Electrical	+	+	-
Analytical Chemistry	+	+	-
Computers	+	+	+
Geology	+	+	-
Mine Surveying	-	+	+
Ventilation	-	-	+
Finance and Administration	+	+	-

\+ Available
\- Not available

For mining disciplines, the practical route progresses a

trainee to shift boss level in about 30 months, while the technikon HND graduate is expected to achieve the same level in six months after qualifying. The university graduate mining engineer, on the other hand, takes an average of 18 months to attain shift boss level because of less time spent in industry prior to graduating.

The Centre also runs artisan and operator training programmes such as fitting and turning, welding, boilermaking and mechanics. The courses are certified by the Mining Industry Engineering Trades Training Board (MIETTB) and the Metal and Engineering Industries Education and Training Board (MEIETB) through the Department of Labour. A Pre-Apprentice Bridging Scheme (PABS) is available to enable employees without academic qualifications enrol for apprenticeship training. A parallel Pre-Apprentice Training Scheme (PATS) enables school leavers without the necessary academic entrance qualifications attend the apprenticeship courses. Both PABS and PATS provide a large pool of potential future apprentices. All trainees attend a Career Orientation and Personal Empowerment (COPE) programme whose objective is to integrate non-technical personal development programmes, such as career pathing, life skills and personal budgeting, into the training programme.

Overall, the training schemes work well and result in well-grounded graduates from a practical viewpoint. Furthermore, the various schemes enable a trainee to proceed as far as his ability will permit. The JCI training Centre is open to outside private clients and has admitted students from Zimbabwe in the past.

Figures to indicate the total output of artisans from the various in-company training sources were not directly available. However, data obtained from the Department of Labour, shown in Table 4, indicates that a total of 3,944 apprentices graduated in 1993 through the Mining Industry Engineering Trades Training Board and the Metal and Engineering Industries Education and Training Board. The two Boards regulate artisan training in the mining and metallurgical industries. In 1994, the number of apprentices graduating through the two Boards fell to 1,391. Compared to the annual demand of 2,123 for artisans shown in Table 3, it is clear that South Africa is able to meet its needs for artisan and operator type of skills for the mining industry. This conclusion is consolidated by the fact that South Africa has some 24 accredited industry training Boards for artisans. Given the labile nature of artisan skills, mobility across industrial sectors can only add to the sufficiency of artisans in the mining sector.

MINTEK, in addition to its basic R&D capability, has excellent facilities for training in the field of extractive metallurgy. MINTEK is currently considering two training proposals for the subregional mineral sector. The first involves a two year diploma-based programme of theoretical and practical training with the latter undertaken at MINTEK while the former would be undertaken in association with an external college using a distance learning approach. A further option would extend the course into a continuing education scheme aimed at individuals in mineral processing plants of the subregion. The second proposal involves technology "franchising" to the other countries in the subregion. Under the scheme, MINTEK would provide procedures, training manuals and technical backup to national research institutions in the subregion. This would include systems to ensure good management and quality control of the national laboratories by some referral type of system in which MINTEK acts as a centre in a network of participating national research institutions.

It is not known whether progress has been made towards these suggestions. Nevertheless, the possibility remains that the excellent research facilities at MINTEK, and those at the Council for Geoscience, the Atomic Energy Corporation, and the Division of Mining Technology of the Council for Scientific and Industrial Research (CSIR) have the capacity to provide hands-on training to research organisations and the mining industry in the subregion.

The **Chamber of Mines of South Africa** has an active Education and Training Advisory Unit which is involved in a number of training initiatives and on which all the major mines have a representative. The Chamber provides training for engine winding drivers, in radiation control and in environmental aspects of mining. The Chamber also underwrites some certificates of competency, such as that in Mining Ventilation. The Chamber runs a training institute for coal mines at artisan level. So far, most of the training efforts of the Chamber have been directed at adult education, to upgrade the historically disadvantaged large mine workforce, and at tertiary education. On the tertiary education support programme, financial assistance is provided to universities to supplement salaries of academic and support staff like laboratory managers, as well as assist with purchases of laboratory equipment. The 1995 budget for the assistance programme amounted to US$ 5.0 million. Among the universities which benefit from the support are Witwatersrand and Rhodes in geology; Cape Town, Stellenbosh and Witwatersrand in metallurgy and Witwatersrand and Pretoria in mining engineering.

A major initiative in which the Chamber is involved is the on-

going reform in education and training in South Africa. The objective of the reforms is to ensure that industrial training qualifications are attuned to the competencies they seek to describe through a uniform national set of guidelines known as the National Qualifications Framework. The education system and the various training systems maintained by various industries have historically been fragmented. A learner emerging from an industry centre has often had educational deficiencies which prohibit his re-entry into the formal educational system to pursue new competencies. Correspondingly, a school leaver has traditionally been inadequately equipped to enter the world of work. The National Qualifications Framework will facilitate the granting of qualifications which are nationally recognised and which meet appropriate industry standards. It is argued that this will permit the leaner to move more freely between education and training systems to exploit all appropriate opportunities for competency development.

With respect to the mining industry, the Chamber has been facilitating the review and conversion of mining based qualifications into a suitable competency-based format. An industry set of guidelines, known as the Mining Qualifications Framework (MIQF) has been under development. The guidelines incorporate a model for skills analysis, the description of minimum competencies required for specific tasks and their grouping into learning modules which can serve as components of new formal mining skills. The mining industry, with assistance from the Chamber, has been working closely with the Government Mining Engineer's (GME) Qualifications Forum with a view to transferring all statutory mining qualifications from the GME to industry in the form of competency-based qualifications.

For an industry like mining with large pools of unskilled and semi-skilled employees, the competency based qualifications, together with the various Adult Basic Education and Training schemes (ABE/T), will provide opportunities for individuals to use their full ability to improve and diversify their skill base. The system will also afford employees opportunities to obtain qualifications equivalent to formal educational system qualifications. For the industry, a thoroughly and appropriately trained labour force should enhance productivity and competitiveness. Overall it is noteworthy that skills development at all levels is undertaken with the comprehensive participation of industry ensuring the usefulness of the end product in the work environment.

Annex 1.7 - ZAMBIA

Overview of the Mining Sector

The mineral sector in Zambia has always been, and still is, the backbone of the Zambian economy. It accounts for nearly 90% of foreign exchange earnings, 13% of the Gross Domestic Product and about 15% of the total formal employment (39,40). The mineral output is disproportionately dominated by copper, and to a lesser extent the by-products of cobalt, gold, silver and selenium. Zambia also mines a number of gemstones, notably; emeralds, aquamarine, amethyst and tourmaline, although most of this production does not enter the formal marketing sector. Other minerals mined include coal, manganese and aggregate, for road construction and cement production.

Copper mining is exclusively undertaken by Zambia Consolidated Copper Mines (ZCCM), a state-owned company operating five large divisions at Nchanga, Mufulira, Nkana, Luanshya and Konkola. ZCCM was formed from a merger in 1982 between Nchanga Consolidated Copper Mines (NCCM) and Roan Consolidated Copper Mines (RCM). Prior to the acquisition of a 51% shareholding in 1970, the mining interests of NCCM belonged to Anglo American Corporation (AAC), while those of RCM were owned by the Rhodesian Selection Trust. The current equity stock in ZCCM is shared between Government (60.3%), AAC through Zambia Copper Investments Holdings Limited (27.3%), the public (9.4%) and the balance by several private companies (41).

The nationalisation of the copper industry appears to have precipitated a continuous decline in copper output from a peak of 755,000 tonnes in 1969 to a record low of 350,476 tonnes in 1995 (41). Major reasons cited for this include the declining low grades at deeper mining levels, high investment in non-core business activities, and the lack of retained profits for reinvestment into exploration, maintenance and replacement of capital equipment. This compelled ZCCM to borrow heavily to finance both capital expenditure and operational costs resulting in a large accumulated debt overhang (41,44). Although rarely acknowledged, the poor stewardship of the company by managers successively appointed by, and answerable to, the State has also been a significant contributory factor to the declining performance.

As a direct result, ZCCM now lacks the large financial resources, estimated at $2 billion over 15 years, to restore production capacity and a number of operations are threatened with closure or have closed down. Revival of the copper industry hinges on the company's privatisation to bring in the much needed new

investment, modern technology, new management and a new crop of stakeholders committed to increasing productivity and lowering production costs to industry-wide acceptable levels. Fortuitously, reserves of copper, and the cobalt by-product, are sufficiently large to attract private sector re-capitalization.

Coal is exploited by Maamba Collieries, another state-owned enterprise, with production highly constrained by poor equipment availability, design problems and poor management (43). Although the installed capacity of the plant is 1.2 million tons/year of washed coal, production is typically about 350,000 tons/year. Several rehabilitation campaigns funded by the World Bank and the ADB, among others, appear not to have arrested the problem (43). In the gemstone sector the largest emerald mine, Kagem, is also state-owned although there is a collection of small privately-owned mines operating in the main gemstone belts of the Copperbelt (emeralds), Eastern (aquamarines, tourmaline) and Southern (amethyst) provinces. Manganese in Mansa is exploited on a small scale by Mansa Batteries Limited, another state enterprise. Previously, MINDECO Small Mines exploited gypsum, amethyst, feldspar and limestone but the company is now inactive.

The predominance of the copper industry in Zambia has regrettably stunted the development of other mineral deposits. Zambia has over three hundred recorded gold occurrences, a small but significant nickel deposit, the potential for diamonds and substantial iron ore resources (39). Inadequate legal and fiscal incentives and poor infrastructure have, however, precluded the development of these resources, particularly by private capital.

Administratively, the mining sector is regulated by the Ministry of Mines and Mineral Development (MMMD) through four technical departments. The Geological Survey's chief function is to produce maps and provide economic information on mineral deposits. The Mines Development Department issues mining rights, provides mineral statistics, and monitors existing mining operations, in addition to evaluating new mining projects. The Mines Safety Department is responsible for compliance with regulations in relation to the health and safety of operations and their effect on the environment. The fourth portfolio of Mineral Promotion and Investment is a recent addition to attract investment into the mining sector (42). Probably due to the historical dominance of the State in mining operations, there is no Chamber of Mines, although there are associations in the gemstone sector, perhaps due to the overwhelming presence of small scale private operators.

Profile of Mining Skills

Despite the serious decline in production volumes and employment levels, ZCCM remains the largest industry employer in Zambia. In 1986, the company begun to reduce its labourforce from a peak of some 60,000 to just over 55,000 in 1992. Continuing operational problems forced the company to embark on an Interim Short Term Plan (ISTP) in 1994 with the objective of reducing production costs and expenditure, and maximising revenues (41,44). In employment terms, the ISTP has lead to further "labour right sizing" with the loss of more than 10,000 jobs in the last three years to leave the labourforce at 44,241 at the start of 1996 (42). Naturally, this has significantly reduced employee morale and provides another reason why production has proved difficult to resuscitate.

Employment for skilled categories of the labourforce has, however, not suffered as much. Table 1 shows the distribution of skilled manpower in the mining sector as a whole and to which ZCCM is the major contributor. The Government data includes skilled manpower employed by the four technical departments of the MMMD. The Government data also includes skilled staff at academic institutes but not the private sector exploration companies. The industry data is based on employment statistics for skilled manpower in the State-owned companies of ZCCM, Maamba Collieries and Kagem. The Government departments and mining companies included in the survey employ virtually all the core mining skills in the country. ZCCM alone accounts for about 94% of the total skilled manpower employment numbers indicated by Table 1.

The major visible feature of Table 1 is the large concentration of skilled manpower in the mineral sector of Zambia. The estimated total number of skilled manpower jobs for the indicated categories is 5,652. With respect to the core professional skills, the sector employs some 224 mining engineers, 226 mineral processing and metallurgical engineers and 104 geologists. These figures reflect the considerable size and long history of large scale mining in Zambia.

Nevertheless, the table shows some deficits in several skill categories. In the professional category, the deficit is largest for geologists and to a lesser extent, mining engineers and surveyors corresponding to numerical deficiencies of 40, 15 and 15, respectively. In the technician category, there is a deficit for geological technicians with some 21 vacancies. The largest deficit, however, is for artisan level skills where a total of 961 vacancies

Table 1: Estimated distribution of skilled manpower in the sector of Zambia

Skill Category	Government		Industry		Total	
	Filled	Deficit	Filled	Deficit	Filled	Deficit
Professional						
Mining Eng.	29	9	195	6	224	15
Min. Proc.Eng./Met.	17	1	209	0	226	1
Geologists	18	18	86	22	104	40
Chemists	5	1	76	-2	81	-1
Surveyors	1	0	148	15	149	15
Gemologists	0	0	2	0	2	0
Other Engineers	11	-5	542	-2	553	-7
Sub Total	81	24	1,258	39	1,339	63
Technicians/ Technologists						
Mining	6	4	50	-41	56	-37
Min.Proc.Met.	5	0	68	-31	73	-31
Geological	4	0	8	21	12	21
Surveying	6	3	52	-5	58	-2
Chem.Lab.	6	0	14	5	20	5
Cartog./D'men	14	0	112	-10	126	-10
Sub Total	41	7	304	-61	345	-54
Artisans	0	0	3,968	961	3,968	961
TOTAL	122	31	5,530	939	5,652	970

Source: Computed from data supplied by Ministry of Mines and Mineral Development, ZCCM, Maamba Collieries and Kagem.

exist. For Government departments, the deficits are partly accounted for by the new expanded organisational structure at the MMMD which aims to decentralise the provision of technical services to the major mining districts (40). The deficiency in geological skills may also be explained by the increasing number of private sector exploration activities which attract geologists away from traditional employers. In the case of geological technicians, the deficit is probably due to the historical absence of local training facilities. Although not indicated in the table, small deficits for mining engineers and mineral processors were reported by Maamba Collieries.

A further interesting feature of Table 1 is the apparent over-employment of technician level skills where a surplus of 37 mining technicians and 31 metallurgical technicians are indicated. These figures arise primarily from ZCCM, who are making significant cuts in the number of technicians in these categories. This is probably

related to the overlap of competencies between technician level skills and those from in-house training schemes, such as the staff learnership, which have the same career paths. In the case of mining operations, for example, a staff learner's career path progresses through section boss, shift boss with mine captain as the terminal point. A diploma holder mining technician has a similar progression path. Similar considerations apply to metallurgical technicians whose terminal point is at general foreman (42). This may be further clarified by Table 2 which shows that to the contrary, there are deficits in the jobs located along the career paths of the mining staff learner and mining technicians. Yet in the latter case, the numbers in post are declining. Clearly, there appears to be a preference for the in-house trained staff learner skills compared to external diploma level qualifications. To compound the problem, jobs higher than mine captain, such as superintendent and mine manager, are reserved for degree holders. This further marginalises diploma level mining skills.

Table 2: Distribution of opportunities along the mining engineering technician - mining staff learner career path

Job level	Current	Required	Deficit
Section Boss	978	1,087	109
Shift Boss	506	525	19
Mine Captain	136	146	10
Mining Technicians/ Technologists	47	4	-43

Source: ZCCM, Survey Data

Expatriate labour force has largely declined in ZCCM due to a sustained "Zambianisation" programme and by 1996 all general and most middle management jobs were held by Zambians. Currently there are 195 expatriates out of a total workforce of 44,241, equivalent to 0.4%. The distribution of the expatriate labourforce by function is indicated in Table 3. It is clear that expatriates are concentrated in the engineering maintenance function, and to a much less extent the medical and production functions of mining and metallurgy. The administrative functions of purchasing, finance and human resources management show the least concentration of expatriate personnel.

Table 3: Distribution of Expatriate Manpower by functional areas in ZCCM

Function	Expatriates	%
Medical	36	18.4
Education	17	8.7
Engineering	61	31.1
Finance	7	3.6
Human Res.	7	3.6
Supply	1	0.5
Geology	14	7.1
Mining	32	16.3
Metallurgy	21	10.7
TOTAL	196	100

Source: Computed from data supplied by ZCCM.

In March 1996, a large number of expatriates was, however, recruited. ZCCM argued that this was not a de-Zambianisation exercise rather than an effort to engage experts with world-wide experience to help regain productive capacities. Several Zambian general managers were replaced with expatriates and at Nchanga Division alone, 28 expatriates were engaged in the areas of mining, smelting, maintenance and management information (46). This development adds support to the notion that mining skills must remain globally competitive for the industry to maintain competitiveness at the world level.

Major Developments in the Sector and Demand for Mining Skills

Following nationalisation of the mineral sector, investment in mineral exploration by the private sector virtually dried up. In recent years, Government has made major policy changes to reduce its role to that of facilitator rather than participator. The main policy objectives hinge on privatisation of all existing mining operations and attracting private sector investment in new mining ventures to both increase and diversify mineral production, thus maximising foreign exchange earnings and fiscal receipts. The new policy is supported by a new Minerals Act of 1995 in which the central pillars are security to mining rights, a range of legal and fiscal incentives, the right to market mineral products and guarantees that there would be no mandatory participation by Government in mining ventures (42).

As a direct result, Zambia has recently witnessed an unprecedented surge in the number of international mining companies taking up large grounds for exploration. The list is sizeable and includes major companies such as Phelps Dodge, Rio Tinto Zinc (RTZ), Anglovaal Limited, Johannesburg Consolidated Investments (JCI), Anglo American Corporation (AAC), Billiton International, Gencor Limited, Southern Era Resources, and African Minerals Corporation. The minerals of interest are predominantly gold, diamonds and base metals (42) and the areas of interest are well-spread over the country. However, due to the long lead times between exploration and mine development, the surge in exploration can only translate into significant employment opportunities in the medium and longer term.

In the short term, the major impact on employment opportunities in the sector can be expected from two sources; the privatisation of ZCCM and the development of the Konkola Deep Mining Project. The mode of privatising ZCCM could influence the number of job losses. A 1994 World Bank funded study on Strategic Options of Privatising ZCCM recommended unbundling the company into smaller units to attract a larger group of investors and reduce levels of redundancies (44). AAC, the minority shareholder with preemptive rights are opposed to this and prefer to sell the company as a single unit. A re-assessment of the different methods of privatising the company is being undertaken to prepare an action plan which maximises the company's value to Government, facilitates the mobilisation of capital into the sector and takes into account the shareholders agreements and creditor agreements.

As a first step in privatising the industry, a decision to develop Konkola Deep as a majority private sector-owned and managed mine has been taken by Government. Negotiations are underway with AAC who, subject to agreement, are expected to lead a consortium of investors (47). The project involves the mining at depth of four hundred millions tonnes of copper ore and is therefore a potential major employer of mining skills. Its gestation period is not, however, expected to be less than five years.

In the light of the above developments, a logical assumption to be made is that the levels of mining skills in the mineral sector of Zambia will stabilise at current or slightly lower equilibrium levels although a major decline is inevitable if ZCCM is not swiftly privatised. In the longer term, however, the numbers of skilled manpower can be expected to increase in the light of the large exploration effort currently taking place and planned mine development. Based on current employment levels, an extrapolation of the demand for mining skills in Zambia for the next five years

has been given in Table 4. The extrapolation takes into account the existing deficiencies in the sector.

Table 4: Projected demand for mining skills for the period 1996-2001 in the Mineral Sector of Zambia

Skill Category	Government	Industry	Total
Professionals			
Mining Eng.	16	74	90
Min.Proc./met	5	73	78
Geologists	23	52	75
Chemists	2	25	27
Surveyors	0	67	67
Gemologists	0	1	1
Other Eng.	-2	188	186
Sub-Total	44	480	524
Technicians/ Technologists			
Mining	6	-23	-17
Min.Proc./Met	1	-7	-6
Geological	1	24	25
Surveying	5	13	18
Chem.Lab.	2	10	12
Cartog./D'men	4	29	33
Sub Total	19	46	65
Artisans	0	2,350	2,350
TOTAL	63	2,876	2,939

Source: Recalculated from Table 1.

The highlights of the demand distribution indicated in Table 4 are that Zambia will still need to train a large number of both core and service skills for its mining sector. For the professional core skills, the demand distribution forecasts a requirement of 90 mining engineers, 78 mineral processing engineers and metallurgists, and 75 geologists. This translates into an annual requirement of 18 mining engineers, 16 metallurgists and 15 geologists per year. The demand estimates also predict the recruitment into the sector of 27 chemists, 67 surveyors and 186 other engineers over the same period.

For technician level skills, the distribution in Table 4 underlines the declining numbers required by the sector for mining and metallurgical technicians, while 25 geological technicians will be required over the five year period. Surveying, chemical laboratory technicians, as well as cartographers also show a

positive demand. The greatest need for mining skills, however, is for artisan level skills which stand at 2,350 over the period. This points to the necessity to expand training opportunities for this group of skills.

Mining Skills Development Facilities

Academic Facilities

The long history of large scale copper mining in Zambia provided a strong incentive to establish academic facilities to cater for the sector. At degree level, the School of Mines at the University of Zambia, operational since 1973, offers five-year undergraduate programmes in mining engineering, metallurgy and mineral processing and geology. The capacity for each department is about 15 graduates per year. All three Departments offer two-year MSc. programmes by a combination of research and coursework, or research only.

The Department of Mining Engineering also graduates an average of four students from Tanzania per year. Options for the MSc. course work include Mine Environment, Rock Mechanics, Mineral economics and Production Management while planned new undergraduate courses include small scale mining and environmental pollution and control. Starting 1997, mining technicians from the Copperbelt University would be permitted to enrol at second year level. The department also offers a training programme for small scale miners known as Village Orientation and Mineral Exploitation Programme (VOME) in which the Ministry of Mines and the Geology Department participate (42).

The undergraduate course programmes in the Department of Metallurgy and Mineral Processing are centred on mineral processing, extractive and physical metallurgy. A course in corrosion engineering and fracture mechanics is planned. The Department is also considering the enrolment of metallurgical diploma holders from the Copperbelt University at third year level (42).

In addition to the two programmes on small scale mining and VOME in which the Department of Geology participates, it runs a programme of Research and Development for the Gemstone Industry in conjunction with the Ministry of Mines. Planned new undergraduate courses include Coal Resources and Use, Environmental Geology and Pollution Control, and Mineral Economics and Commodity Markets. The Geology Department has also started a new programme leading to the

award of a diploma in geology (42).

The facilities in the three Departments are reasonably adequate and have recently improved following the establishment in the School of a Mineral Resources Unit (MRU) under the auspices of the United Nations University Institute for Natural Resources in Africa (UNU/INRA) (13). There is, however, a paucity of funds which limits the ability of the School, and University as a whole, to retain teaching staff resulting in periodic shortages. Replacement through further staff development by the University is low and staff have to mostly source their own funding for postgraduate studies. Limited funding has also reduced the levels of field work for geology students and, for those in mining and metallurgy, visits by lecturers to supervise industrial training activities during end-of-year vacations. Academic visits by staff to seminars and symposia have also been greatly curtailed. Despite the problems, good contacts with industry have been maintained by the School, particularly through student sponsorship and industrial training programmes. ZCCM also sits on the School's Advisory Board (42).

Three-year technician programmes in Mining, Ventilation, Mineral processing and Surveying are offered by the School of Technology of the Copperbelt University, formerly the Zambia Institute of Technology. The School also trains technologists, the equivalent of higher national diplomas, in mineral processing and surveying. Like the School of Mines, funding problems have led to shortages of staff in all the four programmes and laboratory infrastructure is insufficient (48).

Table 5 shows the performance of the Schools of Mines and Technology in training degree and diploma level core skills, respectively, in the five years up to 1994. Compared to the projected demand for mining skills indicated in Table 4 there are two notable points. Firstly, the average annual output of professional core skills is less than the demand indicated in Table 4. Annual deficits of 7, 5 and 10 for mining engineers, mineral processing engineers and geologists, respectively, are observable. Secondly, the average annual output of mining and mineral processing technicians is far in excess of the declining employment levels indicated by Table 4. The obvious conclusion to be made from these observations is that the Departments of Mining, Metallurgy and Mineral Processing and Geology of the School of Mines need to operate at about capacity levels to meet the short term demand for mining skills in the sector. In contrast, there is an apparent redundancy of capacity for training mining and metallurgical

technicians at the School of Technology of the Copperbelt University.

One solution to the observed redundancy for technicians would be to upgrade their skills to degree level through re-training programmes. Plans by the Departments of Mining and Metallurgy, in this direction, are therefore timely. A more permanent and equitable solution lies in creating opportunities for diploma holders, through competency-based appraisals such as the Mine Manager's Certificate, to progress to middle and senior management positions. This practice is common in South Africa where diploma holders do become general managers of operating mines.

Table 5: Average output of degree and diploma holders in the core skills in Zambia

Graduates	1990	1991	1992	1993	1994	Annual Average
Professional						
Min.Eng.	12	13	11	9	9	11
Min.Proc.	15	11	5	14	11	11
Geologists	3	5	2	9	4	5
Technicians						
Min./Vent.	20	33	17	38	33	28
Min.Proc.	31	0	26	30	30	23
Survey	0	13	16	8	10	9
Geology	Prog.	started	1996			

Source: From reference 42 and 48.

In-Company Training Schemes

As one of the biggest employers of mining skills, ZCCM has established extensive facilities for in-company manpower development. The training schemes cover a broad range of levels of skills and include:-

Artisan Training for school leavers which is undertaken at 4 company training centres. The training centres also offer assayer courses (42). As part of a broad effort to improve the competencies of artisans, the company has recently introduced in-plant multi-skilling programmes for engineering maintenance personnel to equip them with multiple skills and hence improve their productivity. The first 49 multi-skilled trainees graduated at Mufulira division in April, 1996 (46).

Staff Learnership aimed at accelerated practical and theoretical training of school leavers to prepare them for supervisory jobs in production. The programme is aimed particulary

at mining operations to improve the stock of section and shift bosses, and to a less extent mine captains (42).

Graduate integration comprising a 30 month development programme for degree level entrants which systematically exposes them to their working environment. The entrants are panel-assessed at regular six month intervals.

Management and Supervisory training which consists of a series of in-house courses to support progression along career paths. Typical management programmes include General Management, Productivity Improvement Strategies, Business Skills Development and Performance Planning. Supervisory courses include a series of supervisory modules, Skills Development, and Human Resources Management and Industrial relations. Sometimes middle and senior managers are sent overseas for management courses.

To support their operations, ZCCM has also built up a capability in the specialised skills such as mine and mineral process design, project engineering and management, ore estimation and operational research, and mine planning and development (42). Most services in these areas are provided by Techpro, a wholly-owned subsidiary, located in the UK. ZCCM cite the major problems with junior graduates joining the company as low morale with most of them leaving for greener pastures within a period of a year.

Outside ZCCM, the only other company with limited in-company training facilities are Maamba collieries who operate a training school for mechanical and electrical craftsmen. The company also regularly sends personnel to external institutions for short training courses at management and supervisory levels. Difficulties they encounter with fresh graduates include resistance to supervision if the supervisor is non-graduate, unwillingness among supervisors to upgrade fresh graduates due to job insecurity, discontent with remuneration and the unwillingness by graduates to stay due to the remote location of the mine. The mine's capability in the specialised skills elaborated above is limited, and in the case of project engineering and management, totally absent. In the latter case, these services were previously provided by expatriate contracts. Skills in ore reserve estimation and mine planning and production also need to be supported by computer techniques.

In conclusion, Zambia appears to be self-sufficient in mining skills and the institutional infrastructure for meeting any foreseeable demand is in place. Whether this will remain so depends on current developments taking place in the mineral sector.

Annex 1.8 - ZIMBABWE

Overview of the Mining Sector

Minerals have historically been the basis for Zimbabwe's impressive economic growth and the development of much of its present infrastructure. The mining industry, which in 1993 earned about 32% (40% in 1990) of the country's foreign exchange, is not only large but is well diversified, producing more than forty different mineral products. The major minerals exploited include gold, asbestos, coal, nickel, copper, chromite, iron ore, diamonds and a variety of industrial minerals. Gold, with an output of 20.6 tons in 1994, is by far the major mineral product and in 1993 accounted for 42% of the total value of mine output with nickel, coal and asbestos contributing a further 40% (51). Of more than 1,400 operating mines in 1993, 86% were gold mines located in the greenstone belt which boasts of the highest known gold production per km^2 in the world. Zimbabwe also has the world's largest high grade chromite resources, for which it is the world's third biggest producer, and the second largest platinum reserves. In 1990, the country ranked second in the world production of lithium minerals and was the fourth largest producer of asbestos (53). Over 90% of the mineral output is exported although coal, iron ore and phosphate rock are mined primarily for local use.

Zimbabwe's mineral industry is largely dominated by the private sector while there is a declining presence of the State in mining operations. Despite the numerical majority of small scale mines, the major mineral output is accounted for by international mining corporations. The major multinational companies include: Anglo American Corporation, AAC (nickel and chrome); Cluff Resources, now taken over by Ashanti Goldfields (gold); Falconbridge Investments (gold); Falcon Gold (gold); Forbes and Thompson (gold); Lonrho (gold and copper); Rio Tinto Zimbabwe (nickel and gold); Union Carbide (gold); Turner and Newall (asbestos); and Auridiam (diamonds) (49,51). The state interest in mining is mainly represented by the Zimbabwe Mining Development Corporation (ZMDC), created in 1982. ZMDC's traditional mining operations include copper, graphite, tin and gold. Following persistent losses, particularly in the non-gold operations, the company's corporate strategy has shifted to exploration and advisory services (52). The other major State-owned companies in the sector are Zimbabwe Iron and Steel Co (ZISCO) producing iron and steel and Wankie Colliery, mining coal.

The activities of the mining industry are regulated by the Ministry of Mines whose mission statement is to promote the sustainable development of mineral resources to achieve their optimal contribution to the economic and social development of Zimbabwe. The Ministry is divided into several technical departments. The Mining Law Adminstration Department implements mining legislation and provides an administrative function for the plant hire and loan scheme. The Department of Mineral Promotion and Development is responsible for promoting the industry, mine development and policy formulation. The Department of Mining Engineering oversees engineering and mine survey services and offers free technical advice in these areas, particularly to small

scale mines. It also conducts feasibility studies for mine loan applications. In addition, the Department issues blasting licences, Mine Managers and Mine Surveyors certificates of competency. The Department of Metallurgy provides free analytical and metallurgical services including process development to establish optimal mineral treatment methods. The Geological survey collects and disseminates economic information on mineral deposits, as well as providing free mine geological services. For administrative purposes, the Ministry's activities are divided into four mining districts, namely Harare, Gweru, Bulawayo and Masvingo, each manned with a mining commissioner responsible for local adminstration (50).

It is clear that the success of the mining industry in Zimbabwe is underpinned by a wide range of free technical incentives and services provided by the Ministry although funds and manpower have increasingly become major limitations (50). The Ministry's efforts are complemented by the Chamber of Mines of Zimbabwe (COMZ) funded from voluntary subscriptions by members. The COMZ is one of the oldest and largest chambers in Africa and represents about 95% of all mineral organisations in Zimbabwe. Membership of the Chamber includes the major mining corporations, State-owned companies and small scale workers. Some 90% of total gold output is produced by Chamber members. The Chamber intercedes on behalf of members in a broad range of issues such as interpreting mining legislation, labour issues, training and taxation. The Chamber also acts as a source of industry information.

Zimbabwe has several other mineral-based associations including the Small Scale Miners Association, and the professional associations of Mine Managers and Mine Surveyors.

Profile of Mining Skills

As would be expected from the large number of mines, the mineral sector in Zimbabwe is a major employer although total formal employment has declined from a peak labourforce of 68,200 in 1981 to about 50,000 in 1996 (3,50). The decline largely reflects improvements in labour productivity over the years since mineral output has steadily expanded. Despite the decline in employment numbers, the mineral sector still accounted for about 4% of total formal sector wage earners in Zimbabwe in 1993.

Table 1 shows the distribution of skilled manpower in the mineral sector of Zimbabwe. The Government data includes all the technical departments of the Ministry of Mines, as well as the academic institutions. The industry data was based on estimates supplied by the Chamber of Mines whose membership includes service companies such as those in exploration and supply of equipment and spares. Due to the form in which the information was available at the Chamber, data is missing for some skill categories indicated in the table. For similar reasons, the table does not show the deficits of skilled manpower in the industry. Nevertheless, the estimates shown in the table are sufficiently accurate to indicate the general levels of skilled manpower in the industry.

Table 1: Distribution of skilled manpower in the mining sector in Zimbabwe

Skill Category	Government	Industry	Total
Professionals			
Mining Eng	29	65	94
Min. Proc. Eng./ Metallurgy	32	110	142
Geologists	43	53	96
Chemists	5	52	57
Surveyors	6	n.a.	6
Gemmologists	3	n.a.	3
Other Eng.	2	150	152
Sub Total	120	430	550
Technicians			
Mining/Ventilation	16	200	216
Min. Proc./Assayers	n.a.	59	59
Geological	9	n.a.	9
Surveying	11	n.a.	11
Cartog/D'men	21	15	36
Chem.Lab	n.a.	21	21
Sub Total	57	295	352
Artisans	3	695	698
TOTAL	180	1,420	1,600

Source: Government statistics were provided by the Ministry of Mines. The Chamber of Mines provided industry data.

n.a. : Not Available.

The broad numerical strength of skilled manpower revealed by Table 1 is somewhat less than would be expected in the light of the large number of mines in Zimbabwe and the equally large labourforce. This points to the major feature of the industry that is mostly labour intensive. Nevertheless, the point can be made that the industry as a whole has a relatively large concentration of mining skills compared to other major mining countries in the region. It is not possible from the data available to judge the numerical sufficiency of skilled manpower in the industry. Verbal indications from the Ministry (50) suggested that the country might be approaching saturation limits for mining engineers, while deficits should be expected for mineral processing engineers/metallurgists and geologists. The data contained in Table 1 would, however, seem to suggest otherwise. A further point to note from Table 1 is the large concentration of the core mining

skills in the government sector. This underscores the large and diverse services offered by the Ministry to industry, particularly the large small scale sector.

An interesting feature of the industry in Zimbabwe is the dispersion between job functions relative to the expected career paths as determined by academic achievement. It is not impossible for a geologist or a surveyor to ascend to the position of mine manager. Two main factors may be responsible for this. Competency, rather than mere academic achievement, is an integral part of the progression along a career path, particularly for the larger corporate mines. Unfortunately, due to the proliferation of small mines, competence is frequently equated to hands-on experience thus expanding the grey area between competency, academic standing and technical literacy.

A final feature of the industry not shown in Table 1 are the levels of expatiates in the industry. Previous studies (6) have indicated these to be concentrated in the general and middle management positions. Available information indicates that this trend has persisted especially in the major multinational mining companies.

Major Developments in the Sector and Demand for Mining Skills

Since about 1993, mining output has been experiencing a sustained boom while exploration has risen to unprecedented levels. The main mineral of focus has been diamonds although gold, base metals and platinum have continued to receive attention. Of the 131 exclusive prospecting orders issued in 1993, 98 were for diamonds and 31 for gold (32).

The exploration boom is in line with the Government's policy objective to achieve a sustained growth rate of 5% per year in mining output (50). However, there has not been many major mine developments so far. In 1995, UK-based Reunion Mining developed a 5,000 t/year copper mine at Sanyati. However, the biggest mine development is the Hartley Platinum Project expected to produce 150,000 oz of platinum, about 3% of the world output, with palladium, rhodium and gold by-products. The mine is being developed at a cost of US $250 million by the Broken hill Proprietary Company, the managing partner with 67% equity, and Delta Gold who own 33% of the shares. Full production is expected to be achieved in 1997 with a total workforce of 2,700 (13,27,53).

The current exploration efforts and mine developments have the

potential to create significant skilled manpower employment opportunities. This is, however, diluted by the closure of some significant mining operations. For example, in 1994 alone, ZMDC closed the Kamativi Tin operations and there was mounting pressure to close the copper ventures at Mhangura and Lomagundi Mining and Smelting operations due to sustained losses. In the same year, two of Anglo's Zimbabwe Alloys mines closed down due to an oversupplied market and the need for changes to the cost structure of the company (52,54). Although these considerations may point to declining overall employment opportunities in the industry, the demand for mining skills is expected to increase in the short term if only because of the intensity of the exploration efforts. Added to this is the fact that the small scale mining sector is largely skill deficient. Efforts to improve productivity in this considerably large sector should add to a sustained demand for skilled manpower.

Based on current employment levels of skilled manpower, projections of demand for skills for the next five years are shown in Table 2. The table indicates that Zimbabwe needs to recruit into the sector at least 6 mining engineers, 9 mineral processors and 6 geologists per year. For technician level manpower, the sector needs to source some 15 mining technicians and 6 mineral processing technicians per year. The largest need is that indicated for artisans where some 49 of them are required every year. The figures

Table 2: Demand for selected skilled manpower in the mineral sector of Zimbabwe up to the year 2001

Skill Category	Government	Industry	Total
Professionals			
Mining Eng.	7	34	41
Min. Proc./Metallurgy	8	48	56
Geologists	11	26	37
Chemists	1	22	23
Surveyors	2	n.a.	2
Gemmologists	1	2	3
Other Engineers	1	71	72
Sub Total	31	203	234
Technicians			
Mining/Ventilation	4	77	81
Min. Proc. Assayers	n.a.	25	25
Geological	2	n.a.	2
Surveying	3	n.a.	3
Cartog./D'men	5	9	14
Chem.Lab	n.a.	9	9
Sub-Total	14	120	134
Artisans	1	379	380
TOTAL	46	702	748

Source: Calculated from Table 1.

presented in Table 2 can only indicate a baseline case. The actual requirement for mining skills in Zimbabwe should be much larger on account of the large potential as indicated earlier. Numerical data to indicate this potential was not, however, available.

Mining Skills Development Facilities

Academic and Research Facilities

Degree level training in mining skills is offered by the University of Zimbabwe which has supplied the industry with geologists and chemists since 1965, engineers since 1977 and surveyors, mining engineers and metallurgists since 1988.

The Geology Department, part of the Faculty of Science, offers a range of modular courses leading to the award of BSc. (general) and BSc. (honours) degrees. The Department graduates approximately 30 and 10 students on the general and honours programmes, respectively. The Department has been planning to strengthen the economic and environmental geology components and was due to introduce an MSc. programme in Exploration Geology in 1995. The MSc. course was conceived as a SADC programme and funded by the Dutch Government. It is expected to graduate about 10 students per year. The Department of Geology has good funding links for research with external (overseas) university sources.

The Department of Mining Engineering offers 4 year degree programmes in mining engineering, metallurgy and surveying. Information available (50) indicates that the Department graduates about 15 students per year in mining engineering and an equivalent number in metallurgy. The Department also offers M Phil and D.Phil research programmes of two and three years duration, respectively. An MSc. programme by coursework is planned for the future. In addition to the undergraduate programmes, short courses are offered in areas like Rock Mechanics, Mine safety, Ventilation and Planning Tools. Short courses for small scale miners are also available. The Department has an excellent relationship with industry and has built up an impressive capability in Mine Planning, particularly in open pit mining. Major handicaps of inadequate laboratory facilities, however, persist. Lecturers also carry heavy loads, limiting their effectiveness especially in consultancy.

The Zimbabwe School of Mines offers courses leading to intermediate and full national diplomas in mining, mine surveying,

mineral processing and extractive metallurgy, and mining geology. The mining geology programme started in 1995. The 1995 output figures for both categories in the three streams excluding mining geology were 15, 8, 15, respectively. Out of these, only 1 in mining, 5 in surveying , and 5 in metallurgy obtained full national diplomas. The school's graduates are able to achieve positions such as mine captains and chief surveyors in industry. Unfortunately the school has traditionally been plagued by underfunding and uncompetitive pay scales which has made it difficult to recruit and retain staff (54). The School was in 1994 put under the control of the Ministry of Mines and is now administered by a Board on which the Chamber of Mines and the Ministry are equally represented. This has brought the school closer to the mining industry (50). The school offers certificates of competency for mine managers through distance learning. The school's curriculum has been redesigned since 1994 and facilities improved with the assistance of CIDA. All students are sponsored by mining companies. A number of short courses are available including one in gold extraction which is aimed at small scale miners. Attendance is, however, poor due to an inability to pay fees for the course.

In addition to the above academic facilities, manpower training is undertaken at the Institute of Mining Research. The institutes's primary function is to provide R&D services to the mining industry, particularly the small scale mining sector. The institute has extensive facilities in Mining Geology, Rock Mechanics, Applied Mineralogy, Metallurgy, Mineral Economics and a Coal laboratory which are used for both academic and industrial oriented research. Metallurgy students in the Department of Mines also use the institutes's facilities for their practical classes (50).

Training in pilot plant testwork is possible at the Government Metallurgical Laboratory. Although established to provide metallurgical services to the mining industry, the available pilot facilities particularly in mineral dressing, are ideal for hands-on operational practice.

Table 3 shows the projected performance of the Department of Mining and the School of Mines for the next five years based on current output. Compared to the demand indicated by Table 2, there would appear to be over capacities in the training institutions in all areas with the possible exception of mining and ventilation technicians. It must be noted, however, that the figures indicated by Table 2 are probably understated in the light of the large potential for skilled manpower existing in the industry, as earlier discussed. It needs to be further noted that the large number of

graduates in geology are from the general BSc. quota who, due to their course combination, are far less useful to industry than their honours counterparts. Most of the BSc. general graduates find employment as high school teachers and in other areas. The rationale for training them in such large numbers is not apparent.

Table 3: Projected Performance of mining skills training institutions for the period 1996-2001

Course Type	Projected Output					
	1996	1997	1998	1999	2000	Total
Degree						
Mining	15	15	15	15	15	75
Metallurgy	15	15	15	15	15	75
Geology(Gen)	30	30	30	30	30	150
Geology(Hon)	10	10	10	10	10	50
Surveying	10	10	10	10	10	50
Diploma						
Mining	15	15	15	15	15	75
Metallurgy	15	15	15	15	15	75
Surveying	8	8	8	8	8	40

Source: Estimated from data supplied by Ministry of Mines.

Comparing the existing and qualitative employment opportunities for skilled manpower and the capacities of training institutions, the broad point can be made that Zimbabwe is self-sufficient in the development of core mining skills. Previously, recommendations have been made (6) to introduce a higher national diploma at the School of mines in Bulawayo, to improve the stock of candidates aspiring to positions of underground manager and above. It appears that this has yet to be undertaken.

In-Company Training Schemes

Training and career development are a major feature of the corporate philosophy of the major companies in Zimbabwe. All the large mining companies such as Anglo American, Lonrho and Rio Tinto have training centres where employees are taught management skills, communication techniques, industrial relations and various supervisory courses to add impact to their technical skills. The companies also operate apprenticeship schemes in collaboration with Polytechnics. In addition, a substantial number of students are sponsored by the companies each year for a wide range of disciplines including non-core mining fields such as commerce and management. Graduates from these and other programmes often undergo practical training during vacations and when they complete, are

placed on fixed period graduate integration programmes. Notably also, the training division of Anglo American has grown to become a subsidiary company which offers management courses to all sectors of industry (3). Unfortunately, details of the actual company training schemes were not available during the survey.

ANNEX II - ASSUMPTIONS MADE IN THE DATA FORECASTS

The data forecasts were based on several factors:-

a) Labour Turnover Rate

The labour turnover rate is dependent on a spectrum of attrition factors which may be natural or occupational in nature. Natural factors include for example, death or injury, a person's long term ambition, age, and attitude towards work. Occupational factors may include location of work, relationship with peers and supervisors, working conditions, etc. The turnover rate is also influenced by the type of job and its demand in the labour market. Some skills, such as mechanical engineering, are in wider demand than mineral processing engineering and are therefore associated with higher turnover rates. Furthermore, young graduates at the lower end of career paths will show higher turnover rates than their older colleagues in senior and more secure jobs. Despite these differences, average annual turnover rates of 5% and 7% were assumed for Government and industry jobs, respectively, based on previous turnover rates (6), The five year turnover of skilled manpower was then calculated as the product of the annual rate, the number of years and current employment levels. This may be represented as:-

$$t = r*n*5$$

where: t = labour turnover for five years,

r = annual rate

n = current number of skilled manpower jobs in category.

b) Vacancies in Skilled Manpower Jobs

In the cases where vacancies were known, these were added to the five-year turnover calculated as above.

c) Expatriate Replacement

It was assumed that for equivalent skills and competencies, nationals would be preferred to expatriate staff. Where figures were available for expatriates, these were also added to the five-year turnover of skilled manpower.

d) Distribution of Skilled Manpower Jobs

Where there were firm indications that new mining projects would be implemented in the short term, it was necessary to estimate the number and distributions of the skilled manpower opportunities which they would create. Furthermore, in several cases, only aggregate figures for a category of skills were available. For South Africa, available data was incomplete for several skill categories. For these cases, it was also necessary to estimate the expected number and distribution of the various skilled manpower jobs. In the extrapolations, relatively more comprehensive aggregated industry information from the subregion, especially from Botswana, Namibia, Zambia and Zimbabwe, was used as a sub-sample. For each skilled manpower category in question, the expected number of jobs was calculated as a direct ratio of the employment figure for the industry in question to the total employment figure in the sub-sample and adjusted by the number of similar skilled manpower jobs in the sub-sample. This may be represented as follows:-

$$e = (a*i)/s$$

where: e = expected number of jobs in skill category,

a = total available number of jobs in similar category in sub-sample,

i = total number of jobs in national mining industry (or jobs to be created by a mining project),

s = aggregate number of jobs in the mining industries of the sub-sample.

The expected number of skilled manpower jobs estimated by the above method is based on a subregional industry average employment level for each skill category. A major weakness is evidently the fact that the assumption does not fully account for industry differences in labour productivity and technology to labour relationships. The assumption does not also entirely consider the different structural relationships in the distribution of skills between different mining operations. A gold mining operation may be more labour-intensive than a copper mining one, while a graphite mine may not need chemists unlike in metallic mining. It was recognised, however, that the sub-sample included many different mining scenarios in terms of: the large variety of minerals exploited; balance between capital and labour intensity; a

reasonable reference to an average labour productivity condition because the majority of mines in the sub-sample were privately owned by major mining corporations, while in Zambia the large copper industry is State-owned. It was therefore argued that the average abundance of skilled manpower in the sub-sample represented a reasonable basis for the estimates. Furthermore, the aim was to obtain average expectations of skilled manpower opportunities where absolute data was clearly unavailable.

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