

# Developing Mining Engineers for African Countries – The Mozambique Case Study

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**Abstract** - The development of mineral resources in Africa is to a large extent limited by local skills and knowledge of the applicable discipline. The paper describes the development of skills in the Mozambique context where a Mining and Geology Polytechnic has been developed to provide such skills. Mozambique has natural resources that include significant coal resources in the Tete province and well as developing beach sand minerals and other. The University of Johannesburg partnership with Larenstein University and the Mozambique Government to develop skills and knowledge so that these resources can be responsibly exploited by locals and wealth generated in an otherwise remote and poverty stricken area of Mozambique. The paper describes the development of this education center as a pro active step to development of the peoples of the region. The use of the South African experience as a minerals based economy is described.

*Index Terms* – mining, engineering team, industrial development education, mining education, vocational education.

## HISTORY

The start of higher education in SA took place in Kimberly in 1896 with the establishment of a vocationally based School of Mines in Kimberly[1]. This was effectively a Polytechnic similar to the current Polytechnic established in Tete, Mozambique in 2006. The purpose of the School of Mines was to provide high level manpower to the developing diamond mining industry in Kimberly. No doubt the import of mining engineers and technicians from overseas was a less attractive proposition than the developing of South Africans to provide the necessary skills and knowledge to run the mines effectively.

The discovery of Gold in the Witwatersrand not only was the start of the development of Johannesburg but also the start of the Higher Education centers in the area[2]. First the Mining Education moved to Johannesburg and later (1923) split up to the currently established three major Higher Educational Institutions in the Gauteng area – University of Witwatersrand, University of Pretoria, and

the then Institutions of Advanced Engineering and Scientific Education (now University of Johannesburg (UJ)).[1] Since this time the distance Education University of Southern Africa has been established (UNISA) in Pretoria. All these institutions have passionately maintained their Mining related courses but have also expanded across the disciplines and levels to provide the full spectrum of educational activities – Engineering, Sciences, Humanities, Medicine, Business and commerce, language and history .

Accelerating this history is seen as the possible future experience for the developing of the Polytechnic in mineral rich, but poverty-stricken area in the town Tete, in the province of Tete in the North Western part of Mozambique. Despite the fact that most of the 19 million inhabitants of Mozambique live in dire poverty the economic growth has been spectacular in the last few years mainly on the back of minerals and metals sector investment [3], [4]

In SA, since the establishment of a fully democratic government, major changes have been brought about in the educational provision, mainly with a political agenda. Particularly, the rationalization of racially based higher education (Universities and Technikons (Polytechnic based) and the merging of the many institutions has taken place recently. It is important (and some would say unfortunate), to report that the Technikons (Polytechnics) across SA have opted to be renamed to Universities of Technology or institutions of Technology. More recently and controversially some Universities and Technikons have been merged to be referred to as “Comprehensive Universities” thus allowing the presentation of academic degrees and diploma courses. Despite the various name changes the mission of the institutions has not changed much since the early School of Mines days. Perhaps this is just a natural evolution of development that will also occur in Mozambique.

Whilst in SA traditional Universities may have felt some degree of superiority over Technikons the persons at Technikons have maintained the paradigm of “equivalence but difference” based on years of post school higher education. Mozambique would do well to recognize this fact and entrench it in the educational structure[5].

## DIFFERENCES BETWEEN ACADEMIC UNIVERSITIES AND POLYTECHNICS

Our Department of Education (DoE) in SA has recognized the phenomenon of academic drift [5]. This phenomenon refers to the movement of academic universities to cater more specifically to industry needs whilst the vocational universities of Technology move towards the academic activities of knowledge generation through research and development. This is not a negative development particularly in the SA context where the institutional approaches have been entrenched for many years. It is however important in the Mozambique situation where the industrial development is still in its infancy and especially in Mining related activity.

Mining activities in Mozambique are only now being developed significantly but there is a dearth of higher educational opportunity in Mozambique. The population of Mozambique is about 18 million and this is serviced by only two government sponsored tertiary education institutions (Universities) located in the two major cities (Maputo and Beira). It is completely appropriate to install a vocationally oriented institution to serve the primary industries of agriculture and mining. In Tete where the possibility of major coal mining industry exists, it has been decided to develop the Mining and Geology Polytechnic. The mining area is currently in advanced stages of feasibility and by all accounts mining licenses are about to be awarded to amongst others a major Brazilian Mining Company. It would indeed be a shame to exploit such resource without utilization of locally educated and skilled persons. Indeed the whole philosophy of "sustainable development" requires local and national utilization of human resources[6]. In January 2006 the Advanced Institute Polytechnic Tete opened its doors to the first intake of 40 young prospective engineers to be educated in the ways of supporting the development of a minerals industry. A second intake of some 35 young men and women entered the same course in February 2007. The first diplomas are expected to be awarded for successful completion of the curriculum in December 2007 with many entering the industry directly and others progressing to specialization in Mining Engineering, Mineral resource management, Extraction Metallurgical Engineering or Mining Geology. Plans are in place to broaden the scope of education in the support services and business activities in 2008, followed in later years with broader disciplines of Engineering (Civil, electrical, mechanical, industrial, chemical etc) as well as other.

The University of Johannesburg has supported the installation of this Polytechnic as a regional collaboration effort supported by the World Bank, Nuffic and University of Larenstein in the Netherlands as well as others. The UJ input has been mainly on an advisory basis relating to curriculum development and staff development. The UJ has been significantly involved in the development of teaching staff. It is clear that SA have years of established experience in the areas related to both surface and underground mining and have established courses and suitably qualified staff. This is far from the case of

Mozambique. The closest discipline to mining is geology and many graduates of geology in Mozambique have only been able to find employment in education at schools. Further, the infrastructure (including the mines themselves) in SA is well advanced compared to that in Tete in Mozambique. The current location is as part of a senior School. This is an interim position and earth moving for a substantial tertiary education institute is now in progress. Staffing has been the greatest challenge with only 14 replies being received to an extensive advertising campaign in 2004. Selection was a formality with only 2 candidates being deemed unsuitable. After extensive training in Mozambique and SA only 4 of the candidates started work in January 2006. Administrative support was easily found and more recently importation of technical lecturing staff has been secured to ensure sustainability.

Despite the fact that it is well known, it is continuously necessary to identify the differences between the traditional University and the equivalent Polytechnic: This is applicable across the disciplines found in the SA comprehensive Universities from Mining Engineering to Beauty Care. Within the SA context this is clearly described in the establishment of different (but necessary) categories of Engineers within any specific discipline[7]. Mining Engineering will be taken as the example.

The categories are explained below and it is left to the reader to establish the similarities across other disciplines.

- The Mining industry production activities needs high level manpower to operate the front line production activities – manage safely and effectively the mining operations, to select systems for mine support and mine ventilation and to economically develop and source skills for operational activities. This type of manpower is referred to as "Engineering Technicians" – they work closely with skilled miners and artisans according to established operational standards of activity. They have the ability to detect non-standard situations that develop in the work place. These types of people are sourced and grown from a Polytechnic educational base on a 3 year post matriculation National Diploma (M+3, N Dip)
- The Mining industry production activities also need high level manpower to manage the production activities and plan long term strategies for the sustainable safe and effective operations of the mine. The envisaged possible problems require ability of the person to adapt and develop new standards of operation and to deal with broader problems that may be encountered. This type of manpower is referred to as "Engineering Technologists" and would have a somewhat higher level of applied knowledge being gained by a further year of academic activity (M+4) leading to the Bachelor of Technology (B Tech) qualification.
- The further need of the Mining industry is to have high level manpower to develop knowledge and to be involved in problem solving for proposed and operating mines. This type of manpower has developed intellect in the areas of research and

consultancy and would traditionally be derived from the traditional university engineering programmes that have a stronger base in the sciences (B.Sc. Hon Engineering: Mining)

And so the “Engineering Team” is established with a degree of overlap and portability across the approaches.

Despite the fact that the technology (Polytechnic) graduates inevitably will have less academic but more practical development during their study years it is accepted in SA that all engineers will require, to some extent, additional post qualification practical input into their development. This is referred to as a “2nd Stage” qualification that is obtained through the achievement of professional standards after their theoretical schooling.

In summary the distinction between the output of the traditional academic or science based engineering institutions (well understood) against the Technikon / Polytechnic output (always questioned by traditionalists) is indicated in table 1.

TABLE I  
TERTIARY EDUCATION OUTPUTS

<b>TRADITIONAL OUTPUTS (Engineering)</b>
Broad scientific foundation
Broad and general education
Holistic development
Promotes research and knowledge development
Academic knowledge generation
Strive to gain more insight into the fundamentals
On graduation capable of academic discussion and research
<b>POLYTECHNIC OUTPUTS (Engineering)</b>
Career focused foundation
Includes work place learning – specific focus
Focused industry driven development
Promotes industrial use of current technology and application of research – Useful skills
Practical use of knowledge
Strive to apply new knowledge to make the enterprise more competitive
On graduation capable of employment – job ready

The Polytechnic education system has found favor in many countries although the names of the institutions are different in different countries. In some countries the evolution has resulted in comprehensive institutions and in others the separation has persisted. Based on the developing world and also in Mozambique and in SA there is a natural desire by both scholars and their parents to aim for the academic qualification offered by the traditional academic university. This approach is in the hope of securing employment in an environment where uneducated persons are unable to find useful employment and where unemployment in general is high.

In SA and in Mozambique there is a high level of unemployment even of science graduates from the traditional universities. Many graduates find employment outside their studied direction. Certainly in SA there are

many holders of professional academic qualifications who are unemployed. It appears that in Mozambique the number of geology graduates exceed the demand with graduates finding employment in schools as geography teachers.

In the case of SA employment opportunities appears to be greater for students who obtain qualifications from the Technikons (Polytechnics Philosophy). This is predictable due to the vocational nature of the courses offered. Work place learning is a part of every technology course and it is an opportunity for the employer to guide and or select students for the company or enterprise. In the well-established mining industry in SA the mining technology programmes place the students for a 1-year practical phase. This is the “laboratory” in which they gain practical training and opportunity to prove themselves to the employer. The process is called “Co operative Education” and it is the chance for the enterprise to influence the curriculum and learning of the student. Invariably the students are accepted into the company even as students completing their academic work prior to graduation and some are even paid a salary during the phase of learning at the Technikon. It can be confidently said that in SA all mining diploma holders and graduates from the Technikon find immediate employment and are able to establish rewarding careers. This is not always the case with the academic graduates. Industrialized countries have on many occasions indicated a minimum ratio of 4 technicians to 1 engineer thus allowing experts to develop in the operations and allow the engineer to be most appropriately employed in the solution of problems through research and development of new knowledge.

#### INDUSTRY INVOLVEMENT IN POLYTECHNIC COURSES

One of the reasons for the popularity of Polytechnic programmes with the industrial sector is the industrial focus of the learning curricular and materials. Unless industry is intimately involved in the activities of a Polytechnic it is doomed to failure of its mission.

Industry has a willingness to contribute to education and training for selfish reasons that serve the Polytechnic needs. Effectively, the polytechnic could be looked at as an industry-training center for high level manpower. It is also in the interest of the State to promote the vocational approach to education, so that the full costs do not fall on the state. In SA capital contributions from industry in the form of infra structure often occur and attract positive publicity e.g. the “Goldfields Computer Center” etc. The industry’s interest is also to centralize the specialized equipment for possible academic and consultancy purposes. This serves as a useful tax benefit for donations to education whilst maintaining industrial hardware available for industry use. In SA there is a company 1% “skills development levy placed on all salaries. This is distributed back to the companies that are actively involved in skills development. Effectively this means that most of the education and training carried out in collaboration with institutions of higher learning is virtually for “free”.

In the Polytechnic approach the industry has significant influence in the following academic activities for the Polytechnic education:

- Curricular establishment and development
- Measurement of the standards and accreditation
- Promotion of specific products through donations of equipment etc
- Selection and enrolment management – bursary awards etc

Industry have some degree of obligation for the above opportunities within the co operative model

- Provision of work placed learning (can be subsidized or incentivised through tax or skills arrangements)
- Accommodating industry visits and involvement of industry guest lectures
- Provision of consultancy work for sustaining the institution and ensuring staff continuous professional development
- Possibility of staff secondments or subvention of salary so as to maintain the level of education provided to youth entering their industry

#### **POLYTECHNIC FOCUS**

Polytechnic education is lecturer focused. It is, in the opinion of the author, impossible for a Polytechnic to be successful without the services of qualified and experienced lecturers. The use of electronic learning is not sufficient for successful integration of theory with industrial activities – this needs a suitable lecturer.

It has already been noted that Polytechnic education is industrial focused. At a Polytechnic, It is therefore not as necessary that staff have high levels of qualification but rather that it is vital that the staff of a Polytechnic have industrial experience so as to make the theory applicable to the practice. The ideal is that the staff member should have in depth industrial experience and both education and career focused qualification.

Polytechnic education serves the community and develops the community. As in SA in the 1896 developments, the community in Tete in 2007 has a natural resource (Coal) that is poised for development. This must be the first priority in the education process. Should the mining industry in this region reach its full potential then the community must gain from the activities in a sustainable development approach [6]. The source of wealth is the coal mining but the community must develop around this non-renewable natural resource. The Polytechnic should develop rapidly into a diversified educational institution following the order as suggested below:

- Mining and associated programmes
- Engineering disciplines – electrical, mechanical, civil, industrial, building, construction etc
- Health
- Commerce and Law

- Humanities

It would not be impossible that within a 15-year time frame, the polytechnic in Tete have established courses at higher education level in all these disciplines and more. Indeed it could well be that the transformation of education that has taken SA over a century to establish, takes place in Tete over the next 15 years. We should not be disappointed if the Polytechnic evolves into a comprehensive University or even the traditional University. One can visualize this as a natural progression.

#### **FUNDING STREAMS**

In line with the needs of vocational educational it is thought appropriate to refer readers to the proceedings of the conference held at the Central University of Technology (TUT) in Bloemfontein in July 2006. The conference was arranged through Higher Education South Africa (HESA) in collaboration with TUT and had the theme of “Diversification of Income Streams in the SA Higher Education – Challenges and Opportunities.” Beyond the government subsidies and student fees it was suggested that the following sources of sustenance could be carried out by educational institutions of higher learning such as the UJ and the Tete Polytechnic:

- Development of Intellectual Property – a long term option
- Offering of extra curricula courses for skills development
- Use of facilities e.g. building especially during recess periods
- Use of intellectual capital – consultancy
- Use of equipment – contract research
- Friends – building up an Alumni network
- Industry donations in money or kind

The conference was at pains to point out that support is not only financial and that it was important to build relationships with industry, government, international and local funders, as well as other local, regional and international institutions. The need to establish partnership was highlighted as was the need to establish a “reputable brand”

#### **CONCLUSION**

In differentiating traditional Universities from Polytechnics the primary focus of the Polytechnic should be:

- Application of career knowledge
- High level skills in the career identified
- Focus on the work environment and the career development of students
- Consider the needs of industry
- Produce graduates that are work ready but who know their own limitations

- Produce graduates that have ability to adapt to new technology and are passionate about their choice of career
- Instill a sense of community development

The development of a Mining based Polytechnic in Mozambique in the Tete region is entirely appropriate but it should diversify with vigor to serve the minerals sector and the community at large.

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