ZJER

ZIMBABWE JOURNAL OF EDUCATIONAL RESEARCH

Volume 27 Number 3
November 2015

UNIVERSITY OF ZIMBABWE

Volume 27, Number 3, November 2015
ISSN 1013-3445

Contents **Page**

Engineering Education in Zimbabwe from Antiquity to the Present
D. J. Simbi 335

The Importance of Play in Early Childhood Development: Implications on Design and Technology Education in Zimbabwe
Peter Kwaira 353

Co-incidence or Collusion: An Analysis of the Relationship between the Proposal to Ban the Use of Contraceptives and Lowering the Age of Consent in Zimbabwe
Barbra C.Manyarara 371

Navigating New Horizons: An Analysis of Factors that Influence Computer Literacy among Undergraduate Students
Herbert Zirima , Takupiwa Nyanga & Priscilla Zirima 394

School Head Leadership Style and Its Perceived Influence on Teachers' Performance in Bikita District Rural Secondary Schools of Masvingo Province
V.I. Oyedele, C. Chapwanya & D. J. Fonnah 409

An Anatomy of Curriculum Innovation Failure: The Case of Political Economy in Zimbabwean SecondarySchool Sector
Manasa M. Madondo 439

Primary School Composite Class Teaching and Learning Mode: Views of Some Stakeholders
Nyaradzo Machemedze & Emmanuel Chinamasa 455

Liberating Africa's Future Generations from the Myth of Redemptive Violence through Peace Education
Oswell Namasasu, Venesencia Mupfururirwa & Anna Mupawaenda 485

Reviewer acknowledgements 504

Engineering Education in Zimbabwe from Antiquity to the Present

D. J. Simbi

Vice Chancellor, Chinhoyi University of Technology

Abstract

This article traces the origins of architectural and engineering roots in Zimbabwe from antiquity through the Kingdoms of Zimbabwe (1220-1450 CE), Mutapa (1430-1760 CE) and Rozvi (1684-1834 CE), as well as the Colonial period (1888-1953), Federal Government era (1953-1963) and the War of Liberation (1965-1979) to the present. The review will cover in detail the founding of the Faculty of Engineering in 1974 and the subsequent growth of the Faculty to the present day when the University of Zimbabwe is celebrating 60 years of human capital development for in Zimbabwe. This paper is also an attempt to bring into focus the post-colonial stagnation in academic and research acumen across engineering disciplines that would ultimately have a negative effect on the ability of the Faculty of Engineering to attract and retain both local and expatriate staff. In a nutshell, the article discusses aspects of pre-colonial, colonial and post-colonial socio-economic and industrial developments that influenced the introduction and growth of structured technical and engineering education and profession in modern day Zimbabwe.

Introduction

The Great Zimbabwe monuments, built between 11th and 15th century, are a UNESCO World Heritage site. The walls of this ancient city, built from granite blocks fitted without the use of mortar by laying stones on top of the other, each layer slightly more recessed than the last to produce a stabilizing inward slope, provide evidence of precision and cunning craftsmanship that has been traced to

ancestors of a 'Shona' ethnic group, the Rozvi people. Given the sheer scale of Great Zimbabwe compared to its precursors, archaeologists have been at a loss to explain the unique presence of this trading centre and capital of a medieval Zimbabwe state on the southern African landscape.

The Great Zimbabwe, a 'sacred house' or 'ritual seat of the king' was stripped of nearly all its in-situ cultural material by treasure hunters and those believing it to be of foreign origin who wished to "free it from the filth and decadence of the kaffir." Without the precision of the engineer and professionalism of the builder, this impressive architectural stone structure would today be utter ruins with no trace of the existence of an engineering acumen in the Zimbabwe of antiquity.

Pre-colonial engineering education

The advent of metal extraction and process engineering education in Zimbabwe dates back to the origins of the Kingdom of Zimbabwe (1220-1450 CE), the Mutapa (1430-1760 CE) and Rozvi (1684-1834) dynasties, the ancestral lineage of Great Zimbabwe's rulers. In an attempt to discredit the Africans, the accepted European settler colonial notion has been that the Great Zimbabwe stone works were the creation of either Phoenicians or Egyptians. However, recent archaeological excavations by Randall-MacIver and Caton-Thompson have confirmed the African origins of the Great Zimbabwe monuments. Stories are told that confirm an ancestral engineering acumen among the Mutapa and later Rozvi rulers of Zimbabwe Kingdom. History notes with interest, attempts by the Rozvi people under the leadership of Changamire, to capture the moon to be presented to the king as a plate; the crescent moon considered much lighter than the full moon as an ornament symbolizing the authority of the king. Scaffolding, perhaps the first reference to civil engineering related structure of the time, was constructed with wooden poles using tying rope from tree bark.

These attempts are said to have taken place at Tikwiri, Mupuyo and Firifidye mountains.

Nyanga, in north-eastern Zimbabwe, is the largest complex of ancient buildings in Africa with 5000km^2 of stone faced terraces and cultivation ridges that date from 1300 CE to sometime in the late 18th century CE. This is yet another demonstration of civil engineering prowess where people solved problems inherent in their environment by growing crops and managing water resources. These early civil engineering related applications in ancient Zimbabwe not only facilitated subsistence agriculture but also offered security and vantage sentry observatory points. While these fetes remain fables in our minds, they represent high level of creative imagination in which engineering solutions are suggested. The existence of the Great Zimbabwe and many of monuments around the country is a stake reminder of our ancestors' prowess in both architecture and civil engineering design and construction.

In a recent publication by UNESCO (*Memories of Peoples*), it becomes clear that the Mutapa and later Rozvi Kingdoms possessed refined extractive and metal processing engineers who were revered because of the 'spiritual and secretive' nature associated with their craftsmanship. This late Iron Age Zimbabwe state, in particular the Rozvi under Mambo Changamire, like other African Kingdoms of its time, was working with iron metal to produce both domestic and agriculture implements, and defence technologies of the day. While history, as seen in the eyes of the European settler, might want to record that engineering practice, hence engineering education, came to Zimbabwe with the arrival of the white man in 1890, there is evidence to the contrary. The theory that sub-Sahara Africa borrowed its iron technology from other cultures is no longer tenable. Therefore, it must be acknowledged that the Zimbabwe

state of antiquity invented and developed its own iron metallurgy extraction and fabrication processes long before the arrival of European settlers. This represents the earliest form of pyrometallurgical extraction of iron from ore that would later form the basis for establishing the Rhodesia Iron and Steel Commission in 1942 with the iron works in Bulawayo later transferring to Redcliff in 1948. It is the very same locations where Portuguese traders' records show that the Rozvi were expert military strategists who worked with ir[illegible] [illegible] [illegible] King of the [illegible] century CE

[illegible] [illegible] that the art of iron making and smithing [illegible] understanding of both science and engineering [illegible] consumed is a measure of the well-being of the [illegible] the peoples of Africa correctly. The archaeological [illegible] Zimbabwe bear testimony to the existence of an engineering knowledge in which considerable quantities of iron metal were made for both domestic and weaponry implements, and that this was well established before the European settlers set foot on the shores of Africa. It comes as no surprise, therefore, that the late Iron Age 'Shona' craftsmen were respected and revered for their roles as suppliers of the much needed iron and other metallic materials, as were their counterparts in Europe and elsewhere.

Colonial or pre-independence engineering education

The iron industry as a benchmark of civilization is underpinned by a whole body of tried and tested concepts. When Portuguese traders visited the Great Zimbabwe in the sixteenth century, both iron and copper smithing was evident.

[illegible] to import all the iron and steel required to meet the demands of an expanding economy. By then rich iron ore deposits had been found at Buchwa, Kwe Kwe, Redcliff, Shurungwi, Hurungwe and Hwedza (all within the Great Dyke plateau that straddles the country), the very areas previously inhabited by an industrial late Iron Age civilization. However, discoveries of artefacts of agriculture and weaponry implements around these locations confirm the existence of wide spread iron workings that belong to Early Iron Age inhabitants.

The establishment of the first iron-works in Bulawayo in 1948, and later moved

to Redcliff, meant that engineering education would simultaneously expand in the British colony of Southern Rhodesia. As it turned out, the few European settlers continued going to South Africa for their technical and engineering education. In the same timeframe, the few black African craftsmen confined their activities to smithing using scrap metal from such materials as copper, brass and steel to produce mainly domestic and agricultural implements. Their engineering and craftsmanship though technically sound remained rudimentary, traditional and 'a family secret'.

The establishment of a local iron making facility at Redcliff led to mushrooming of many engineering outfits to support mainly agriculture, mining and the relatively nascent steel industry. With the founding of the Federation of Rhodesias and Nyasaland in 1953, the need for a coherent technical and engineering education and training system became apparent. The demand, for example, for civil engineers and technicians knowledgeable in dam construction increased in the countries making up the Federation of Rhodesias and Nyasaland (1953-1963). This, however, remained a European settler concern as black Africans were not considered intelligent enough to conceptualise three dimensional designs, let alone the science of engineering materials involved. With an increase in agriculture and mining activities, the need for maintenance and repair services in settler communities like Salisbury (Harare), Bulawayo, Gwelo (Gweru) and Umtali (Mutare) also increased. A few select Africans were absorbed as 'handyman' to assist the European technocrats and engineers. Technical skills development centres for the training of apprentice 'technical engineers' were thus established along the Guilds of London format. Funding for the establishment of these centres was provided by private companies with the support of government. In Southern Rhodesia (Zimbabwe), these were to be found in Salisbury (Harare) and Bulawayo, and

on the Copperbelt of Northern Rhodesia (Zambia) in the towns of Kitwe and Ndola.

As is well established, both colonial and pre-independence (Federation of Rhodesias and Nyasaland: 1953-1963 and the War of Liberation period: 1965-1979) systems of education in general were designed to provide the Government of the day through the Native Commission, Africans with literacy skills and elements of good governance. This was true for all colonial governments in Africa. There was, however, an exception in Ghana where Sir Gordon Guggisberg, the colonial Governor (1917-1927) who, against stiff opposition from London, tried to develop the Gold Coast with 'all his heart and with all his soul'. Britain disowned him to the extent that he died a pauper in 1930 and was buried in an unmarked grave at Bexhill-on-sea in the south of England.

Early programmes of study at the University College of Rhodesias and Nyasaland, which opened its doors in 1955 under the opuses of the University of London, were designed to fulfil the European settlers' objective which was to provide literacy and humanities education for *good governance* as civil servants in the Native Commission division. The science, technology, engineering and mathematics were thus not given the necessary prominence despite their importance to the productive sector of the economy.

The need for science, technology, engineering and mathematical education would continue to be a preserve for the few albeit availed at institutions in South Africa. However, with the war of liberation escalating, programmes in medicine (under the University of Birmingham) and engineering were added in 1971 and 1974, respectively, with British Overseas Development support. Even

then, technical and engineering education, with the exception of medicine and nurse training remained the preserve of European settlers. Medical doctors and nurses were trained to meet the separate needs of European and African hospitals and clinics.

With the euphoria of post Unilateral Declaration of Independence period waning and the war of liberation intensifying, the need for new military strategies by the European settler became apparent as did the demanded for new technological approaches for military, mining, industrial manufacturing and agricultural activities. The United Nations imposed sanctions also added a further constrain in available resources. The need to produce human capital that was technically astute and innovative in their application of science and engineering education took centre stage. Thus, the Faculty of Engineering founded in 1974 had many technical and engineering education challenges to meet, and government support was evident from the onset.

The first programmes on offer were in the disciplines of civil, mechanical and electrical engineering. Except for a few, the bulk of the academic staff was recruited from either South Africa or the United Kingdom, and the few students admitted were all of European settler stock. The lead discipline then was civil engineering with the geotechnical and dam construction engineering among the principle subjects taught. It is not surprising that the geotechnical engineering and dam construction group dominated the affairs of the Rhodesia (Zimbabwe) Institution of Engineers.

Some other projects pursued by the Faculty of Engineering were designed to meet the needs the Rhodesian army, air-force and police. The amphibious army trucks seen in the African townships in the 1960s and 1970s that had bullet

proof thick armour plates were partly designed and tested by Faculty members who were also army reservists. Rumour has it that the transistor radio mechanism that triggered bombs once the radio is switched on was designed and developed by Faculty of Engineering members of staff.

Post-colonial engineering education

Undergraduate engineering studies

A good many of the Faculty of Engineering founding academic staff left soon after independence in 1980. The Faculty had by late 1979 opened its doors to black students. Concomitantly, white student enrolment declined and stopped completely by mid-1980s. This was, however, not peculiar to the Faculty of Engineering. With the departure of founding academics, the newly enacted University Council encouraged the Faculty to take the bold step and invite fellow African academics from across the region and beyond to fill the gap. At the same time a comprehensive staff development programme was initiated in all teaching departments of the Faculty of Engineering.

In order to address the issue of mineral resource exploitation, develop minerals processing and engineering skills, three new programmes funded by the Government of Germany, namely: surveying, mining and metallurgical engineering were introduced in 1985 albeit with a lot resistance from some Faculty members of staff, particularly those from the "old guard". Many of the arguments were concerned with engineering content in the new programmes. As part of the remedy, it was resolved that all freshmen would do a common first year programme in which uniform engineering concepts would be introduced. All the founding academic members of staff were expatriates from as far as Sweden (Metallurgy), Germany (Mining) and Tanzania (Surveying).

A new course Workshop Practice was crafted to provide students hands experience in handling carpentry and joinery equipment such as welding torches. At the same time, the University opened faculty doors to black academics from such countries as Ghana, Nigeria, Tanzania, Zambia and Sierra Leone and this did not go down very well with some senior white technical staff who were not used to taking orders from blacks irrespective of their position. Most of these chaps found themselves teaching this non-academic course referred to as Workshop Practice. The real or true value of this course remains to be quantified given that it is given in the first year of study when students are still to find their feet.

Except for Civil Engineering, all other programmes were headed by expatriate academic staff. While the Faculty in line with University policy was embarking on aggressive staff development programmes, the expatriate academic members of staff were loaded with teaching and as such had little time devoted to the development of local talent to infuse a culture of research. Other than standard laboratory class equipment, no new innovative research tools were available. Upon completion of their studies, the returning staff development fellows could not carry from where they left with respect to their research interest as there were no appropriate research tools with which to work. Worse still, others found themselves with heavy teaching loads. Right now, most or all of the Faculty of Engineering academic members of staff educated under the staff development fellowship scheme have left the University of Zimbabwe for employment at universities in South Africa or industry in the same country. A few have gone abroad to countries where they studied.

On balance, the Faculty of Engineering has produced graduates many of whom have become leaders in the engineering community and have made a mark at

home, regionally and abroad. At the turn of the century, many of the household engineering enterprises were either being run by a University of Zimbabwe graduate engineer or owned by one. A good number who won scholarships for graduate engineering studies abroad have gone on to do very well in their adopted countries. Three students from the Department of Metallurgical Engineering who graduated with First Class honours degree were admitted into the Royal School of Mines for the doctor of philosophy degree programmes. They are all holders of earned doctorate in mineral processing and hydrometallurgical engineering with one an Associate Professor at School of Metallurgy and Materials, at the University of Witwatersrand in South Africa. In the region, Faculty of engineering graduates are leaders in industry. Over the years many ladies who have taken various engineering disciplines have made it to the top as leading engineering academics at institutions of higher learning, and in industry. Clearly, the Faculty has been able to deliver a balanced engineering education which meets national, regional and international standards.

In essence, the above is proof that the architects of the Faculty of Engineering undergraduate degree programmes have held sway and should be congratulated. Today, the Faculty of Engineering at the University of Zimbabwe can boost as having founded or participated in 'growing' engineering programmes at sister universities in Zimbabwe as well as providing leadership from among the few academics who have remain in the Faculty.

Graduate engineers

Science, technology, engineering and mathematics are increasingly perceived not only as sources of intellectual progress, but also transversal problem – solvers, magic boxes that can produce solutions to the problems that challenge

the citizen. Problem solving requires better understanding and a mastery of a discipline. The introduction of this second tier of engineering education ladder has been fraught with difficulties. Most programmes have been promoted out interest by external development aid agencies. Programmes stop with termination of the development aid as this affects both student and academic staff retention support.

In late 1980s and early 1990s, the Faculty of Engineering introduced a number of taught master's degree programmes in the Departments of Civil, Electrical, Mechanical, Mining and Metallurgical Engineering. Only those in the Department of Mechanical and Civil Engineering, namely: Manufacturing Systems and Renewable Energy; Integrated Water Management, respectively are still running today. Graduates from the three running taught master's degree programmes are being employed as lecturers at many of the young universities offering engineering education in the disciplines of production engineering and renewable energy.

Because of the Faculty's reliance on development aid support, many programmes and associated research activities collapsed when this was withdrawn (victim of the land reform). The situation has been exacerbated by the exodus of expatriate senior academic from the Faculty some of whom partially funded from the development aid support. Thus, at the beginning of the century, there has been limited knowledge production and innovation, a situation *(in the opinion of the author)* that has affected the academic environment for many of the junior academic staff and learners.

In the 1990s and at the beginning of this century, the Departments of Mining and Metallurgical Engineering embarked on an aggressive graduate research

programme which too was heavily supported by external development agencies. The research activities produced thirteen Master and three Doctor of Philosophy graduates. When the external development agencies collapsed so did the programmes, and with that came the exodus of many of the young academics who had joined the Department. It is, however, heartening to note that efforts from a few members that remained in the Department of Mining and Metallurgical Engineering, with the support of the University's Vice Chancellor, Professor Levi M. Nyagura, are beginning to bear fruits. There is now a semblance of research with new graduate students enrolling for Master of Philosophy degree programmes by research. Support from the mining industry has led to the construction of a third floor to the mining and metallurgy building and the establishment of a professorial chair in either mining or metallurgy that will soon be advertised.

The Faculty of Engineering's participation in knowledge transfer which is a key determinant in innovation and economic growth has been confined to the repair and maintenance domain due to the Faculty's poorly developed research acumen. It is important to note and learn from well developed countries in Europe, Asia and the Americas, that have successfully built academic research capacities within and outside the university, yielding many positive results, including a more innovative industrial sector and better technical skills in the workforce than any other nation.

To some extent, the industries that dependent on engineering innovations and services are also to blame in the slow developments in graduate studies in the Faculty of Engineering. The policies inherited from the colonial system have tended to override developments at home Faculty. For example, in the mining and metallurgical industry, any problems encountered are referred to South

African institutions of higher learning or research organizations in that country with which the company or companies have strong 'biological' bonds. There has been no desire on the part of mine houses in Zimbabwe to emulate their counterparts in South Africa by supporting the establishment of engineering post graduate engineering education centres with research units of merit at the University of Zimbabwe or any other institution of higher learning in the country. Most engineering firms in Zimbabwe are happy with the status-core. To this extent, the Faculty of Engineering and its sister units at other universities in the country has suffered major setbacks in its upward trajectory as a centre of excellence in the provision of engineering education and training.

The notion of a global economy should in reality compel the Faculty of Engineering, the engineering profession and the engineering community to work towards an engineering education philosophy encompassing the three levels of higher education, namely: knowledge (undergraduate); understanding (taught/dissertation graduate); wisdom (research graduate/thesis) as the key drivers in formulating strategies for innovation and technology creation that will provide Zim-Asset with appropriate solutions for socio-economic growth of the country.

Developing a professional engineer

Over the years, the Faculty of Engineering has developed a very strong relationship with the Zimbabwe Institution of Engineers. The two institutions continue to contribute to development two publications: *The Zimbabwe Engineer* and *Journal of Sciences, Engineering and Technology* that promote best engineering practice and the generation of new knowledge in engineering technology applications, respectively. The Annual Congress Proceedings of the Zimbabwe Institution of Engineers has also been introduced as a collection of

referred publications covering industrial practice and engineering innovations. The 'Engineering Paperette', now a National Annual Competition for all institutions offering engineering education, was the brain-child of the Faculty of Engineering with strong support from the Zimbabwe Institution of Engineers and the engineering corporate world. This gathering of students has helped foster a sense of belonging and national pride within the engineering student body. The Faculty of Engineering at the University of Zimbabwe hosts the largest Student Chapter of the Zimbabwe Institution of Engineers; a situation that sister institutions that include Chinhoyi University of Technology, National University of Science and Technology and Harare Institute of Technology would like to emulate.

Admission to the professional body, the Zimbabwe Institution of Engineers, as corporate member and be addressed as 'Engineer', the equivalent to Chartered Engineer or Ingénue in the United Kingdom and Germany respectively, is the ultimate goal for all engineering graduates. This is jealously guarded by the elders of the profession to which the Faculty of Engineering has provided leadership at the level of the Presidency on many an occasion. The Engineering Council of Zimbabwe, which regulates all engineering practice, is constituted mainly by graduates of the Faculty, some retired and others still active.

The Faculty of Engineering together with the Zimbabwe Institution of Engineers were instrumental in the formulation of the Draft Bill that ultimately established the Engineering Council of Zimbabwe by an Act of Parliament. This later development has consolidated engineering education in Zimbabwe as a key driver in knowledge production for innovation and technology development to provide a sound industrial base that will better define the socio-economic needs of the country.

Concluding remarks

Engineering.

Engineering education in post independent Zimbabwe was expanded to include mineral exploration, extraction and exploitation. The exploitation (value addition) aspect is yet to be realised. It is imperative that a programme to address Material Synthesis and Property Evaluation be established at graduate level as an extension of the Physical Metallurgy and Advanced Materials courses. Because of the complexity inherent in both mechanical and electrical engineering and the need for remote controlled technologies, a new programme in Mechatronic Engineering should be launched as a foundation for Robotics at

medicinal processing and renewable energy schemes.

References

Ankomah, B. (2015, June). Every object tells a story... Why colonial symbols are loathed in Africa. *New African*, pp. 46.

Bocoum, H. (Ed.). (2004). *The origins of iron metallurgy in Africa: New light on its antiquity - West and Central Africa*. UNESCO Publication.

Cloete, N., Maassen, P., & Bailey, (Ed.). (2015). Knowledge production: Contradictory functions in African higher education. *African Higher Education Dynamics Series, 1*.

Mcintosh, R. J. (1998). Riddle of Great Zimbabwe. *Archaeology Archives, 51*(4).

Simbi, D. J. (2005). Once upon a time, there were two first bodies, then the first body contact. An Inaugural Lecture, Faculty of Engineering, University of Zimbabwe.

Soper, R. C. (2001). The role of cattle and manure in the agricultural systems of the Nyanga terrace complex. *Zimbabwe Prehistory, 24*, 22-30.

Zimbabwe's proud architectural roots, (2015, June 13). *The Herald*, pp. L6.