Engineering Education at South Africa's Technikons

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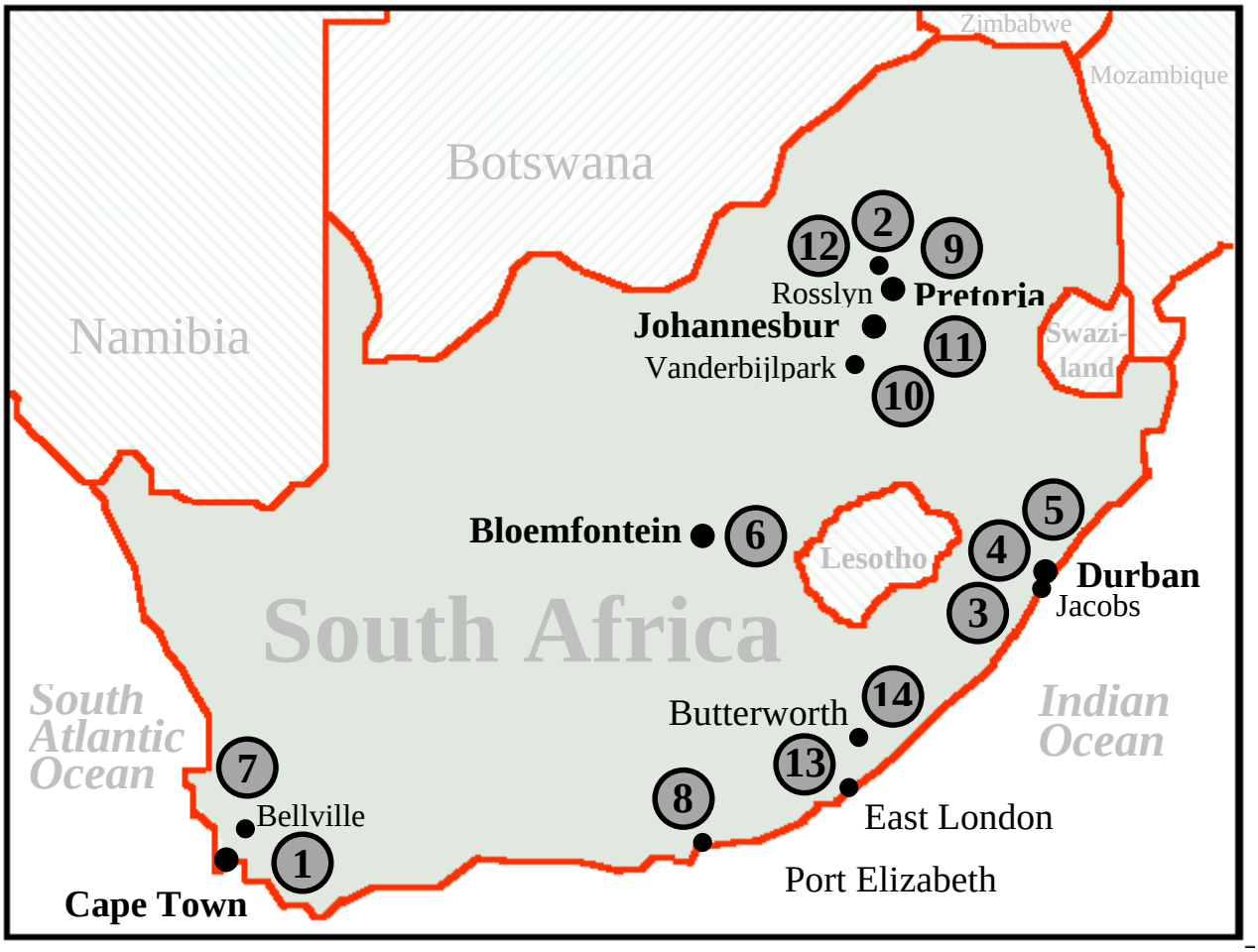
Abstract—This paper describes engineering education at the technikons of post-apartheid South Africa. In addition, the history of technikons is explained in the context of South African tertiary education. Comparisons are drawn between technical colleges, technikons and universities. Finally, some challenges now facing the technikon movement are described. These include the need to adapt to the country's evolving educational environment—which has radically changed as a result of the dismantling of apartheid—and the move by technikons into the awarding of undergraduate and graduate degrees with the attendant concentration on research and the need for technikon educators to seek higher qualifications.

I. EDUCATION IN SOUTH AFRICA

Education in South Africa is stratified into three layers: primary school (first 7 years); followed by secondary school (next 5 years) and tertiary education.[1] Secondary (High) school culminates in a (so-called "matric") Matriculation Certificate or Senior Certificate which is typically earned at age 18 and is symbolically represented by the letter "M" in the vernacular. Admission to post-matric tertiary education, which is offered by universities, technikons and colleges, is contingent upon earning the Senior Certificate.

There are technical colleges which play a dual secondary/tertiary role by providing the knowledge and skills which prepare their graduates for specific trades or occupations.[2] They offer National Technical Certificates (N Certificates) such as the N3, which is regarded as equal to a Senior Certificate (provided that languages are also included in the course) and the N4 which is evaluated as M+B (matric + 8 months) provided it is earned in addition to a qualification equal to the Senior Certificate.

The main players in tertiary education are the (public-sector) universities, technikons, teacher training colleges and technical colleges. About 350,000 students are enrolled at South Africa's 21 universities and another 150,000 at technikons.[3] Enrollments at teacher training colleges and technical colleges are approximately 98,000 and 52,000 respectively.[4] Tertiary-level engineering education is offered at 9 universities and 13 technikons.[2] There are 15 technikons in South Africa as indicated in Figure 1. Of these, Technikon RSA (Republic of South Africa) offers education by correspondence only. Demographic data for South Africa's technikons is presented in Table 1. All of these figures should be read against a background of South Africa's total population of approximately 44 million people[5] of which roughly 34,000 will earn the Senior Certificate this year (thus potentially entering tertiary institutions).



Key

1. Cape Technikon (CAPE)
2. Technikon Northern Transvaal (NTVL)*
3. Technikon Mangosuthu (MANGOSUTHU)*
4. M. L. Sultan Technikon (M L SULTAN)*
5. Technikon Natal (NATAL)
6. Technikon Orange Free State (OFS)
7. Peninsula Technikon (PENINSULA)*
8. Port Elizabeth Technikon (PE)
9. Technikon Pretoria (PRETORIA)
10. Vaal Triangle Technikon (VAALTRI)
11. Technikon Witwatersrand (WITS)
12. Technikon North-West (NORTHWEST)*
13. Border Technikon (BORDER)*
14. Eastern Cape Technikon (EASTCAPE)*

— Technikon South Africa (TSA)**

* Historically Disadvantaged Technikon (HDT).

** Correspondence only.

Figure 1. Technikon Locations and Abbreviations

Technikon	Student Headcount	African (%)	Coloured (%)	Asian (%)	White (%)	Total Faculty	African (%)	Coloured (%)	Asian (%)	White (%)	Students/ Faculty
Cape Technikon	9,688	9.9	19.3	1.7	69.2	312	1.0	1.0	0.6	97.4	31
Technikon Northern Transvaal*	7,567	98.4	0.4	0.4	0.8	197	31.5	0.0	3.0	65.5	38
Technikon Mangosuthu*	4,986	98.3	0.2	0.1	1.4	116	24.1	0.9	9.5	65.5	43
M. L. Sultan Technikon*	8,975	35.1	2.2	57.0	5.8	196	1.5	2.0	68.9	27.6	46
Technikon Natal	8,548	37.1	2.7	14.1	46.0	278	0.7	0.3	5.4	93.5	31
Technikon Orange Free State	7,241	33.1	3.8	0.2	62.9	130	3.1	2.3	0.0	94.6	56
Peninsula Technikon*	6,776	46.6	49.6	1.5	2.3	186	1.6	65.6	0.0	32.8	36
Port Elizabeth Technikon	8,851	39.8	12.1	1.2	46.9	261	2.0	2.7	0.3	95.0	34
Technikon Pretoria	16,509	36.3	1.4	0.8	61.4	457	2.8	0.0	0.3	96.9	36
Vaal Triangle Technikon	9,907	47.2	1.5	1.6	49.8	211	2.8	0.0	0.9	96.2	47
Technikon Witwatersrand	11,281	51.0	3.6	40.6	4.9	371	3.0	1.3	0.8	94.9	30
Technikon North-West*	3,800	100.0	0.0	0.0	0.0	48	72.9	0.0	10.4	16.7	79
Border Technikon*	1,446	97.5	0.1	0.3	2.1	53	28.3	0.0	9.4	62.3	27
Eastern Cape Technikon*	2,982	99.4	0.0	0.1	0.5	125	59.2	8.8	7.2	24.8	24
Technikon South Africa	83,741	49.5	7.3	4.2	39.0	204	7.8	2.0	1.5	88.7	410

* Historically Disadvantaged Technikon (HDT).

Source (in part): Jan Lategan (Compiler) and Prof. Nick Kok (Editor), “Profiles of S A Technikons 1995” Compiled for the Committee of Technikon Principals, November 1995.

Table 1. Students and Faculty at South Africa’s Technikons (with demographic data)

II. HISTORY OF THE TECHNIKON MOVEMENT

A majority of today's tertiary systems in South Africa have the technical colleges as their roots. For example, in KwaZulu/Natal there was the Natal Technical College from which the University of Natal broke away in 1929. A growing shortage of skilled, high-level personnel to meet the needs of commerce and industry led to the adoption of the Advanced Technical Education Act of 1967. As a result, the technical colleges of the Cape, Natal, Pretoria and Witswatersrand were changed to colleges of advanced technical education (CATEs). To these were later added new colleges at Vanderbijlpark and Port Elizabeth, so that by 1969 there were six CATEs enrolling over 23,000 students. Others were soon to follow, such as M. L. Sultan College for Advanced Technical Education (in 1969). As these colleges evolved, their CATE designation was changed to Technikon as a result of the Advanced Technical Education Amendment Act of 1979.[6-7] The name Technikon is derived from the Greek language, and was formulated by Dr. Allan Pittendrigh (a former Principal of both M. L. Sultan Technikon and Technikon Natal) by forming the root word "techni" (which refers to ingenuity, dexterity or skill) and the suffix "kon." Thus, the existing CATEs were henceforth known as technikons. In addition, a number of new technikons were established such as Technikon Mangosuthu (1979), Technikon Northern Transvaal (1981), Peninsula Technikon (1982), Border Technikon (1987) and Transkei (now Eastern Cape) Technikon (1991).

It was Dr. Pittendrigh who, as chairman of the Committee of Technikon Principals, spearheaded the move by technikons into post-diploma studies and higher qualifications.[8] An important milestone in the history of the technikon movement, the Technikon Act of 1993 established technikons as degree awarding institutions.

Some technikons are designated as Historically Disadvantaged Technikons (HDTs, see Figure 1). This is a legacy of the apartheid era (and earlier) during which, inter alia, education was racially segregated. With regard to technikons for example, in KwaZulu/Natal, Mangosuthu Technikon (named after Chief Mangosuthu Gatsha Buthelezi, leader of the Inkatha Freedom Party) [9] was established by way of a grant from the Anglo American Corporation as a technikon for Africans (blacks). Another example is M. L. Sultan Technikon, which was established by its original benefactor Hajee Malukmohammed Lappa Sultan for the technical education of Asians (Indians).[6] Still another example is Peninsula Technikon, which was intended to cater to the needs of the coloured population mainly centered in Cape Town. By no means were HDTs of equal quality compared to the Historically White Technikons (HWTs), and as a result the HDTs remain disadvantaged institutions.[10]

III. ENGINEERING EDUCATION AT THE TECHNIKONS

Engineering education is available at 13 of South Africa's 15 technikons.[2] The total number of students and faculty by engineering discipline is given in Table 2. The mainstream disciplines are chemical, civil, electrical and mechanical engineering. Other disciplines such as avionics, industrial and medical engineering as well as town and regional planning, computer science, architecture and building are also offered but not at every technikon.

The engineering qualifications offered at South African technikons consist of the following:[11]

- National Diploma in Engineering (3 year course)
- Baccalaureus Technologiae, B Tech degree in Engineering (at least one year beyond the National Diploma)
- Magister Technologaie, M Tech degree in Engineering (at least one year beyond the B Tech)
- Doctor Technologaie, D Tech research (only) degree in Engineering (at least one year beyond the M Tech)

Technikon	Chemical	Civil	Electrical	Mechanical	Other*	Totals
CAPE	142 (4)	561 (25)	750 (30)	666 (23)	421 (31)	2540 (113)
NTVL	396 (14)	439 (14)	372 (15)	216 (7)	336 (8)	1759 (50)
MANGOSUTHU	416 (5)	320 (11)	524 (9)	369 (15)	125 (6)	1754 (40)
M L SULTAN	306 (15)	664 (12)	1073 (26)	477 (15)	596 (15)	3116 (68)
NATAL	181 (4)	689 (17)	1046 (32)	583 (11)	167 (11)	2666 (64)
OFS	0 (0)	850 (12)	940 (24)	348 (12)	148 (3)	2286 (48)
PENINSULA	324 (16)	437 (11)	862 (14)	852 (11)	0 (0)	2475 (52)
PE	0 (0)	324 (12)	619 (24)	600 (22)	257 (8)	1543 (58)
PRETORIA	172 (2)	968 (13)	2607 (24)	1088 (13)	714 (18)	5549 (52)
VAALTRI	369 (5)	254 (8)	1382 (51)	752 (25)	287 (7)	2757 (89)
WITS	197 (16)	427 (4)	1193 (27)	481 (24)	190 (5)	2298 (71)
EASTCAPE	0 (0)	130 (12)	149 (14)	100 (12)	212 (19)	591 (57)
TSA	0 (0)	0 (0)	796 (16)	478 (1)	0 (0)	1274 (17)
Totals:	2503 (81)	6063 (151)	12313 (306)	7010 (191)	3453 (131)	31342 (860)

Note: Table entries are of the form S (F) where S and F are the number of students and faculty respectively.

* Other disciplines include avionics, industrial and medical engineering as well as town and regional planning, computer science, architecture and building.

Table 2. Engineering Students and Faculty by Discipline at South Africa's Technikons
(See Figure 1 for technikon abbreviations)

The foundation technikon qualification is the three-year National Diploma which presently consists of 4 semesters of theoretical studies (i.e., lectures and laboratories on campus) followed by 2 semesters of experiential training at a cooperating accredited industrial employer. At M. L. Sultan Technikon for example, the minimum theoretical component for the National Diploma in electrical engineering (heavy current) consists of 20 subjects at 5 contact hours per week per subject. The highest level examinations are externally moderated by suitably qualified personnel from other academic institutions or industry. Certain subjects such as communication skills and computer skills are compulsory across engineering disciplines.

As mentioned in Section II, the Technikon Act of 1993 established technikons as degree granting institutions. Because this is a relatively recent development, most technikon engineering students are presently enrolled in National Diploma courses of study as indicated in Table 3.

In the past, the relationship between South Africa's universities and technikons has been uneasy. However, there is more cooperation now possibly as a result of political and financial pressure being exerted on the universities. "The universities and technikons are intended to be complementary sectors with formally equal status but with differentiated missions. The binary

distinction between the two sectors is based on the universities' role in general formative and professional education and basic and applied research, and the technikons' role in vocational and career education and 'product related' research and development."[12]

Thus technikons and universities enjoy equal status but different foci.[13] This means that in the South African context, both the technikon B Tech and university BSc (Eng) degrees are rated as M+4 (matric + 4 years) qualifications. The differences are in emphasis with the B Tech being more pragmatic (e.g., by way of the experiential training component of the National Diploma— which is a B Tech prerequisite qualification) than the BSc. Likewise, the M Tech and D Tech have a more practical emphasis than their MSc and Ph.D. university counterparts.

Technikon	National Diploma	B Tech	M Tech	D Tech	Totals
CAPE	2037	187	14	0	2238
NTVL	1749	5	0	0	1754
MANGOSUTHU	1460	9	0	0	1469
M L SULTAN	2084	145	0	0	2229
NATAL	2012	243	17	7	2279
OFS	2137	141	8	0	2286
PENINSULA	2396	56	14	0	2466
PE	1388	125	1	12	1526
PRETORIA	4603	401	50	8	5062
VAALTRI	2517	255	2	13	2787
WITS	2177	287	0	0	2464
EASTCAPE	591	0	0	0	591
TSA	1274	0	0	0	1274
Totals:	26425	1854	106	40	28425

Table 3. Engineering Student Enrollments by Qualification
(See Figure 1 for technikon abbreviations)

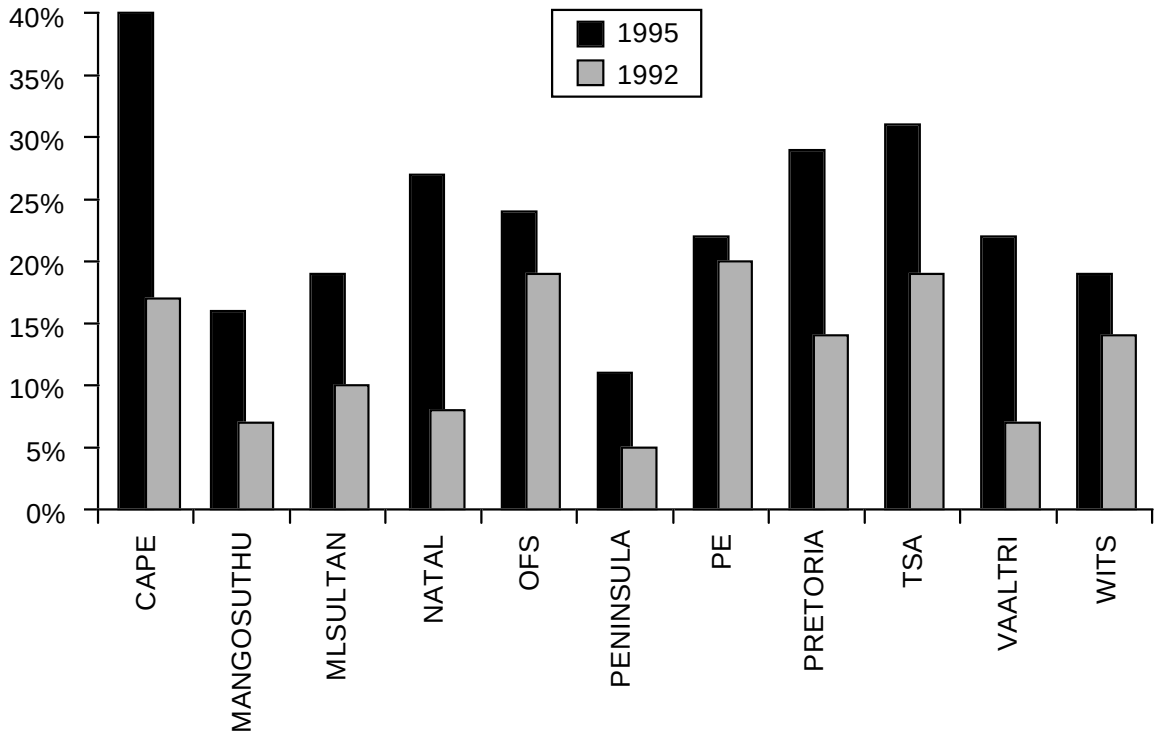
IV. CHALLENGES: TECHNIKONS IN THE NEW SOUTH AFRICA

The Republic of South Africa has come a long way since President Nelson Mandela[14] took office (May, 1994) but it still faces a heavy haul to peace and prosperity.[15] A critical challenge to the success of the new South Africa will be its ability to deliver the educated work force needed in order for the country to prosper in the global economy. Half of South Africa's population is under 15 years old.[16] It has been estimated that by the year 2000 the country will be faced with a shortage of around 250,000 technical people and 220,000 managers.[17] Thus the enormity of this challenge to the entire education sector—including the technikons—is both profound and of paramount importance to the country's future.

As equal educational opportunities have now become available for all South Africans, more Africans are striving to earn higher qualifications by way of tertiary education. As a result, the traditional (apartheid era) racial makeup of the student population at some of these institutions is changing dramatically. For example, the majority of students at the traditionally Asian (Indian) M. L. Sultan Technikon are now African. Because apartheid's demise occurred only a

short while ago, South Africa's African population will remain a disadvantaged majority of 76%[5] for some time to come. At this time, 41.1% are unemployed and only 38% of their homes have electricity, while the corresponding figures respectively are 6.4% and 99.5% for whites, 23.3% and 85.2% for coloureds (mixed race) and 17.1% and 98.9% for Asians (Indians).[18] The attendant educational preparation for tertiary education of African students generally follows suit resulting in low (e.g., 20%) pass rates. It has been estimated that out of 10,000 black children who start primary school, only 1300 reach matric of which only 113, pass and only 27 pass well enough to go to university—and only one passes with exemptions in mathematics and science.[19] Coping with this situation; i.e., turning it around, is obviously a daunting national challenge. The technikons are striving to do their part in meeting this challenge.

As mentioned in Section II, the Technikon Act of 1993 established technikons as degree granting institutions. As shown in Figure 2, this responsibility, along with the equal status of technikons and universities, is challenging technikon educators to seek the higher qualifications; e.g., postgraduate degrees, needed to carry out the elevated educational mission of the technikons. In addition, technikon educators lost through normal attrition are being replaced by degree-holding personnel.



Source: Adapted from "Profiles of S A Technikons 1995," Figure 1.5.3.

Figure 2. Technikon Lecturing Staff with M+5 Qualifications
(See Figure 1 for technikon abbreviations)

While technikon educators devote themselves to attaining higher qualifications, their ability to contribute directly to their institution's educational mission is diminished. This exacerbates the existing severe shortage of highly skilled educators needed to teach critically under-

staffed engineering courses as well as the attendant courses in science, mathematics and the application of computer technology. To address this challenge, some HDTs are now exploring possible exchange linkages with foreign universities with a view towards establishing joint ventures such as student exchange programs, visiting professor arrangements and research collaboration. In particular, these efforts are attracting financial and technical assistance from American donors. For example, M. L. Sultan Technikon is now establishing linkages with American institutions by way of the USAID-funded Tertiary Education Linkages Project (TELP)[20] and the International Foundation for Education and Self-Help's (IFESH) Educators for Africa Program.

IFESH is a not-for-profit U.S.-based private developmental non-governmental organization (NGO) that has, inter alia, created with support from the USAID mission in South Africa, the Educators for Africa Program. This program permits appropriate American university professors (especially emeritus professors and professors who can participate in the Program by way of sabbatical leave) to spend at least one academic year as visiting professors at HDTs.

IFESH Visiting Professors are expected to act as catalysts in fostering an intellectual climate that encourages HDT educators to be proactive academic leaders at their institutions. By assuming the teaching duties of HDT educators who undertake further education, and by promoting research at HDTs, these professors play an important role in helping the HDTs to help themselves and South Africa.

V. CONCLUSION

Engineering education at South Africa's technikons continues to be a vital component of the country's education sector. The Historically Disadvantaged Technikons are a legacy of apartheid. Through several initiatives, these institutions are striving to help themselves become equal partners in the country's tertiary education system. If the new South Africa is to avoid the dismal economic and social conditions that plague many of its African neighbors, it is of paramount importance that the country's entire education sector, including technikons, be sufficiently robust so as to avoid the crisis facing higher education in Africa.[21]

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