DEMOCRACY

POPULAR
PRECEDENTS
PRACTICE
CULTURE

13 - 15 JULY 1994

UNIVERSITY OF THE WITWATERSRAND

HISTORY WORKSHOP

WHAT DO SOUTH AFRICAN TECHNIKONS DO?
THE NEED TO RESHAPE STUDENT PERCEPTIONS AND ENROLMENT PATTERNS

Dave Cooper
Department of Sociology
University of Cape Town

AFRICANA

WHAT DO SOUTH AFRICAN TECHNIKONS DO?
THE NEED TO RESHAPE STUDENT PERCEPTIONS AND ENROLMENT PATTERNS

by Dave Cooper
Department of Sociology
University of Cape Town

Are Technikons following the Same Trend as Universities?

Historically from the 1960s, technikons in South Africa were established as higher education (post-matric) 'institutes of technology'. Yet recently they have been moving away from science and engineering. Why? Why do students appear to prefer commerce, management and other fields? Should the new state intervene at national and regional levels with policies to reverse these trends? Can and should this be done democratically, and in terms of whose interests?

This paper raises important questions about technikon education in relation to higher education restructuring, state policy and national development. The main aim of the paper is to outline the core findings of a recent research project (Cooper, 1994), which revealed an extremely sharp shift by students away from science/ engineering fields of study to commerce/ management fields at technikons during the past decade. Evidence emerging from universities too, is that in recent years there has been a significant trend away from science and engineering (SE) fields, while the relative output of commerce/ arts/ social science (CAS) graduates has been expanding much more rapidly.

For some time, popular perceptions and even public debate has identified an aversion by many students to enrol in SE fields at South African universities. However, recent evidence shows the shift away from SE during the 1980s to be much more stark than generally assumed (FRD, 1991, see below). My findings for the technikons were as pronounced, if not more so: for graduates over the period 1988 to 1991, there was a significant shift away from SE fields, at every one of the 15 technikons. Despite the origins of these institutions as new 'institutes of technology', the trend has thus been away from technology-orientated disciplines.

A secondary aim of the paper is to raise questions concerning (a) the possible reasons for this shift including student perceptions of the value of SE versus CAS fields of study; and (b) whether the new state in South Africa, and the universities and technikons themselves, need to develop policy initiatives which actively attempt to reverse this trend away from SE fields?

My research on the technikons began as an attempt to investigate whether recent research findings by the FRD (1991) on university trends were being replicated at the technikons. The FRD study had revealed a startlingly large trend away from the sciences towards enrolment in CAS disciplines at South African universities during

the 1980s. Data for the FRD study was collected on the number of SE graduates in 1984 compared to 1988.[1] A significant shift towards CAS disciplines was found for all universities. For example at Natal university during this four year period, SE graduates remained constant at around 700 while the number of CAS graduates jumped from around 1000 to over 1500; moreover, nationally the universities (all except the historically African universities were examined) revealed such a trend during 1984-88, often even more stark than at Natal.

There are no indications that this shift is purely cyclical or of short term duration. Although the reasons for the trend were not the focus of the FRD study, I would hypothesise that some major reasons for students avoiding SE fields at university are:
(i) poor matriculation results in science and mathematics;
(ii) the perceived difficulty of SE subjects at university;
(iii) the absence of a national culture which stresses the importance of SE to economic and general social development;
(iv) the perception that even if one obtains a degree in an SE field, significantly better job opportunities, higher pay and higher status do not necessarily await the graduate - so why not seek a qualification in a commerce/ arts/ social science (CAS) discipline?

These possible reasons including underlying perceptions of students at South African universities, and technikons, which are shaping trends in enrolments away from SE fields, will be considered briefly in the latter part of this paper. However in the first part, the data arising from my research on technikons will be examined. This data revolves around a core empirical question: is the trend away from SE fields at universities being replicated at the technikons? As noted, technikons were purposefully established from the 1960s onwards as 'institutes of technology' with a specific focus on applied science/ technology fields of study. It was thus important to collect data similar to that of the FRD study on universities, to inform debate on a broader set of questions.[2]

It is relevant to contextualise the issue with a brief overview of the historical and current situation of the 15 technikons which make up the technikon sector of education in the country. The legal framework for post-matriculation 'Colleges of Advanced Technical Education' (CATEs), established in the late 1960s, provided the essential foundation on which these 15 evolved over the next two decades, primarily as technical institutes. The shift away from SE fields at these institutes is comparatively recent: mainly over the past decade.

History and Growth of Technikons as 'technical institutes'

Aggregate figures on the technikon sector as a whole tend to blur important differences between the various technikons. Figure 1 below (and most subsequent Figures) gives data on each technikon, grouped within the apartheid administrative categories which have shaped the growth of the technikon system. A discussion of the contents of Figure 1 provides insights into the historical

evolution of these 'technical institutes' of post-secondary education.

Technikons 1-7 of Figure 1 comprise the historically white technikons (HWTs) which have fallen under the 'white own affairs' Minister of Education (Bunting, 1992:16-17). The 'big four' of Cape, Pretoria, Witwatersrand and Natal have significantly more students: betwee 6000-11000 in 1991. These four, the historical anchor of the system, were originally technical colleges. After World War II they began to offer post-matriculation SE courses (today N4-N6) for the training of technologists, mainly engineers (eg. in mining, telecommunications etc.). These courses were additional to the traditional courses (today N1-N3) up to matriculation level provided by technical colleges for the training of artisan technicians. The four institutions increasingly focused on the 3-year post-matriculation National Diploma and under new legislation in 1967, they became established as tertiary level institutions, Colleges of Advanced Education, renamed 'technikons' in 1979 (Pittendrigh, 1988). Other technical colleges continued to focus on the pre-tertiary N1-N3. In this way the new CATEs followed international trends (eg. British Polytechnics), by specifically providing post-matriculation training for 'technicians/ technologists'. The latter were conceptualised as 'somewhere between' (Goode Committee, 1978) the traditional artisan (via technical colleges) and the professional engineer (via universities). Technikons in South Africa in the 1960s/70s were viewed, and named, as places primarily for SE fields of study; the shift away from technology-oriented diplomas is recent and relatively unplanned.

In the fifteen years following the establishment of these CATEs in 1967, most of the other technikons of Figure 1 were established. Vaal Triangle and Port Elizabeth Technikons emerged in the late 1960s to provide training for 3-year National Diploma technicians for industry in their regions. They were followed in the 1980s by Technikon OFS. These three are smaller than the big four but growing fast. By 1991 all seven were still very much 'white' institutions in terms of student enrolment (see Figure 1). Data for 1993 however shows black enrolment beginning to rise fairly rapidly (Cooper, 1995).

It should also be observed in Figure 1 that in 1991, Technikon RSA enrolment (43737) made up just under half of the total national head count (106003). Founded in 1980 out of the external studies department of Wits Technikon, Technikon RSA is a distance-learning 'polytechnic' whose black and particularly African student enrolment has increased very rapidly in the 1990s (under 50% white students by 1994; Cooper, 1995). Data discussed below will show that the vast majority of these distance-learning students have always enrolled in non-SE fields.

While coloured and Indian students still made up around two-thirds of 1991 enrolment at Peninsula and ML Sultan Technikons respectively (Figure 1), these technikons have been rapidly increasing their proportion of African students in the past few years. Both institutions evolved out of 'own affairs' technical

colleges, becoming CATEs shortly after the 1967 legislation. Mangosuthu and Northern Transvaal Technikons were established in the 1970s 'for Africans' (under the Department of Education and Training), with a sharp focus on the training of technologists in SE fields (Cooper, 1994:10). Data will show that by the early 1990s, all four of these historically black technikons (HBTs) were shifting away from their original stress on SE fields.

The other three HBTs were established in the so-called 'homelands'. Their student enrolment is considerably less than the other technikons, though increasing rapidly; like Mangosuthu and Northern Transvaal, their student composition is almost entirely African (Figure 1). The seven HBTs had a total head count of only 16662 students in 1991, much less than the better resourced seven HWTs with their total of 45605 students. The physical location of the HBTs was based on Apartheid ideology, with little consideration given to national and regional economic and geographical factors. For example, Setlogelo in Bophuthatswana is only a few kilometres from N Transvaal Technikon; in the Durban region one finds Natal, ML Sultan and Mangosuthu within 10 kilometres of each other. This 'apartheid chaos' will be seen to be carried over to the pattern of enrolments in CAS versus SE fields of study, where the original stress on the latter fields has been reduced without any examination of its effects on national development.

It can be observed in Figure 2, which follows, that student numbers at technikons have grown much more rapidly than at universities since 1986. This has happened by default rather than by conscious education planning (NEPI PSE, 1992). Figure 2 also shows, however, that total university student enrolment in 1991 was still about 3 times that of technikons. South Africa thus accords priority to the universities by a ratio of 3:1. And with less than 20% of the approx. 300000 university students in 1991 enrolled for science/ engineering degrees (Bunting, 1992:36-7), the universities were contributing significantly to the national enrolment pattern away from SE fields. This should be contrasted with a country such as South Korea, where the reverse is the case: here students at 'polytechnics' outnumber university students by a ratio of over 10:1, and there is a stress at all levels on SE fields.[3]

The Shift from Engineering/ Science to Commerce/ Management Diplomas at Technikons: Detailed Findings

A specific methodology was employed to investigate whether there was a trend at technikons away from SE fields. Data was collected (via technikon visits and interviews with officials) on student graduate statistics per diploma for 1988 and 1991, and enrolments for 1991, for each technikon. Over three-quarters of students at each technikon were found to be undertaking the 3-year National Diploma (versus 4th-year higher diploma or 1-2 year certificates etc.) (Cooper, 1994:Appendix 2A). It was thus decided to focus the investigation of trends in relation to this 3-year diploma, over the recent period 1988-91. To avoid distortions and inconsistencies arising from applying the university-based SAPSE

official classification system to fields of study at the technikons, discussions were held with technikon officials which resulted in my classifying technikon diplomas in terms of a schema of broad technikon 'schools' of study (1994:Appendix 1). All 3-year diplomas were classified into 16 'schools' as in Figure 3. This formed the basis of the comparison between 'engineering (school 1)/science (schools 2-6)' on the one hand, and 'commerce/management (schools 7-9)' on the other, with respect to the findings outlined in Figures 4-7 below.

Graduates at HWTs: from 1988 to 1991

Figure 4 illustrates the findings for the historically white technikons (HWTs), in terms of graduates of the 3-year National Diploma for engineering/science compared to commerce/management. It can be seen that for 1988 versus 1991, for every single HWT there was a significant fall in the proportion of graduates in engineering/science fields, and a concomitant rise in the proportion of graduates in commerce/management. For example at Cape Technikon, an institution with a reputation for training in technology fields, the percentage graduates in engineering/science fell from 58% to 49% over this three year period, while commerce/management graduates rose from 21% to 27%. At Vaal Triangle Technikon - the heart of heavy industry - the fall was even sharper, from 73% to 59%.

This is quite a startling result: at the 7 HWTs, the core of the technikon system, over a relatively short period of 1988-91 there has been a very significant shift away from the SE fields.

Graduates at HBTs (excluding TBVC areas): from 1988 to 1991

Figure 5 shows that at the 4 HBTs outside the TBVC areas, the shift is even more sharply away from engineering/science fields than at the HWTs. Northern Transvaal displays an enormous shift during 1988-91: down 90% to 38%, and up 11% to 54% for commerce/management. Even Mangosuthu, with its strong historical stress on technology, fell from 88% to 61% in engineering/science.

The HBTs in the 'homelands', and Technikon RSA

Figure 6 shows a more complex breakdown of data for the remaining 4 technikons, since the situation was more varied at these institutions. In 1988 there were as yet no 3-year diploma graduates at Ciskei and Transkei Technikons. A relevant comparison at Transkei was found to be enrolment figures for 1991 compared to 1992: the stress on engineering enrolments (100%, 1991) was shifting towards commerce/management in 1992 (a jump to 24%, Figure 6). Enrolment figures for Ciskei were found to be similar in 1991 and 1992, thus only figures for 1991 are shown for Ciskei in Table 6. This technikon has since its inception had no focus on SE fields, as evidenced by the large enrolment in commerce/management (70%). Data for graduates at Setlogelo for 1988 could not be obtained, hence enrolment figures (1st-3rd years) for 1991 were compared with graduates (3rd years

qualifying) in 1991: clearly there was a sudden jump (up to 60%) in commerce/management enrolments (i.e. mainly 1st-2nd year enrolments). This was a marked shift from the past, when this technikon had placed considerable stress on the sciences, particularly applied chemistry (Cooper, 1994:33).

Finally it can be observed from Table 6 that Technikon RSA has had a weak focus on the sciences (only 6%, enrolments 1991), with the vast majority of its students enrolled for commerce/management diplomas (89% in 1991).

An Overview of engineering/science across the 15 Technikons

Table 7 provides aggregate data of 1991 enrolment figures for the technikon sector as a whole. Only 32% (15%+17%) of all technikon students were found to be enrolled in engineering plus other sciences. In other words, by 1991 the technikon sector as a whole had shifted to a situation of only one-third enrolment in SE fields for the core 3-year National Diploma. This raises serious questions of whether this unplanned trend - following student choices for enrolment when they apply to the technikons - should continue unchecked over the next decade. Of perhaps even more urgent consideration is the issue of enrolment trends amongst African students within the technikon sector. It can be observed from Table 7 that by 1991, African stude
ynts made up around one-quarter of total enrolments for the 3-year diploma (26054 out of 105828). Yet only 23% (11%+12%) were enrolled in engineering/science fields, versus 32% for all students (mainly white). On the other hand, 30% of African students were enrolled in commerce/management fields, compared to the 'all student' figure of 24%. Clearly therefore, the relatively new intake of African students into the technikon sector is accompanied by this group avoiding SE fields of study even more than their white student counterparts.

Perhaps the most stark illustration of this 'unplanned' trend away from SE' is the data on 'applied law' in Table 7. The latter grouping has been classified separately in this table: the 31835 students were actually all enrolled at Technikon RSA in 1991, for the Diploma in Police Administration (located within the school of Applied Law at RSA). It can be seen that these policemen/ women, via correspondence courses with RSA, made up 30% of all students and 38% of all African students enrolled across the technikon sector for the 3-year National Diploma. Obviously this sector is playing a role in the maintainance of law and order in the country!

Some Comments on the Research Data

The thrust of my research at this stage has been fairly limited and specifically focused: to gather a set of valid statistics about recent trends in enrolment patterns at technikons. The aim was to establish solid baseline data for the recent period, in order to open up the debate on wider questions. Some of these questions are: Why is this marked shift away from SE occuring at technikons (and universities)? Is such a sharp shift away from

SE at tertiary level desirable for a third world country like South Africa, which is hoping to achieve new and significant economic growth over the next two decades?

Questions such as these are complex and cannot be explored in detail here. Also, more research is needed on a series of related issues before discussions can be fruitfully undertaken.[4] However, some comments towards a preliminary interpretation of the above data, which revealed clearly the relative shift away from SE fields, may be useful.

The Trend away from SE involves Relative, not Absolute, Numbers

A salient point is that the shift is relative i.e. at technikons there has been a proportionate drop in graduates in engineering/science in relation to commerce/management diplomas. Detailed data[5] showed that in all technikons of Figures 4-6, the absolute numbers of graduates in engineering/science remained constant or rose slightly; however the absolute numbers of graduates in commerce/management rose very fast since 1988 - hence the relative increase vis-a-vis engineering science (eg. Cape Technikon 21% to 27% increase in commerce/management diploma graduates, with 58% to 49% decrease in engineering/ science, Figure 4). Similarly the FRD data for universities (Appendix 1 below) showed that absolute numbers of SE graduates remained constant or rose slightly - compared to a big increase in CAS graduates during the 1980s.

Linked to this, it should be noted that the technikons grew in student numbers from around 40000 to around 100000: over the short period 1986 to 1991 (Figure 2). Thus I would argue that when the student population more than doubled at technikons over this period, a significant proportion of these new students selectively avoided SE fields of study and enrolled particularly for commerce/management 3-year diplomas. This orientation away from SE was sharp for white students and even sharper for African students. There was therefore not an absolute decline in the number of students graduating in SE fields at each technikon: rather there was a proportionate shift towards commerce/management diplomas. The big jump in newly enrolled students after 1986 and especially after 1988 (see Figure 2) was picked up via the higher % of 1991 graduation figures for commerce/management (in Figures 4-6) i.e. as this large cohort began to graduate at the various technikons.

The data in Appendix 1 suggests a similar phenomenon for universities in the 1980s, particularly as the university population has risen over the past decade (see Figure 2).[6]

Student Perceptions towards SE Fields of Study

Despite the fact that this trend is relative, I would argue that it is long term rather than a short term cycle. It is linked to a series of factors which, unless countered by intervention through active policy measures, will almost certainly increase the trend away from SE fields over the next decade.

As noted earlier, the following factors associated with student perceptions are hypothesised as ranking amongst the most important variables shaping this trend:

(i) The poor matriculation results in science and mathematics are undoubtedly influencing students' choices towards non-SE fields at university. For example, fewer than 2% of African matriculants at DET schools in 1990 passed mathematics at higher or standard grade. Moreover, the 1980s saw a declining proportion of white matriculants passing higher grade mathematics and science (AS&TS/JCSS/SAVI, 1993:4). It is well known that in African schools, there is a low level of well-qualified teachers and adequate resources in the sciences. Less appreciated is the fact that even in white schools - as the Science Curriculum Group Report of NEPI has forcefully argued - much science teaching is outdated and inappropriate for a modern technological society (NEPI SCGR, 1992).

Given the state of science and mathematics in the South African school system, it is not surprising that many of the students enrolling at technikons and universities in the past decade have avoided SE fields of study at tertiary level. The problems cannot be addressed at this level unless the gross deficiencies at secondary level are confronted.[7]

(ii) SE fields are perceived as 'difficult' and 'likely to result in failure' by many technikon and university students. This can be illustrated by a case study of female engineering students. In 1993 a group of my third year female sociology students undertook a research project involving interviewing of female engineering students at UCT.[8] The social science interviewees were quite intimidated by these 'super-scientists', who were viewed as 'exceptional', 'brilliant' and 'workaholics'. In general the sociology interviewees felt that SE fields were 'out of their reach'. This had been an important factor in their choice of the social sciences, where success was perceived as more attainable.

(iii) Another factor which emerged as shaping the choice of social science by these female sociology interviewees was that they 'simply had never ever thought of the idea of doing engineering at university', and most had not done science or mathematics for matric. In contrast, it was found that most of the female engineering students had done very well at school in these subjects, a significant number had a father or relative in the SE fields, and quite a few had been specially influenced in their choice of engineering by school teachers and/or visits by science/engineering bodies to their schools. To some extent therefore, 'exceptional' factors had influenced them towards SE fields, unlike the vast number of their fellow female students who avoided these fields. This 'exceptionalism' was also revealed amongst a group of African male engineering students at UCT who were interviewed in an allied project in 1993. A major factor influencing many of these African students was the fact that special scholarships were offered to them to study engineering at UCT. A considerable number cited medicine and law as their

first choices at school, but funds had not been available for them to pursue careers in these directions.

This points to the issue of a national culture (and subcultures) across South Africa where science and technology are undervalued - at school, in higher education, and at work. African school children, and female scholars of all 'racial' groups, seriously lack role models in particular, and value systems in general, which would encourage them to pursue SE fields of study at tertiary level. But even amongst white males at and beyond school, there is a relative absence of cultural values which stress the sciences both for their own sake and in terms of their role in economic and general social development. This differs markedly from some Asian countries and elsewhere (eg. Israel), where a technological culture plays an important role in economic development. Hence the call recently by South African science and engineering asssociations, for a 'SET (science, engineering, technology) for All' national campaign in the new South Africa, to begin to address the issue of national consciousness around science and technology issues (AS&TS/JCSS/SAVI, 1993:25). This has particular relevance, I would argue, for the success of the Reconstruction and Development Programme in the medium/long term.

(iv) A further underlying problem is economic (1993:7-13): South African manufacturing industry is not providing sufficient jobs in SE fields (eg. chemical or computer technology) with sufficient monetary rewards to attract students away from commerce/management fields. Surely it is rational for a promising African technikon student to enrol for a diploma in personnel management or marketing and sales (in 'school' 8, Figure 3), with job opportunities particularly for black males opening up in the large South African companies - rather than embark on what is perceived as the difficult and not well-rewarded path linked to the attainment of a diploma in analytical chemistry or plastics technology (in 'school' 4, Figure 3)? Even for white males, it is not clear that monetary rewards in SE fields after graduation offer anything like the benefits obtainable in fields such as commerce and law.

The whole question of job availability and monetary rewards for SE graduates, currently and in the future, needs much more extensive and detailed research. However, let me conclude this section with two anecdotal comments. A colleague recently addressed over 100 MBA (Masters in Business Admin.) students at a South African graduate school of business. He asked the audience how many of them had previously studied engineering, and well over three-quarters indicated in the affirmative. Clearly, many South African engineers move away from the technology coal-face some time after graduating. Secondly, in 1992 I undertook a group discussion at Peninsula Technikon with the 4th year electrical engineering higher diploma students. They stated that not one of their fellow 3rd year diploma students could hope to get a job in the field of electrical engineering in Cape Town, and they themselves would have difficulty. Quite a number expressed extreme regret that they had not undertaken

commerce/management fields of study, but that 'it's now too late, we're in our fourth year and must live with the decision'.

How does this shape inductrial trends in the country? What are the implications for the country's new Reconstruction and Development Programme, which hopes to increase manufacturing exports in part via enhanced technologies in our factories?

Is There a Need for Democratic State Intervention to Alter these Trends?

The precise relationship between science/technology and economic development is complex and imperfectly understood. Nonetheless, there is a significant relationship, particularly for the international economies of the 1990s of which South Africa forms a part. Moreover, the role played by science/technology in relation to the enhancement of a society's social and cultural development is important, and should not be neglected. The above data on the relative decline of enrolments in SE fields at technikons (and universities) must surely therefore give cause for concern.

A range of policy interventions by the new state, at national and regional levels and within technikons and universities, are currently being debated. These include suggestions for a National Education Council for Science, Engineering and Technology (NECSET) (see AS&TS/JCSS/SAVI, 1993:49), and for new, democratic Higher Education National and Provincial Councils 'above' the existing university and technikon councils (reviewed in Cooper, 1995). These latter councils would facilitate higher educational restructuring at national and regional levels including a review of SE fields of study, etc. However, the potential area of debate is enormous, and many issues will come under the spotlight of the proposed National Commission on Higher Education. Here I wish to focus comment merely on one particular area of policy intervention which a democratic state will be forced to confront, in relation to the above data on student enrolment trends.

It has been argued above that the relatve trend away from SE fields at technikons and universities has been 'unplanned', in part a product of student perceptions and choices. It has also been argued that this student trend is unlikely to change 'spontaneously' over the medium term; the trend is actually likely to accentuate as the proportion of African students at higher education level grows over the next decade. Nor are the monetary and other rewards in the labour market for SE jobs likely to change very significantly over the next decade. Admittedly if the economy grows, some growth in SE jobs and associated rewards is probable, but this is likely to be slow and long term, and one can expect a potential over-supply of CAS graduates relative to SE graduates with respect to medium/long term economic needs.

At the same time, given the rising costs of higher education, it is clear that very few middle class white parents, let alone the vast majority of African parents, will be able to afford even

half the costs of a student's technikon or university fees by the turn of the century. South Africa will need to be served by a state-coordinated national student loan scheme along the lines of some countries (eg. Australia): students receive a full-cost (or large % cost) loan for their technikon/ university studies and repay the loan over a long (eg. 20 year) period once they obtain a job after graduation.

Moreover, it seems likely that under such a scheme, there would have to be quotas for loans in various fields of study. For example, new state policy might specify that no more than 30% of state loans could be for CAS fields of study. This would enable flexibility - depending on demand, so the actual number of loans could vary between say 15%-30%, but there would be an upper limit.[9] At the same time, I would argue that individual students with the necessary entrance qualifications should be permitted to register for any field of study - provided they raised the funds for their own finances (from parents, work, sponsorship etc.). Nonetheless, the national loan scheme would end up providing for the vast majority of students, with some form of 'democratic quota setting' appearing unavoidable in this regard.

In conclusion, I would stress that the new South Africa undoubtedly needs a significant number of well-trained graduates from technikons (and universities) in non-SE areas, i.e. CAS fields. In my view, it is in the long-term interests for non-SE departments (eg. sociology) to have a group of serious and motivated students, rather than a sizeable proportion who only enrol for these fields because they wish to enrol at a technikon (or university) but want to avoid SE subjects. It is also my view that non-SE departments which seek to expand their student numbers, should seek especially to introduce additional teaching of CAS subjects to engineering and science students. Most of these students seriously lack a social/ humanities dimension to their generally narrow curriculum of science and technology subjects.[10]

Thus I would argue that CAS departments at universities and technikons should strive to retain a (smaller) core of committed students who have clear interest and motivation in majoring in these fields for degree or diploma purposes. There should be a simultaneous expansion of the teaching of commerce, arts and social science subjects (on a modular basis) to engineering, architectural, medical, applied science etc. students who currently lack a foundation in these fields. There is a growing argument that in a 'Post-Fordist' economic world of multiskilling and fast-changing technology (Mathews, 1989), SE graduates need a sizeable component of their undergraduate training to be in economics, sociology, language and communication etc., if they are to perform their tasks in industry adequately. Fortunately for CAS departments, therefore, narrow engineeers are bad engineers in the postmodern world.

REFERENCES

AS&TS/JCSS/SAVI (1993) A contribution towards developing an education policy for technology. Discussion document of Associated Scientific and Technical Societies of South Africa, Joint Council of Scientific Societies, South African Engineering Association. Johannesburg (Second Edition Revised, October).

BUNTING, I.A. and HENDRY, J. (1991) South African Technikons, 1988-89. University of Cape Town.

BUNTING, I.A. (1992) Post-secondary education in South Africa: an overview. University of Cape Town.

COOPER, D. (1994) Science and technology - a 'hidden crisis' of post-secondary education in South Africa? Shape and size of S&T in the technikons. Research Report No.1, Education Policy Unit, University of the Western Cape.

COOPER, D. (1995) 'Technikons and higher education restructuring'. Forthcoming, in Comparative Education (January).

FRD(1991) Science policy in South Africa. Government funding of academic and related research. Pretoria:Foundation for Research and Development.

FRD(1993) South African science and technology indicators 1993. Pretoria: Foundation for Research and Development.

GOODE COMMITTEE (1978) Report of the committee of enquiry into training, use and status of engineering technicians in the Republic of South Africa. Pretoria: Government Printer.

HUGO, F., KEMP, A., ROHDE, A. (1989) Report of an international investigation of university education in civil engineering. (November).

MATHEWS, J. (1989) Tools of Change. New South Wales:Pluto Press.

NEPI HRD (1992) Human Resources Development. National Education Policy investigation, Human Resources Development Research Group Report. Cape Town:OUP.

NEPI PSE (1992) Post-Secondary Education. National Education Policy Investigation, PSE Research Group Report. Cape Town:OUP

NEPI SCRG (1992) Science curriculum research group. EduNet, Johannesburg.

PITTENDRIGH, A. (1988) Technikons in South Africa. Johannesburg: Building Industries Federation (SA).

FIGURE 1: THE TECHNIKON SYSTEM, 1991

a. Technikons administered by 'white own affairs':

		Head Count 1991	% white students
1.	CAPE	6678	86%
2.	PRETORIA	11489	97%
3.	WITWATERSRAND	8908	78%
4.	NATAL	5643	81%
5.	OFS	3586	96%
6.	PORT ELIZABETH	4167	73%
7.	VAAL TRIANGLE	5134	88%
	Sub-total	45605	

b. Technikon administered by 'coloured own affairs':

			% coloured students
8.	PENINSULA	4496	67%

c. Technikon administered by the 'Indian own affairs':

			% Indian students
9.	ML SULTAN	5945	62%

d. Technikons administered by DET (Dept. of Ed. and Training):

			% African students
10.	N. TRANSVAAL	3348	99%
11.	MANGOSUTHU	1564	99%

e. Distance-learning technikon (under 'white own affairs):

			% white students
12.	RSA	43736	56%

f. Technikons administered by TBVC 'homelands':

			% African students
13.	CISKEI	484	88%
14.	TRANSKEI	80	100%
15.	SETLOGELO	745	100%

TOTAL HEAD COUNT: 106003
(15 technikons)

Source: (i) Head Counts for technikons 1-12 from Bunting (1992:38-9).
(ii) Head Counts for technikons 13-15 and 'racial' group % from data collected by D. Cooper, visits to all technikons, June-July 1992 (see Cooper, 1994).

FIGURE 2:

STUDENT HEAD COUNT

	TECHNIKONS	UNIVERSITIES
1986	41419	233625
1987	50096	250243
1988	56815	272442
1989	75797	283781
1990	83424	286910
1991	104652	308172
Average Annual Increase	20%	6%

Source: Bunting and Hendry (1991:2) (excl. TBVC technikons).

FIGURE 3:
Detailed Listing of All 3-Year National Diplomas for 1991, Under 'Schools' of Technikons

(see Cooper, 1994:Appendix 1, for detailed discussion of methodology of classification)

A. ENGINEERING/SCIENCES

1. ENGINEERING
   - Chemical Eng
   - Civil Eng
   - Cartography
   - Surveying
   - Materials Testing
   - Electrical Eng (heavy)
   - Electrical Eng (light)
   - Telecoms
   - Industrial Eng
   - Marine Eng
   - Maritime Studies
   - Mechanical Eng
   - Aircondi. and Refrigerat.
   - Metallurgical Eng
   - Wood Production Eng

2. ARCHITECTURE/BUILDING
   - Architecture
   - Building Surveying
   - Construction Supervision
   - Plumbing Technology
   - Town and Regional Planning

3. AGRICULTURE
   - Agriculture
   - Animal Health
   - Equinine Studies
   - Forestry
   - Horticulture
   - Laboratory Anim. Technol.
   - Meat Hygiene
   - Nature Conservation
   - Parks and Recreation
   - Veterinary Technol.
   - Landscape Technol.
   - Animal Health

4. BIOL/CHEM/PHYS SCIENCES
   - Analytical Chemistry
   - Beauty Technol.
   - Ceramic Technol.
   - Coal Mining
   - Economic Geology
   - Electron Microscopy
   - Explosive Technol.
   - Extraction Metallurgy
   - Fire Service Technol.
   - Food Technol.
   - Geotechnology
   - Metalliferous Mining
   - Meteorology
   - Microbiology
   - Mining Surveying
   - Nuclear Technol.
   - Oceanography
   - Optical Dispensing
   - Paint Technol.
   - Plastics Technol.
   - Pulp and Paper Technol.
   - Textile Technol.
   - Water Care

5. COMPUTER SCIENCE
   - Computer Data Processing

6. HEALTH SCIENCES
   - Ambulance and Emerg. Care
   - Chiropractic
   - Clinical Technol.
   - Dental Technol.
   - Environmental Health
   - Health Service Admin.
   - Homoeopathy
   - Medical Orth. and Prosth.
   - Medical Technol.
   - Podiatry
   - Public Health
   - Radiography

FIGURE 3 (CONTINUED)

B. COMMERCE/MANAGEMENT

7. GOVERNMENT SERV. ADMIN
   Municipal Admin.
   Prison Management
   Public Admin.
   Registration of Deeds

8. MANAGEMENT/ADMIN/MARKETING
   Clothing Management
   Commercial Practice
   Company Admin
   Credit Management
   Housing Dev. and Management
   Management
   Marketing and Sales
   Materials Management
   Organisation and Work
   Packaging Management
   Personnel Management
   Pharmaceutical Marketing
   Post Office Admin.
   Printing Management
   Production Management
   Property Dev. and Management
   Property Evaluation
   Purchasing Management
   Safety Management
   Retail Business

9. SECRETARIAL
   Secretarial Business Comp.
   Secretarial Executive Sec.
   Secretarial Office Admin.

C. OTHER

10. ACCOUNTANCY
    Accountancy
    Cost and Man. Accounting
    Government Finance
    Internal Auditing
    Local Government Finance
    State Acc. and Finance

11. ART AND DESIGN
    Ceramic Design
    Clothing Design
    Film and Video Technol.
    Fine Art
    Graphic Design
    Industrial Design
    Interior Design
    Jewellery Design
    Photography
    Textile Design

12. COMMUNICATION
    Journalism
    Public Relations

13. FOOD AND CATERING
    Food
    Food & Clothing Technol.
    Food Service Management
    Hotel Management

14. PERFORMING ARTS
    Ballet
    Drama
    Light Music
    Music Theatre
    Performing Art

15. APPLIED LAW
    Police Admin

16. ADDITIONAL
    Library & Info. Services
    Tourism

FIGURE 4:

HWTs - 3-Year Dipl., Graduates 1988 versus 1991,
Eng./Science compared to Commerce/Management.

TECHNIKON	TOTAL ENG/SCIENCE Graduation (Year) 1988	1991	TOTAL COMMERCE/MANAGEMENT Graduation (Year) 1988	1991
CAPE	58%	49%	21%	27%
PRET	64%	55%	17%	22%
WITS	60%	54%	16%	20%
NATL	60%	46%	11%	21%
OFS	48%	36%	31%	48%
PE	54%	46%	28%	33%
VTRI	73%	59%	12%	19%

Source: Cooper (1994:Appendix 2, Table I)

Note: In terms of the technikon 'schools' of Figure 3:
Engineering/Science = No. 1-6
Commerce/Management = No. 7-9

FIGURE 5:

HBTs - 3-Year Dipl., Graduates 1988 versus 1991,
Eng./Science compared to Commerce/Management.

TECHNIKON	TOTAL ENG/SCIENCE Graduation (Year) 1988	1991	TOTAL COMMERCE/MANAGEMENT Graduation (Year) 1988	1991
PENTECH	65%	57%	21%	26%
ML SULT	48%	42%	22%	22%
NTVL	90%	38%	11%	54%
MANGOS	88%	61%	12%	23%

Source: Cooper (1994:Appendix 2, Table J).

FIGURE 6:

Technikons in the 'TBVC homelands', and RSA - 3-Year Dipl.,
Eng./Science versus Commerce/Management Enrolments (or Graduates).

TECHNIKON	Graduation/ Enrolments (Year)	1 Engineering	2 Other Science	3 Total Eng/Science (col.1+col.2)	4 Total Commerce/ Management
CISKEI	Enrol 1991	0%	0%	0%	70%
TRANSKEI	Enrol 1991	100%	0%	100%	0%
	Enrol 1992	34%	8%	42%	24%
SETLOGELO	Grads 1991	0%	28%	28%	4%
	Enrol 1991	0%	13%	13%	60%
RSA	Grads 1988	0%	1%	1%	(96%)
	Grads 1991	0%	11%	11%	(77%)
	Enrol 1991	0%	6%	6%	(89%)

Source: Cooper (1994:Appendix 2, Table 3).

FIGURE 7:

Enrolments 1991, All Students compared to African Students, by Fields of Study (for 3-Year Dipl.)

	Enrolments 1991 (N)	All Students	African Students
Engineering	15942	15%	11%
Other Sciences	18275	17%	12%
Commerce/Management	25371	24%	30%
Applied Law	31835	30%	38%
Other	14405	14%	8%
TOTAL	105828	100%	99% (n = 26034)

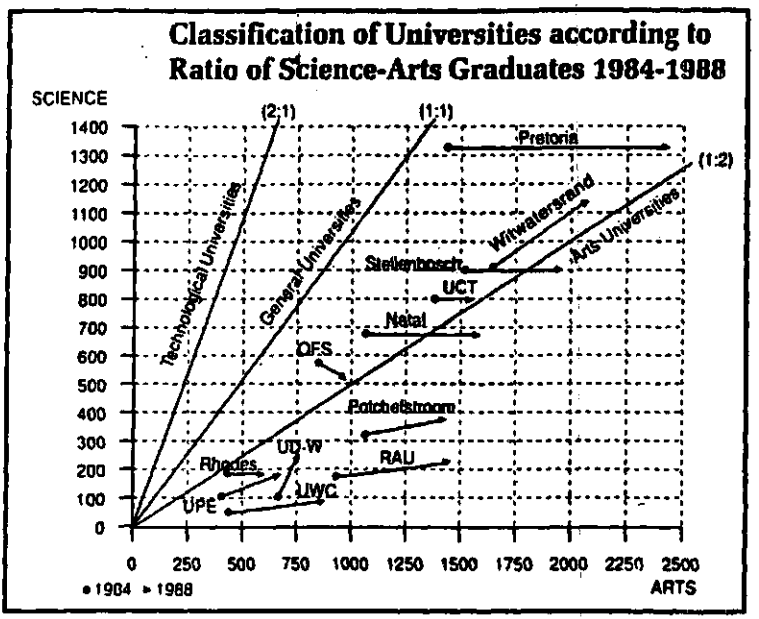
Source: Cooper (1994:27)

Note 1:
In terms of the technikon 'schools' of Figure 3:
Engineering = No. 1
Other Sciences = No. 2+3+4+5+6
Commerce/Management = No. 7+8+9
Applied Law = No. 15
Other = No. 10+11+12+13+14+16

Note 2:
The definition of 'enrolment' utilised for this study (hence for Figure 7) included students (mainly in SE fields) undertaking experiential training for a portion of the academic year (see Cooper, 1994: Appendix 1). In relation to Figure 1 above, it should be noted that the total head count for Figure 1 includes all students whereas Figure 7 here includes only students of the 3-year diploma (hence the slight difference in 'totals' respectively, for 1991).

APPENDIX 1

In the diagram below (from FRD, 1991:12), 'technological universities' are those producing twice as many science (natural sciences and engineering) versus arts (social science and humanities) graduates i.e. 2:1 ratio, while 'arts universities' have the opposite ratio i.e. 1:2. As can be observed, the South African universities in 1984 were already on the 'arts' side and all moved further in this direction by 1988.



ENDNOTES

1. See Appendix 1 below where these FRD findings are illustrated.

2. See Cooper (1994) for an outline of the research methodology utilised, including the relationship of the research to the National Education Policy Investigation (NEPI) with respect to post-secondary education (NEPI PSE, 1992) and human resources development (NEPI HRD, 1992). Broader technikon issues, which cannot be explored in this paper, include particularly questions of (i) the technikons in relation to universities and the restructuring of the higher education system (HES) as a whole; (ii) new governance structures needed at national and provincial levels in order to restructure the HES; (iii) the need for HES restructuring to take account of both equity issues (gender and 'racial' redress questions) and development issues (linkages of universities and technikons to the Reconstruction and Development Programme). I have explored the issues of technikons and HES restructuring elsewhere (Cooper, 1995).

3. See Cooper (1994:1-5) for data on international comparisons.

4. I am currently involved in projects investigating (a) student perceptions and enrolment patterns amongst white female and African male engineering students at UCT, and (b) career patterns and perceptions amongst graduates of social science at UCT over the past decade.

5. From Appendix 2, Tables A,G,H (Cooper, 1994).

6. See also recent FRD data (FRD, 1993:30-33) for university graduates for the whole period 1981 to 1991, which supports my argument.

7. See AS&TS/JCSS/SAVI (1993) for a series of proposals to improve science and mathematics at school level over the medium and long term.

8. The data from this research, including the interviews of African male engineering students cited below, is currently being analysed and what follows here are a few impressionistic results.

9. It would seem difficult to avoid some form of national 'personpower planning', even of a rough sort, in relation to long term economic needs, in the setting of these 'upper limit' allocations.

10. A recent review of civil engineering university training in South Africa has argued for a much broader undergraduate engineering training (Hugo et al, 1989).